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ABSTRACT

This is a catalog of instructional films for college chemistry, designed for use by chemistry and other science teachers. The films in this catalog are listed in topical arrangement, which consists of (1) preparatory topics, (2) structure, (3) interaction of radiation with matter, (4) physical states, (5) formulas, equations and calculations, (6) dynamics, (7) thermochemistry, thermodynamics, and electrochemistry, (8) equilibria, (9) inorganic chemistry, (10) organic chemistry, (11) biochemistry, (12) laboratory techniques, (13) physics review, (14) miscellaneous, and (15) special interest. Each topic is divided into one or more sub-topics. Each film is listed alphabetically by title, and is identified further by its producer, length, film type (16mm, 8mm, Super 8), color or black/white, catalog number, and price. A brief description of the contents of each film is included. Starred films in the catalog are those which have been personally used and recommended by members of the panel who compiled this catalog. (LC)

A CATALOG OF INSTRUCTIONAL FILMS FOR COLLEGE CHEMISTRY

A PROJECT OF THE
FILM REVIEW PANEL
OF THE
ADVISORY COUNCIL
ON COLLEGE CHEMISTRY

CATALOG

OF

INSTRUCTIONAL FILMS

(16mm, Super 8, and 8mm)

FOR

COLLEGE CHEMISTRY

Advisory Council on College Chemistry
Department of Chemistry
Stanford University
Stanford, California 94305

Serial Publication No. 42 1969

Advisory Council on College Chemistry

Department of Chemistry, Stanford University, Stanford, California 94305

The Advisory Council on College Chemistry, an independent group of chemists, has as its goal the improvement of undergraduate chemistry curricula and instruction. The Council collects and disseminates information through the activities of standing committees on Freshman Chemistry, Curriculum and Advanced Courses, Teaching Aids, Teacher Development, Science for Non-Science Majors, Two-Year College, and Resource Papers. Additional *ad hoc* groups act as necessary to further assist the Council in providing leadership and stimulus for imaginative projects on the part of individual chemists.

The Council is one of a group of collegiate commissions supported by grants from the National Science Foundation.

- PREFACE -

In an attempt to advise the chemical community on the availability of useful films for lecture supplements or laboratory instruction, The Advisory Council on College Chemistry appointed a film panel in early 1968. This panel, consisting of Dr. Samuel Schrage, Chairman, University of Illinois at Chicago Circle, Dr. Norman Duffy, Kent State University, Dr. J. Leland Hollenberg, the University of Redlands, and Dr. Rod O'Connor, the University of Arizona, was charged with collecting information on college-level chemistry films produced within recent years. It was hoped initially that the films could be carefully reviewed so that some indication of their value to college teachers could be made. However, the unexpected volume of films available rendered this task impossible for the small panel to accomplish.

The resulting collection in this catalog, then, is simply a listing of films available. Every attempt was made to include all current films with correct descriptions and prices.* Only those films known to be unsuitable for college use because of recognized content errors or level of presentation have been deliberately omitted. In a collection of this magnitude inadvertent errors and omissions are, unfortunately, likely to occur and the panel will appreciate any suggestions for corrections and improvement.

At the end of the catalog are several reply forms. Teachers wishing to advise the Council of films which should be added, deleted, or highly recommended are urged to do so.

Almost all of the distributors of educational motion pictures have new films under contract. Teachers wishing to keep up with new releases should write to the distributors, requesting to be placed on mailing lists for chemistry films. It is hoped that this booklet will form a useful background reference for improved use of instructional motion pictures and that teachers will keep it up to date by adding new listings as they appear.

Starred films in this catalog are those which have been personally used and recommended by one or more members of the panel. There is no intent to indicate that many of the unstarred films may not be equally good. It is never wise to use a film without previewing well in advance.

Comments and suggestions for revision of this booklet should be addressed to:

Advisory Council on College Chemistry
Film Programs
c/o Rod O'Connor
Department of Chemistry
University of Arizona
Tucson, Arizona 85721

* Prices are generally subject to change without notice and listings in this catalog must be considered as approximate costs only.

SOURCE OF FILMS

ACS	American Chemical Society 1155 Sixteenth Street NW Washington, D.C. 20036
AEC	Audio-Visual Branch Division of Public Information U.S. Atomic Energy Commission Washington, D.C. 20545
AFL	Anargyros Film Library 1813 Fairburn Avenue Los Angeles, California 90025
AGC	Aerojet-General Corp. Corporate Public Relations 9100 East Flair Drive El Monte, California 91734
AIM	Association Instructional Materials c/o Association Films, Inc. 347 Madison Ave. (Dept. DC) New York, N.Y. 10017
ALFI	Almanac Films, Inc. 29 E. 10th Street New York, N.Y. 10003
BFI	Bailey Films 6509 DeLongpre Avenue Hollywood, California 90028
CCA	Charles Cahill & Associates, Inc. P.O. Box 3220 Hollywood, California 90028
CHUR	Churchill Films 662 N. Robertson Blvd. Los Angeles, California 90069
CONTEMPF	Contemporary Films, Inc. 267 West 25th Street New York, N.Y. 10001
CORF	Coronet Films 65 E. South Water Street Chicago, Illinois 60601
DUART	Du Art Film Laboratories, Inc. U.S. Government Film Service 245 W. 55th Street New York, N.Y. 10019
EAL	Ealing Film-Loops 2225 Massachusetts Avenue Cambridge, Massachusetts 02140
EBF	Encyclopaedia Britannica Films, Inc. 425 N. Michigan Avenue Chicago, Illinois 60611
EYE	Eye Gate House, Inc. 146-01 Archer Avenue Jamaica, N.Y. 11435
FAC	Film Associates of California 11559 Santa Monica Blvd. Los Angeles, California 90025
GAEF	Gateway Educational Films Ltd. 470-472 Green Lanes Palmers Green London N13, England
GE	General Electric Educational Films 60 Washington Avenue Schenectady, N.Y. 12305
HR	Harper & Row Publishers, Inc. 49 East 33rd Street New York, N.Y. 10016
ICF	International Communication Films 1371 Reynolds Avenue Santa Ana, California 92705
IFB	International Film Bureau, Inc. 332 S. Michigan Avenue Chicago, Illinois 60604
INDU	Indiana University Audio-Visual Center Bloomington, Indiana 47401
JCA	John Colburn Associates, Inc. 1215 Washington Avenue Wilmette, Illinois 60091
JOUR	Journal Films Educational Motion Pictures 909 W. Diversey Pkwy. Chicago, Illinois 60614
LBF	L B Films 3435 Grant Street Corvallis, Oregon 97330
LGC	Longmans, Green & Co. Ltd. 48 Grosvernor Street London W.1., England
MCA	Manufacturing Chemists' Assn., Inc. 1825 Connecticut Avenue, N.W. Washington, D. C. 20009
MGHT	McGraw-Hill Book Co. Text-Film Division 330 W. 42nd Street New York, N.Y. 10036
MINNU	Audio-Visual Education Service 55 Wesbrook Hall University of Minnesota Minneapolis, Minnesota 55455
MLA	Modern Learning Aids 1212 Avenue of the Americas New York, N.Y. 10036
MSC	Macalaster Scientific Corp. Waltham Research & Development Park 186 Third Avenue Waltham, Massachusetts 02154
NFBC	The National Film Board of Canada 680 Fifth Avenue New York, N.Y. 10019

PPG		PPG Industries, Inc. One Gateway Center Pittsburgh, Pennsylvania 15222
RIC	*	The Royal Institute of Chemistry 30 Russell Square London, W.C.1, England
ROB		Peter M. Robeck & Co., Inc. 230 Park Avenue New York, N.Y. 10017
SDC		System Development Corp. 2500 Colorado Avenue Santa Monica, California 90406
STER		Sterling Movies, Inc. 43 West 61st New York, N.Y. 10023
SUTH		Sutherland Educational Films, Inc. 201 N. Occidental Blvd. Los Angeles, California 90026
TEK		Films Library Tektronix, Inc. P.O. Box 500 Beaverton, Oregon 97005
THORNE		Thorne Films Dept. 113 1229 University Avenue Boulder, Colorado 80302
UEVA		Universal Education & Visual Arts 221 Park Avenue South New York, N.Y. 10003
UKAEA		United Kingdom Atomic Energy Authority 11 Charles II Street London, SW 1, England
UNESCO		Unesco P.O. Box 1425 Bangkok, Thailand

* A number of the films described in this catalog are available from the Royal Institute of Chemistry - for details write for their <u>Index of Chemistry Films</u>.

TOPICAL ARRANGEMENT OF INSTRUCTIONAL FILMS

001

THE SLIDE RULE: THE "C" AND "D" SCALES
Collaborator: R. B. Williamson, MIT
(24 min., 16mm, B/W, sound)

Purpose of the slide rule; parts of the rule; how to use, and "C" and "D" scales in the multiplication and division of numbers.

DUART, cat. no. OE179, $32.72

THE SLIDE RULE: CI SCALE
Collaborator: R. B. Williamson, MIT
(4 min., S-8, color, silent) 1967

Two wooden blocks from Film 83-0018/1 are manipulated to show that the readings on the CI scale are the reciprocals of those on the C and D, and that the resulting scale is a C or D scale in reverse. The camera traverses the indexed rule to identify the integers on both scales, and, in extreme closeup, shows how to obtain a reciprocal of a 2-digit and 3-digit number. Multiplication on the CI scale is explained and compared to division on the C scale. Conversely, division on CI is seen as the equivalent of multiplication on C. Throughout the film, operational procedures are summarized by subtitles wherever necessary, and numerical readings are identified by use of color-coded strips.

EAL, cat. no. 83-0059/1, $21.50

THE SLIDE RULE: DIVISION, C AND D SCALES
Collaborator: R. B. Williamson, MIT
(3:40, S-8, color, silent) 1967

Using the circular saw and wooden blocks from film 83-0018/1 division is shown as the subtraction of lengths. Direct comparison is made between the blocks and a real rule, using the simple example $6 \div 3 = 2$. A more complicated example involving two 3-digit numbers is then worked. The problem of how to choose the appropriate slide index is introduced and solved by reference once again to the wooden blocks. Throughout the film, operational procedures are summarized by subtitles wherever necessary, and numerical readings are identified by use of color-coded strips.

EAL, cat. no. 83-0042/1, $21.50

THE SLIDE RULE: MULTIPLICATION, C AND D SCALES
Collaborator: R. B. Williamson, MIT
(3:50, S-8, color, silent) 1968

A simple example ($2 \times 3 = 6$) is demonstrated using the wooden blocks from film 83-0018/1. With the blocks still in view for comparison, the calculation is repeated using the real rule. Two more complicated examples follow, first a pair of 2-digit numbers and then a pair of 3-digit numbers. Positioning the decimal point is discussed and illustrated. The example $4 \times 5 = 20$ is used to introduce the problem of how to choose the appropriate slide index. This is solved by reference once more to the wooden blocks. Throughout the film, operational procedures are summarized by subtitles wherever necessary, and numerical readings are identified by use of color-coded strips.

EAL, cat. no. 83-0034/1, $21.50

THE SLIDE RULE: READING AND HANDLING
Collaborator: R. B. Williamson, MIT
(4:05, S-8, color, silent) 1967

This film begins with the assembly of a rule from its labeled parts. The location of the C and D scales is compared on various elementary rules in common use. The positions of the single-digit numbers are related to those on a wooden block from film 83-0018/1. Then, the camera makes two slow traverses of the indexed rule to illustrate how to read 2-digit and 3-digit numbers respectively. The scale subdivisions are clearly explained, and a total of 24 readings taken. Various alternative methods are shown for holding the rule while operating the slide, making fine adjustments of slide and indicator, and setting the slide index to a number.

EAL, cat. no. 83-0026/1, $21.50

THE SLIDE RULE: SQUARES, CUBES, AND ROOTS
Collaborator: R. B. Williamson, MIT
(4:05, S-8, color, silent) 1967

A rule with slide removed is laid on top of a wooden block from film 83-0018/1. The single-digit numbers on A are shown to be the squares of those on D. The example of 16^2 is then worked, and a careful explanation given of how to position the decimal point by expressing numbers in powers of ten. Powers of ten are also the basis of the method used when choosing the correct half of the A scale in order to find a particular square root. A multi-digit example is worked to test the method. The K scale is then identified, and the cubes of three simple numbers found. The method of finding cube roots, analogous to that illustrated for square roots, is delegated to the film notes.

EAL, cat. no. 83-0067/1, $21.50

THE SLIDE RULE: 2-DIGIT PRACTICE
Collaborator: Ealing Corp.
(3:40, S-8, color, silent) 1967

This film is designed to give the student practice in reading and interpreting numbers on the C and D scales. The film is composed of a series of short scenes. Each scene is a close-up of the hairline resting on a two-digit number superimposed on the picture. With practice the student will find that he can beat the film to the answer. This film is designed for repetitive, individual student viewing.

EAL, cat. no. 83-0075/1, $21.50

001

THE SLIDE RULE: 3-DIGIT PRACTICE
Collaborator: Ealing Corp.
(3:40, S-8, color, silent) 1967

This film is similar to 83-0075/1 two-digit practice. Each scene shows an extreme close-up of a three-digit number on the C and D scales. In each case, one of the large primary digits appears for ease in scale reading. Each scene appears briefly, then the answer is superimposed.

EAL, cat. no. 83-0083/1, $21.50

THE SLIDE RULE: WHY IT WORKS
Collaborator: R. B. Williamson, MIT
(4:10, S-8, color, silent) 1967

The film begins by reviewing the concepts of number, base, and exponent, and illustrates the addition of exponents to achieve multiplication. A number of wooden blocks are then cut and labeled so that their exponents are proportional to their lengths. The blocks are used to show that addition of lengths represents multiplication. Next, two identical blocks are labeled and manipulated to introduce the idea of a pair of scales. Sliding produced addition of lengths and, therefore, multiplication. Non-integer exponents are produced by subdividing a 10^1 block. Conversely, a block representing 2 (10^3) is used. to mark off the position of 4 (10^6) and 8 (10^9) and so begin the construction of the non-linear C and D scales. Finally, two C- and D-type blocks are used to multiply 3 x 2 and related to the body and slide of a real rule.

EAL, cat. no. 83-0018/1, $21.50

002

DENSITY
Collaborator: Carl Clader, New Trier Township High School, Winnetka, Illinois and L. Carroll King, Northwestern University
(3 min., 8, S-8, color, silent)

Presents the actual derivation of the density of a solid together with the qualitative measure of liquid density. Defines density as weight/unit volume. Illustrates the relationship of the density of a solid to a liquid.

EBF, cat. no. R80602, 8, $16.; S80602, S-8, $17.60

MEASUREMENT
Collaborator: William Siebert, MIT; ESI; PSSC
(21 min., 16mm, B/W, sound)

The measurement of the speed of a rifle bullet is used as the basis for a discussion of the art of measurement. Problems that are met and discussed include noise, bias, use of black boxes and the element of decision in all measurements.

MLA, cat. no. 0105, $120.

MEASUREMENT IN PHYSICAL SCIENCE
Collaborator: J. Donald Henderson, University of North Dakota
($13\frac{1}{2}$ min., 16mm, B/W, color, sound)

Laboratory demonstrations are used to illustrate principles for measuring distance, mass and time.

CORF, B/W, $75.; color, $150.

MEASURING TECHNIQUES
Collaborator: BSCS
(14 min., 16mm, color, sound)

Techniques and principles of handling basic laboratory equipment for measuring lengths and volumes, and determining concentrations, ranging from gross to microscopic. This includes demonstration of the ocular and stage micrometers, hemacytometer, and various types of volumetric glassware (burette, pipette flask, and graduated cylinder).

MSC, cat. no. 65029, $150.

SHORT TIME INTERVALS
Collaborator: Campbell Searle, MIT; ESI
(21 min., 16mm, B/W, sound) 1959

A study of the extension of the senses to deal with very short time intervals. As an example, special techniques reveal complexities in a flash of lightning which are not ordinarily perceptible to the eye. Timing devices shown include moving cameras, pen recorders and the oscilloscope, with an explanation of its use in these measurements.

MLA, cat. no. 0119, $120.

SURFACE AREAS OF SOLIDS I
Collaborator: E. H. C. Hildebrandt and Larry H. Miller, Northwestern University
(15 min., 16mm, B/W, color, sound)

Surface areas of cubes, prisms and pyramids are dealt with in this film. We see how surface areas can vary according to the size and shape of various geometric solids. Life situations are shown where it is necessary to know a means for finding surface areas in order to pursue an occupation. This film has a considerable amount of animation in it to insure a thorough understanding of how surface areas are determined.

EYE, cat. no. EG508, B/W, $75.; EG509, color, $150.

SURFACE AREAS OF SOLIDS II
Collaborator: E. H. C. Hildebrandt and Larry H. Miller, Northwestern University
(15 min., 16mm, B/W, color, sound)

Cylinders, cones and spheres are dealt with in this presentation. Animation, as well as demonstrations, clearly illustrate the logic of the formulas developed for finding the surface areas of these solids. The film concludes with

002

specific concepts; that the area of a solid is the measure of its bounding surfaces; that the area of the side surfaces is called the lateral area of the solid; that the entire area of the surface is called the total area; that a sphere has only a total area.

EYE, cat. no. EG510, B/W, $75.; EG511, color, $150.

THERMOMETERS AND HOW THEY WORK
Collaborator: Lee Wickline, Science Supervisor, State of West Virginia
(11 min., 16mm, B/W, color, sound)

Explores the three basic types of thermometers - those made with liquids, gases, and solids, then shows by means of simple demonstrations how each type works.

EBF, cat. no. 2068, B/W, $70.; 2067, color, $135.

TIME AND CLOCKS
Collaborator: John King, MIT; ESI; PSSC
(28 min., 16mm, B/W, sound)

Discusses concepts of time measurement and shows various devices used to measure and record time intervals from 1 second down to 10-9 seconds. Points out that the accuracy of a clock can be judged only by comparison with another clock. The question of what time is, psychologically, is raised briefly as well as the question of a possible limit to the subdivision of time.

MLA, cat. no. 0101, $150.

THE ULTIMATE SPEED
(38 min., 16mm, B/W, sound)

Using a Van de Graaff electrostatic generator and a linear accelerator, the speeds of electrons are determined by time-of-flight techniques, and the kinetic energy of the electrons is measured by calorimetric means. The results indicate a limiting speed equal to that of light, in agreement with the theory of special relativity.

UEVA, $160.

VERNIER EXAMPLES
(2:05, 8, color, silent)

Five examples of vernier readings are given, showing the scale of actual vernier calipers in extreme close-up. These readings can be used to test the ability of pupils to arrive at the correct answer.

GAEF, cat. no. PM/464, $6.60

THE VERNIER SCALE
(3:18, 8, color, silent)

The film shows vernier calipers being used to measure an object. An animated diagram that shows how the vernier scale works and the manner in which one set of divisions are read against the other.

GAEF, cat. no. PM/463, $8.28

VOLUME
Collaborator: Carl Clader, New Trier Township High School, Winnetka, Illinois and L. Carroll King, Northwestern University
(3 min., 8, S-8, color, silent)

By means of animation and live photography, the concept of volume as a three-dimensional measure is developed. Illustrates basic volumes used in chemical laboratory practice.

EBF, cat. no. R80603 (8), $16.00; S80603 (S-8), $17.60

003

ANIMALS IN MICROUNIVERSE
(11 min., 16mm, B/W, color, sound)

By use of photomicrography and polarized light, we are able to study the factors accounting for the complexity of life in microscopic organisms. The relationship of minute animals in a micro-environment and the seemingly endless variety of life in this part of our world is studied in a manner not possible with other methods of observation. These micro-animals are seen in this film: Vorticella, Amoeba, Paramecium, Didinium, Stentor, Cyclops, Rotifer, and Volvox.

JCA, cat. no. 502, B/W, $60.; color, $120.

CHANGE OF SCALE
Collaborator: Robert Williams, MIT
(23 min., 16mm, B/W, sound)

Shows how changes of size necessitates change in structure of objects and emphasizes scaling problems, illustrating with scale models.

MLA, cat. no. 0106, $120.

COMPARATIVE SIZES OF MICROSCOPIC ANIMALS
(4 min., S-8, color, silent)

This film is designed to help students gain some idea of the relative sizes of the various microscopic organisms which they may encounter. Those which appear in this film are seen in more detail in other films in this series: Paramecium, Eugoena, Amoeba, Blepharisma, Stentor, Rotifer, Vorticella, Volvox, Stylonychia.

EYE, cat. no. 81011, $15.50

003

ELECTRON MICROSCOPY
Collaborator: AEI Film Unit of Assoc. Electrical Industries, Ltd.
(23 min., 16mm, color, sound) 1963

This film traces history of the microscope from the optical instruments of the seventeenth century to the electron microscope of today. It shows the principles of electron microscopy, the instruction and operation of an electron microscope and its use with the image intensifier; the preparation of specimens; and examples of its use in research and industry.

IFB, cat. no. 3IFB347, $200.

EYE FOR TOMORROW
Collaborator: Gilbert S. Aberg, Penn State University; Cenco Educational Films
(15 min., 16mm, B/W, sound)

This film tells the story of the exciting Muller Field Ion Microscope whose ability to magnify over 2 million times with a resolution of 3 Angstroms or better has enabled the world's scientists to view the atom directly for the first time. This unusual film, produced right in Dr. Muller's laboratory at Penn State University, explains the basic theory of field ion microscopy and how this new instrument evolved from the first basic experiments. Exciting cinemicrographs show layers of atoms being bombarded and stripped away to reveal voids, inclusions and distortions in crystal lattice arrangements.

EYE, cat. no. EG538, $75.

HOW BIG IS AN ATOM?
(30 min., 16mm, B/W, sound)

The reality of the conception of an atom is established by showing size in relationship to the visible world. Various determinations of atom size are reviewed, and ways in which the effects of atoms have been observed are discussed. Through use of optical and electron microscopes, a visual notion of the size of atoms is presented.

INDU, cat. no. FS-356, $100.

MEASURING LARGE DISTANCES
Collaborator: Fletcher Watson, Harvard; ESI; PSSC
(29 min., 16mm, B/W, sound)

Using models of earth, moon and stars, Dr. Watson described the place of triangulation, parallax and the inverse square law for light in geophysics and astronomy; his demonstrations point up the immensity of interstellar space, and suggest the complexities of measurement on this scale.

MLA, cat. no. 0103, $150.

MEASURING SHORT DISTANCES
Collaborator: Dorothy Montgomery, Hollins College; ESI; PSSC
(20 min., 16mm, B/W, sound) 1959

Starts with the centimeter scale, moves on to microscopic dimensions, and then to the dimensions of atoms by means of Erwin Mueller's field emission microscope. Shows how calibration of instruments can give us accurate knowledge of these small distances.

MLA, cat. no. 0104, $120.

MEASURING THE VERY SMALL
Collaboratory: Nuffield Foundation
(2-5 min., 8, B/W, silent) 1966

See RIC, p. 224

A SIMPLE OCULAR MICROMETER
(3:10, 8, S-8, color, silent)

Illustrates a simple method for mass producing, mounting, and calibrating uniform, precision ocular micrometers for measuring the size of objects under the microscope.

THORNE, cat. no. 43, $18.50

THE SIZE OF ATOMS FROM AN ATOMIC BEAM EXPERIMENT
Collaborator: John King, MIT
(28 min., 16mm, B/W, sound) 1966
(28 min., 16mm, 8, B/W, sound)

This film investigates the scattering of an atomic beam of potassium by argon to find out something about the size of atoms. A series of experiments is performed measuring the loss of intensity of a beam of potassium atoms traveling through argon gas at various pressure. From these data, assuming spherical atoms of potassium and argon, the size of the atoms is determined and the size is found to be independent of the pressure of the argon.

MLA, cat. no. 0455, $150.
UEVA, (16mm), $145.; (S-8), $115.

TIME AND QUANTITY
(27 min., 16mm, B/W, sound)

Originally presented as part of a television program, this film relates oscilloscope measurements to other measuring techniques. Dr. John Allen of Portland State College and Charles Sanford of Tektronix discuss the measurement of time and quantity, from billions of years to billionths of a second. The film stresses the oscilloscope's vital role in accurately measuring very small time segments.

TEK, cat. no. 067-0130-00, $51.

003

UNIVERSE
Collaborator: National Film Board of Canada
(26:10, 16mm, B/W, sound) 1960

A triumph of film art, creating on the screen a vast, awe-inspiring picture of the universe as it would appear to a voyager through space. Realistic animation takes you beyond our solar system into far regions of the sky perceived by the modern astronomer. Beyond the reach of the strongest telescope, past moon, sun, Milky Way, into galaxies yet unfathomed, you travel on into the staggering depths of the night, astonished, spellbound at the sheer immensity of the universe. Starting point for this journey is the David Dunlap Observatory, Toronto.

MGHT, cat no. 692402, $145.

004

LIKELY OR NOT? (Reasoning: Applied Concepts)
(3 min., 8, S-8, color, silent)

Several real life situations involving events of differing probabilities are depicted to introduce the idea of how the probability of a given event varies widely.

EBF, cat. no. R80180 (8), $20.; S80180 (S-8), $22.

NECESSARY BUT NOT SUFFICIENT (Reasoning)
(3 min., 8, S-8, color, silent)

Real life and mathematical examples are used to emphasize that a condition may be necessary, but not a sufficient one on which to base a conclusion.

EBF, cat. no. R80189 (8), $20.; S80189 (S-8), $22.

PATTERNS OF SCIENTIFIC INVESTIGATION
Collaborator: Yale Chem. Films
(22 min., 16mm, color, sound)

Harold G. Cassidy, Professor of Chemistry at Yale discusses the basic concepts and operation of the scientific method, using as an illustrative example the discoveries that contributed to our present understanding of static behavior. Professor Cassidy outlines and demonstrates a typical pattern for scientific work; observation of a reproducible phenomenon, improvement of measurement, experimentation, correlation of data, construction of theory, test of theory by further experimentation. Each step is illustrated with a key experiment in the exploration of static electricity.

AIM, cat. no. YF-235, $209.

*RANDOM EVENTS
Collaborator: Patterson Hume and Donald Ivey, University of Toronto
(31 min., 16mm, B/W, sound)

This film shows how the overall effect of a very large number of random (unpredictable) events can be very predictable. Several unusual games are played to bring out the statistical nature of this predictability. The predictable nature of radioactive decay is explained in terms of what is shown.

MLA, cat. no. 0116, $150.

THE SCIENTIFIC METHOD
Collaborator: Phillip K. Frank, Harvard
(12 min., 16mm, B/W, color, sound)

Explains the steps of the scientific method, demonstrates the way this method of problem solving is applied by scientists, and discusses the value of scientific thinking in dealing with problems of everyday life. Features the discovery of penicillin by Sir Alexander Fleming.

EBF, cat. no. 702, B/W, $60.; 703, color, $120.

005

CHANGES ON MIXING
(4 min., 8, color, silent)

A variety of substances are brought together in pairs and the results observed.

UNESCO, cat. no. 5, $6.

COMBUSTION I - BURNING CANDLE
Collaborator: Halas & Batchelor
(1:15, 8, color, silent) 1963

Shows the result of a flame burning in an enclosed space.

MGHT, cat. no. 669026, $10.95

COMBUSTION: AN INTRODUCTION TO CHEMICAL CHANGE
Collaborator: Iwanami Film
(16 min., 16mm, color, sound)

Using combustion as an example of a chemical change this film illustrates a number of fundamental chemical principles. It is shown that new substances with properties different from the original substances are formed as a result of chemical change, and that in the case of combustion these new substances incorporate oxygen atoms. Because oxygen has been combined with the burnt substance, the products of combustion weigh more than the material that was burnt, and if we remove oxygen we can often obtain the original. The film serves as an elementary introduction to the nature of chemical change and the conservation of matter.

FAC, $190.

005

THE COMBUSTION PROCESS
Collaborator: British Petroleum Co., Ltd.
(26 min., 16mm, color, sound) 1966

Theory of combustion; chemical reactions involved; creation of the correct conditions practical considerations; application to more efficient use of petroleum fuels.

See RIC, p. 131

CONDITIONS NECESSARY FOR COMBUSTION
(3:45, 8, S-8, color, silent) 1964

Combustion is shown under various conditions. The results of varying the conditions; fuel, oxygen and kindling temperature, are shown. A flame in carbon dioxide and rapid burning in the pressure of oxygen are illustrated.

ICF, cat. no. 13150 (8), $16.; (S-8), $19.50

CONSERVATION OF MASS
Collaborator: Don Herbert, Prism Productions and M. H. Shamos, New York University
(4 min., S-8, color, silent)

Two experiments demonstrate the principle of conservation of mass. The first experiment shows a candle on one side of a two-pan balance. The candle is lighted and allowed to burn. When the flame is extinguished, it is observed that the candle has lost mass. The experiment is repeated, this time with the candle enclosed in a glass jar. The candle is ignited from outside the bottle by means of a magnetically operated lighter. The candle burns and eventually goes out, but the balance continues to make equal oscillations about zero, indicating that there has been no net loss from the system.

EAL, cat. no. 80-3254/1, $22.95

*ELEMENTS, COMPOUNDS, MIXTURES
Collaborator: Thomas Sumner, University of Akron
(30 min., 16mm, B/W, color, sound)

Explains through demonstration and illustration the physical and chemical properties of two elements, of a mixture of both, and both in compound form.

CORF, B/W, $137.50; color, $275.

ELEMENTS, COMPOUNDS AND MIXTURES
Collaborator: Iral Johns, Monsanto Chemical Corp.
(33 min., 16mm, color, sound) 1959

A discussion of the difference between elements, compounds and mixtures, showing how a mixture can be separated by physical means. Demonstrates how a compound can be made and then taken apart by chemical methods with identification of components by means of their physical properties such as melting point, boiling point, solubility, color, etc.

MLA, cat. no. 0111, $260.

EXPLAINING MATTER: CHEMICAL CHANGE
Collaborator: Milton O. Pella, University of Wisconsin
(11 min., 16mm, color, sound)

Illustrates that a chemical change takes place when atoms from the molecules of two or more materials join to form molecules of entirely different materials. Examples of changes include burning, digestion of food, and plant photosynthesis.

EBF, cat. no. 1746, $135.

GAS REACTIONS I (THE HYDROGEN/OXYGEN SYSTEM)
(4 min., 8, color, silent)

A continuous variation investigation of the hydrogen/oxygen system is presented. Animation is used to exemplify the making and testing of a Hypothesis.

UNESCO, cat. no. 4, $6.

INTRODUCTION TO CHEMISTRY
Collaborator: Therald Moeller, University of Illinois
(11 min., 16mm, B/W, color, sound)

This film stimulates an interest in the study of chemistry. Defining chemistry, the motion picture introduces some of the important terms and materials common to the subject. The applications of chemistry in industry, in the home and on the farm are presented.

CORF, B/W, $60.; color, $120.

PHYSICAL AND CHEMICAL CHANGE
Collaborator: Thomas Sumner, University of Akron
(28 min., 16mm, B/W, color, sound)

Shows examples of the chemical reactions of direct union, displacement, decomposition and double decomposition.

CORF, B/W, $125.; color, $250.

PROPERTIES OF MIXTURES AND COMPOUNDS
Collaborator: Yale Chem. Films
(4 min., 16mm, color, silent)

Illustrates that "change" must be described in terms of characteristic properties. Iron filings and sulfur powder mixed together are distinguishable through testing, but when heated to ignition the resulting compound does not respond to similar tests.

AIM, cat. no. YF-240, $30.

101

THE ATOMIC THEORY
(10 min., 16mm, B/W, sound)

A general approach starting with the basic theory proposed by Dalton in 1808, and outlining progress in atomic study during the nineteenth century, including Faraday's electrolysis experiments and Mendeleef's Periodic Table.

UEVA, $60.

DEFINITE AND MULTIPLE PROPORTIONS
Collaborator: Robert St. George, Cambridge School and Jerrold R. Zacharias, MIT
(30 min., 16mm, B/W, sound)

The Dalton based conviction that matter comes in natural units, atoms; the chemical laws of definite proportions demonstrated by electrolysis and recombination of water; multiple proportions by quantitative decomposition of N_2O, NO and NO_2.

MLA, cat. no. 0110, $150.

ON THE STABILITY OF MATTER
Collaborator: Philip Morrison, MIT
(30 min., 16mm, B/W, sound)

We know only since Rutherford that, like the solar system, the atom of matter is mostly space within which the electrons move, held by forces at least analogous to the force of gravity. In spite of internal motion and spacious structure, an atom somehow remains itself; that which changes in matter, the rusting blade, the hard coal turned to smoke, is but a rearrangement of the same tiny particles. To suggest the extraordinary stability, the incorruptibility of the atoms themselves, they were named by the Greeks, and the word atom means "The Uncut". The material world is stable because its atoms (bricks) are stable.

ROB, cat. no. 1, $180.

102

AN APPROACH TO THE ELECTRON
Collaborator: Esso Petroleum Co., Ltd.
(14 min., 16mm, color, sound) 1964

The properties of cathode rays and of the electron, and an introduction to atomic structure, introduced by a study of thermionic emission.

See RIC, p. 22

COULOMB FORCE CONSTANT
Collaborator: Eric Rogers, Princeton; ESI; PSSC
(34 min., 16mm, B/W, sound)

Shows a large-scale version of the Millikan Experiment. The small charged plates of the original experiment are made very large and the effects are shown of increasing plate area and separation, and adding more batteries to charge the plates. The same electric field strength used in the Millikan Experiment enables the experimenter to count the number of elementary charges on an object and measure the constant in Coulomb's law of electric force.

MLA, cat. no. 0405, $150.

CROOKE'S TUBES
Collaborator: Yale Chem. Films
(8 min., 16mm, color, silent)

Demonstrates the effect of pressure on electrical discharge in gases. A variety of special tubes are used to show the kinetic energy of cathode rays, the heating effect, fluorescence, their straight-line travel and deflection by a magnetic field.

AIM, cat. no. YF-226, $60.

ELECTRONS IN A UNIFORM MAGNETIC FIELD
Collaborator: Dorothy Montgomery, Hollins College; ESI; PSSC
(11 min., 16mm, B/W, sound) 1962

A spherical cathode-ray tube with a low gas atmosphere (Leybold) is used to measure the curvature of the path of electrons in a magnetic field and with reference to the Millikan Experiment the mass of the electron is determined. Arithmetic involved is worked out with the experiment.

MLA, cat. no. 0412, $60.

ELEMENTARY CHARGES AND TRANSFER OF KINETIC ENERGY
Collaborator: Francis Friedman, MIT; ESI; PSSC
(34 min., 16mm, B/W, sound)

In a diode using the identical geometry of the Millikan Experiment the gain of kinetic energy of electrons flowing from the cathode to anode is measured experimentally and found to be that predicted by the results of the Millikan Experiment. This measurement is made by comparing the thermal energy dissipated as the electrons strike the anode with the thermal energy produced in an identical anode by a mass falling a known distance. In this film the elementary charges as determined from the Millikan and from the Faraday experiment are shown to be the same.

MLA, cat. no. 0409, $150.

e/m DEMONSTRATION
Collaborator: Yale Chem. Films
(4 min., 16mm, color, sound)

A programmed approach combining a film demonstration of Thompson's e/m determination with a worksheet provides study of apparatus, identification of significant experimental parameters and sampling of procedure and results.

AIM, cat. no. YF-245, $38.

102

FIELD EMISSION OF ELECTRONS
Collaborator: A. P. French, MIT
(4 min., 16mm, B/W, sound)

Shows how electrons can be dragged out of an unheated wire by strong electric fields.

UEVA, $20.

MASS OF THE ELECTRON
Collaborator: Eric Rogers, Princeton; ESI; PSSC
(18 min., 16mm, B/W, sound) 1962

Using a cathode ray tube encircled by a current carrying loop of wire, measurements are taken which enable the demonstrator to calculate the mass of the electron with reference to the Millikan Experiment. The calculations are brought out in detail, step by step.

MLA, cat. no. 0413, $90.

MATTER WAVES
Collaborator: Alan Holden and Lester Germer, Bell Telephone Labs; ESI; PSSC
(28 min., 16mm, B/W, sound) 1963

Dr. Germer presents a modern version of the original experiment which showed the wave behavior of the electron. The student sees electron diffraction patterns on a fluorescent screen. The patterns are understandable in terms of wave behavior; Alan Holden presents an optical analogue showing almost identical patterns. The electron diffraction experiments of G. P. Thomson are described by Holden who also presents brief evidence for the wave behavior of other particles such as neutrons and helium atoms.

MLA, cat. no. 0423, $150.

*MILLIKAN EXPERIMENT
Collaborator: Francis Friedman, MIT and Alfred Redfield, IBM; ESI; PSSC
(30 min., 16mm, B/W, sound) 1961

Simplified Millikan Experiment described in the text is photographed through the microscope. Standard spheres are substituted for oil drops; an analysis of the charge related to the velocity of the sphere across field of view of microscope emphasizes the evidence that charge comes in natural units that are all alike; numerous changes of charge are shown, produced by X-rays, with the measurements clearly seen by the audience. Professor Friedman gives an introduction and running commentary; Dr. Redfield does the experiment.

MLA, cat. no. 0404, $150.

MILLIKAN'S OIL DROP EXPERIMENT
Collaborator: Yale Chem. Films
(6 min., 16mm, B/W, silent)

A simple experiment devised to determine the elementary charge on an electron is demonstrated and explained. The formulas necessary for analysis of the data are included.

AIM, cat. no. YF-228, $21.

A NEW REALITY
Collaborator: Statens Filmcentral and Laterna Films, Denmark & OECD
(51 min., 16mm, color, sound) 1965

A New Reality traces the discovery of the structure of the atom and emphasizes the work of the Danish physicist, Niels Bohr. The story begins at the Institute for Theoretical Physics in Denmark, where experts from all parts of the world study and experiment with the atom. Man has devised means of visualizing the sub-microscopic structure of molecules and by advanced electronic equipment has gained an understanding of the character of the atom. We see how one element can be converted to another by atomic bombardment which changes the number of protons in the nucleus. Other demonstrations using light waves establish color measurement in terms of energy. Also illustrated are proofs that the electron components of the atom are both particles and wave energies. The modern concept of the atom is basically that determined bv Niels Bohr, and its implications reach into the realms of biology, psychology and philosophy.

IFB, cat. no. 3/2 IFB 394, $475.

PARTICLES OF MATTER
(13½ min., 16mm, B/W, color, sound; S-8, color, silent)

In this instructional film, familiar aspects of matter and energy are briefly reviewed and their relationship explained by means of a portrayal of basic concepts. The structure, properties, variations, and behavior of atoms are cast into simple teaching terms by the use of models, animation, and live photography.

UEVA, 16mm, B/W, $75., color, $150.; S-8, $119.

RAYS FROM ATOMS
(12 min., 16mm, B/W, sound)

Demonstrates early work with cathode rays and discovery of the electron; how positive rays were discovered and their nature established; the work of Roentgen with X-ray; the work of Sir Joseph Tomson.

UEVA, $60.

102

*RUTHERFORD ATOM
Collaborator: Robert Hulsizer, University of Illinois; ESI; PSSC
(40 min., 16mm, B/W, sound) 1962

Dr. Hulsizer uses a cloud chamber and gold foil in a simple alpha-particle scattering experiment to illustrate the historic Rutherford experiment which led to the nuclear model of the atom. Behavior of alpha-particles clarified by use of large scale models illustrating the nuclear atom and Coulomb scattering.

MLA, cat. no. 0416, $150.

RUTHERFORD-ROYDS' IDENTIFICATION OF ALPHA PARTICLES
Collaborator: Halas & Batchelor
(3 min., 8, S-8, color, silent)

Shows the Rutherford-Royds' apparatus, and how these scientists used it to prove conclusively that helium was formed by the accumulation of alpha particles.

EBF, cat. no. R80208, 8, $16.; S80208, S-8, $17.60

RUTHERFORD SCATTERING
Collaborator: The National Film Board of Canada
(3:45, S-8, color, silent)

The scattering of alpha particles by a nucleus is simulated on a cathode-ray tube with a computer. Rutherford's scattering experiment is performed in reverse by using the theoretical structure and forces of an atom to describe the paths of charge particles moving close to it. The paths of the particles are marked as dots on the screen, making their velocities apparent. The total scattering picture slowly builds up as more and more particles are shot at the nucleus. The kinds of orbits possible under a repulsive inverse square force become apparent.

EAL, cat. no. 80-3965/1, $22.95

SEARCHING FOR THE ULTIMATE
Collaborator: Ross-McElroy Productions, Chicago, Illinois
(29 min., 16mm, B/W, sound) 1962

Atomic structure research; use of particle accelerators; results of such research; matter and anti-matter.

AEC, free loan

*STERN-GERLACH EXPERIMENT
(26 min., 16mm, S-8, B/W, sound)

The film demonstrates that a well collimated beam of cesium atoms is split into two distinct beams when it passes through a non-uniform magnetic field. An introduction describes the behavior of simple magnetic dipoles in uniform and non-uniform magnetic fields. A summary compares the results with what might be expected if the atoms were classical dipoles or gyro magnets. Data are given which will permit the student to calculate the magnetic moment of the cesium atom.

UEVA, 16mm, $140.; S-8, $112.

THE STRUCTURE OF ATOMS
($12\frac{1}{2}$ min., 16mm, B/W, color, sound)

This film provides the experimental evidence for our basic concepts concerning the structure of the atom. An experiment similar to Rutherford's historic alpha particle scattering demonstrations shows that atoms have dense, positively charged nuclei. Another fundamental experiment shows the charge on the electron and the ratio of charge to mass.

MGHT, cat. no. 612010, B/W, $75.; 612022, color, $150.

THOMSON MODEL OF THE ATOM
Collaborator: The National Film Board of Canada
(3:50, S-8, color, silent)

In 1904 Thomson's experiments and calculations suggested to him that structure in the atom took the form of a series of periodic ring arrangements. In a mechanical model used to study this possibility, Thomson used a strong magnetic field acting on magnetized steel needles which represented electrons. In this film, the "electrons" are magnets supported by ping pong balls floating in a tube of water in a strong magnetic field. As the "electrons" are placed in the water one at a time, the student can see the patterns assumed by the "electrons" due to mutual repulsion and the influence of the outside magnetic field.

EAL, cat. no. 80-3957/1, $22.95

THOMSON'S POSITIVE RAY PARABOLA
Collaborator: Halas & Batchelor
($3\frac{1}{2}$ min., 8, S-8, color, silent) 1962

Illustrates the principles of the apparatus used by the English physicist, J. J. Thomson, to investigate positive rays. Concludes with shots of actual parabolas obtained by Thomson.

EBF, cat. no. R80210, 8, $20.; S80210, S-8, $22.

WHAT MAKES ATOMS STICK TOGETHER?
(30 min., 16mm, B/W, sound)

Through use of models, the structure and unique characteristics of atoms are shown reviewing significant studies of atomic structure by Rutherford, Bohr, and others. Explains atom stability and the particle and wave characteristics of electrons. How this wave nature is established by interference effects is demonstrated.

INDU, cat. no. FS-357, $100.

103

EXPLORING THE ATOMIC NUCLEUS
Collaborator: Theodore B. Novey, ANL
(13½ min., 16mm, B/W, color, sound)

The structure of the atom becomes less of a mystery with each passing year, and with the use of gigantic "atom smashers", or massive particle accelerators, physicists are now able to explore the atomic nucleus by accelerating atomic particles to speeds approaching that of light and using them to bombard the nuclei of various elements. Nuclear particles and particle interactions are produced, which help scientists discover what the atomic nucleus is like. Detection devices - such as scintillation counters, spark chambers and bubble chambers - are used to analyze these inter-actions. With the aid of this equipment physicists are working toward a complete and accurate description of the particles and forces within the atomic nucleus. This film shows students some of the recent discoveries concerning nuclear structure, the basic equipment used and how the resulting data are studied. Also shown are the Crockcroft-Walton generator and linear accelerator in use, and electronic computers which researchers use to find relationships among the great number of events they are trying to describe.

CORF, B/W, $75.; color, $150.

THE NUCLEAR STRUCTURE
(19 min., 16mm, B/W, sound)

Reconstructs the early work of Becquerel and the Curies on radioactivity, and explains Rutherford's theory of the Nuclear Structure of the Atom. Animated diagrams explain H. G. Moseley's work.

UEVA, $105.

104

ELECTRONIC STRUCTURE OF ELEMENTS
Collaborator: Yale Chem. Films
(11 min., 16mm, color, sound)

Show how the periodic table is used to determine the electronic configuration of any element. Using Plutonium 94 as an example, the filling of the outermost quantum levels and the jump-back to fill inner levels are detailed.

AIM, cat. no. YF-251, $104.50

*THE HYDROGEN ATOM (As Viewed by Quantum Mechanics) Standard Version
Collaborator: George C. Pimentel, University of California
(13 min., 16mm, 8, color, sound) 1963

This film presents a description of the atom that is in accord with quantum mechanics. This description explains the energy levels and line spectrum of the hydrogen atom and furnished the basis of contemporary theory of chemical bonding. The electron position in the atom is considered in terms of probability, and the meaning of a 1s orbital is clarified with a digital computer plot, two analogies, and animation.

MLA, cat. no. 4148, 16mm, $105.; 4848, 8, $89.

*THE HYDROGEN ATOM (As Viewed by Quantum Mechanics) Advanced Version
Collaborator: George C. Pimentel, University of California
(20 min., 16mm, 8, color, sound) 1963

A 20-minute advanced version includes the complete content of Film No. 4148 plus the final section which contrasts the electron distributions of 1s, 2s and 2p orbitals. The principal quantum number, n, is introduced together with its relation to energy levels, number of orbitals and the number of nodal surfaces.

MLA, cat. no. 4149, 16mm, $150.; 4849, 8, $128.

TEACHER TRAINING INTRODUCTION to "The Hydrogen Atom - As Viewed by Quantum Mechanics"
Collaborator: CHEM Study Teacher Training Films - Lesson 7
(9 min., 16mm, B/W, sound)

Professor Pimentel emphasizes the advantages of the quantum mechanical model of the atom, as presented in the classroom film over the planetary model. He discussed the relationship of quantum number to the spatical distribution of the electron in the one-electron atom. He then considers the screening effect of electrons at lower energy levels upon those at higher energy levels, and the relationship of the quantum states of the electrons to the periodic table.

MLA, cat. no. 4049, $50.

PIMENTEL DISCUSSES THE HYDROGEN ATOM
Collaborator: CHEM Study Teacher Training Films - Lesson 8
(32 min., 16mm, B/W, sound) 1964

This lecture was especially prepared because CHEM Study's treatment of this subject differs substantially from that of many "conventional" high school courses. Professor Pimentel discusses the shortcomings of the planetary model in terms of its inconsistency with experiment and with quantum mechanics. He then gives a basis for understanding the significance of the Schroedinger equation. The film emphasizes the desirability of teaching an up-to-date useful model of atomic structure rather than an easy, incorrect model which students find hard to unlearn.

MLA, cat. no. 4191, $150.

104

*IONIZATION ENERGY
Collaborator: Bruce H. Mahan, University of California
(22 min., 16mm, 8, color, sound) 1960-62

This film presents two methods of measuring ionization energy: Photo-ionization and electron bombardment. A high vacuum system is used with a simple conductivity cell. The photo-ionization of sodium by the use of a mercury light source and monochromator is carried out. The electron bombardment method is then demonstrated with gaseous sodium, and helium, argon and xenon. Animation shows what occurs on the atomic level during the ionization process. Relation of ionization energy to chemical reactivity is explained.

MLA, cat. no. 4151, 16mm, $165.; 4851, 8, $140.

TEACHER TRAINING INTRODUCTION to "Ionization Energy"
Collaborator: CHEM Study Teacher Training Films - Lesson 10
(8 min., 16mm, B/W, sound)

Professor Campbell demonstrates the usefulness of the electron energy level chart and points out that ionization energy data provide some of the important evidence upon which the chart is based. In a novel way he shows the familiar flame test for sodium and uses the energy level chart to identify the energy change responsible for the yellow color.

MLA, cat. no. 4051, $45.

THE PRINCIPLE OF UNCERTAINTY
Collaborator: Philip Morrison, MIT
(30 min., 16mm, B/W, sound)

In the past it was believed that since every cause produces an effect, and since every cause itself was an effect, and since we have a continuous history of cause and effect, then we could, therefore, predict what would happen next. This was proven to be untrue. The principle of uncertainty has made our scientific world open up. It tells us what kinds of mechanical knowledge we may or may not obtain. We know atoms always carry mass, charge, energy, momentum, etc., but we cannot hope to follow the motion of an electron in the orbit of a normal atom. If we could, we mark time in its passage. But then the energy would spread, and the atom would be in no well-defined energy level. Uncertainty?

ROB, cat. no. 6, $180.

105

ELECTRIC INTERACTIONS IN CHEMISTRY
Collaborator: CHEM Study - J. Leland Hollenberg, the University of Redlands and J. Arthur Campbell, Harvey Mudd College
(21 min., 16mm, 8, color, sound) 1963

Observations of two spheres suspended from the terminals of a high voltage generator remind us of the principles that opposite charges attract, like charges repel, and uncharged bodies have no electric interaction. To determine quantitatively the effect of distance on electric force, a sensitive balance measures the force between two charged spheres. The distance is varied and the electric force is calculated from changes in balance readings. A graph of electric force against distance suggests the equation $Fr^2=k$ (a constant) and the tabulated data confirm this relation. To illustrate the applications in chemistry of these principles, the migration of positive and negative ions and their mutual precipitation are shown in time-lapse photography and in animation.

MLA, cat. no. 4109, 16mm, $165.; 4809, 8, $140.

IONIZATION
Collaborator: Paul M. Wright, Wheaton College, Illinois
(18½ min., 16mm, B/W, color, sound)

The theory of ionization is treated with emphasis on its present important status in chemistry. The theory is defined, and we see the identifying characteristics of ions and where they occur. Electrolytes, dissociation, solvents, electrovalent compounds and covalent compounds are shown by animation and laboratory demonstration. In conclusion, reference is made to important applications of ionization in industrial chemistry.

CORF, B/W, $105.; color, $210.

105/106

CHEMICAL BOND AND ATOMIC STRUCTURE
Collaborator: Paul M. Wright, Wheaton College, Illinois
(16 min., 16mm, B/W, color, sound)

This film discusses the structure of the atom and shows that the electrons in the outermost shell, or energy level, of an atom help determine the way in which it bonds chemically with other atoms. Animation and laboratory demonstrations show three types of chemical bond and explain how bonding affects the physical and chemical properties of a substance.

CORF, B/W, $90.; color, $180.

106

ATOMIC AND BONDING ORBITALS
(4 min., 8, color, silent)

Based on quantum mechanical concepts, the principles of s and p orbital hybridization to sp^3 and sp^2, and sp orbitals are shown, along with examples of molecular models.

LBF, cat. no. 6, $15.

106

BUILDING ATOM MODELS-ISOMERISM
Collaborator: Yale Chem. Films
(6 min., 16mm, B/W, silent)

Uses three-dimensional models to show how different bending arrangements of atoms produce different molecules. Seven examples are demonstrated.

AIM, cat. no. YF-252, $21.

*CHEMICAL BONDING
Collaborator: George C. Pimentel, University of California
(16 min., 16mm, 8, color, sound) 1964

This film explains chemical bonding in terms of the electric interactions that cause the bonding in the hydrogen molecule. The release of energy when H atoms combine to form H_2 on a platinum surface is shown. This energy change is related to the simultaneous attraction of electrons by two or more nuclei, opposed by electron-electron and nucleus-nucleus repulsions. Through animation, the quantum mechanical view of electron distribution is portrayed. The bonding interaction between two hydrogen atoms is contrasted to the very weak, non-bonding interaction between two helium atoms.

MLA, cat. no. 4157, 16mm, $120.; 4857, 8, $102.

TEACHER TRAINING INTRODUCTION to "Chemical Bonding"
Collaborator: CHEM Study Teacher Training Films - Lesson 11
(14 min., 16mm, B/W, sound)

Professor Pimentel emphasizes the general application of the explanation for bonding as developed in the course and as presented in the CHEM Study Film. He uses the virial theorem to explain why the change in potential energy rather than in kinetic energy must be the dominant factor accounting for bonding. Using the molecule H_2^+ he explains why "exchange forces", magnetic interactions due to spin, and other electron-electron interactions cannot account for bonding. He discusses the use and misuse of the term "overlap" in discussing bonding, and touches upon a few of the ideas associated with molecular orbital theory.

MLA, cat. no. 4057, $75.

PIMENTEL DISCUSSED CHEMICAL BONDING
Collaborator: CHEM Study Teacher Training Films - Lesson 12
(27 min., 16mm, B/W, sound) 1964

Professor Pimentel amplifies the idea that attraction of one or more electrons for two or more nuclei accounts for bond formation. The virial theorem is presented and used to show that the lowering of the electron's total energy in bond formation can only occur through a lowering of its potential energy by being simultaneously near two or more nuclei. This principle is shown to apply equally well to covalent, ionic, and other types of bonding.

MLA, cat. no. 4192, $150.

THE PROPERTIES OF A COVALENTLY BONDED MOLECULE
Collaborator: Halas & Batchelor
(3 min., 8, color, silent)

Uses Carbon Tetrachloride as an example in showing the properties we associate with a compound whose molecules are discrete.

LGC, cat. no. E/66, $9.

THE STRUCTURE OF A COVALENT MOLECULE CCl_4
Collaborator: Halas & Batchelor
(3 min., 8, color, silent)

Shows the shape of a covalent molecule resulting from the minimization of repulsive forces.

LGC, cat. no. E/66A, $9.

109

PHYSICS AND CHEMISTRY OF WATER
Collaborator: Lever Bros. Co.
(21 min., 16mm, color, sound) 1965

Life on earth depends upon some of water's unusual properties - its slow rate of evaporation - its high surface tension - its power of solution - and the fact that it is heavier in the liquid than the solid form. The water molecule is made of two atoms of hydrogen and one of oxygen, held together by electrical forces. One end of the water molecule is positively charged and the other end is negatively charged. The positive end of one water molecule can be attracted and attached to the negative end of another forming a hydrogen bond. These bonds being made and broken at room temperature, result in fluidity. Hydrogen bonds account for most of water's unusual properties.

FAC, $230.

THE STRUCTURE OF WATER
(14 min., 16mm, B/W, color, sound) 1962

The unusual properties of water are demonstrated in a comparison of changes in state with paraffin and benzene. Other experiments describe molecular polarity, the dipole attraction and hydrogen bonding between water molecules, and their effect on the geometry of the water lattice. In one demonstration, a bursting cast iron bomb shows the forces involved as water freezes.

MGHT, cat. no. 611999, B/W, $85.; 612024, color, $120.

110

SHAPES AND POLARITIES OF MOLECULES
Collaborator: David Dows, University of Southern California
(18 min., 16mm, 8, color, sound) 1963

Observations are made of electric effects, including deflections of streams of liquids by a charged rod, and changes in charging time of a capacitor. There is evidence that different molecules give two types of results: some give very marked interactions with electric charges, while others give little effect. To explain these different results, a conceptual model is developed based on two types of molecules: polar and nonpolar. Consideration of bond polarity and molecular shape allows prediction of molecular polarity. The molecular dipole model is used to explain differences in solubility, conductivity, and chemical reactivity.

MLA, cat. no. 4154, 16mm, $135.; 4854, 8, $115.

112

BUBBLE MODEL OF A CRYSTAL: STRUCTURE AND BOUNDARIES
Collaborator: Sir Lawrence Bragg, F.R.S. - The Royal Institution
(2:05, S-8, B/W, silent) 1967

This film (and its companion, 84-0124/1) utilizes bubble rafts to simulate a two-dimensional crystal structure. The film begins with an examination of an etched aluminum surface on which the crystal boundaries are clearly outlined. The bubble-marking apparatus is then assembled and a large raft formed. Animation superimposed on the structure, reveals the angles made by the crystal planes, and the different orientation of these lines in neighboring crystals. Finally, the changing boundaries of a number of crystals are observed by time-lapse photography.

EAL, cat. no. 84-0116/1, $15.50

CRYSTAL STRUCTURES OF METALS
(4 min., 8, color, silent)

Introduction to the simple, body centered, and face-centered cubic systems and hexagonal closest packed system including tetrahedral and octahedral sites. Structures are demonstrated by animation.

LBF, cat. no. 2, $15.

CRYSTALS AND THEIR STRUCTURES
Collaborator: J. Arthur Campbell, Harvey Mudd College
(22 min., 16mm, 8, B/W, sound) 1963

Crystals have plane faces, sharp edges, sharp melting points and may cleave easily to give new plane surfaces. Crystals also interact with X-rays to produce well-defined diffraction patterns. Such properties lead us to believe that crystals are composed of regular repeating arrangements of atoms. The film raises the question of how we actually discover these arrangements. Experiments are then performed in a ripple tank on an unknown crystalline array so that the student sees the principles and measurements by which actual crystal structures are determined.

MLA, cat. no. 4139, 16mm, $120.; 4839, 8, $102.

TEACHER TRAINING INTRODUCTION to "Crystals and Their Structures"
Collaborator: CHEM Study Teacher Training Films - Lesson 13
(7 min., 16mm, B/W, sound)

Professor Campbell demonstrates the uses and limitations of some styrofoam models. He uses models representing solid krypton, silver, gold, iron, ice, sulfur (S_8) solid carbon dioxide, diamond, and graphite. He relates some of the properties of these substances to their structures as illustrated by the models. The CHEM Study Film then goes on to show some of the experimental evidence upon which such models are based.

MLA, cat. no. 4039, $40.

THE PROPERTIES OF AN IONIC COMPOUND
Collaborator: Halas & Batchelor
(3 min., 8, color, silent)

Shows the properties which result from a strong crystalline structure in an ionic compound. Sodium Chloride is taken as an example.

LGC, cat. no. E/65, $9.

THE STRUCTURE OF AN IONIC CRYSTAL
Collaborator: Halas & Batchelor
(3 min., 8, color, silent)

Demonstrates that the structure of the Ionic Crystal is dependent on the relative radii of the ions and their relative charges and not on their identity.

LGC, cat. no. E/65A, $9.

201

COLOUR TODAY
(17 min., 16mm, color, sound) 1961

Colour and colour vision; colour mixing; the Munsell colour system; chemical production of colour applications.

See RIC, p. 164

CONCERNING COLOUR
(17 min., 16mm, color, sound) 1962

Theory of colour; factors upon which colour depends; reflection and absorption of colours; colour vision; interaction of colours; rules for devising colour schemes.

See RIC, p. 164

201

DIFFRACTION-DOUBLE SLIT
Collaborator: F. Miller, Jr., Ohio State University
(3:40, S-8, color, silent) 1967

Light passes through two slits each 0.004 inch wide and the resultant diffraction patterns are shown. The separation between the slits is first investigated. The patterns for green light with slit separations of 0.012 inch and 0.024 inch are shown, followed by the changing pattern obtained by varying the slit separation from 0.008 inch to 0.024 inch and back again; here the interference changes are of particular interest. The dependence of the pattern on wavelength is illustrated and the wavelength is then varied over the visible spectrum, so that the entire pattern changes. Formulae for the effects are discussed in the film notes.

EAL, cat. no. 80-2074/1, $15.50

DIFFRACTION-SINGLE SLIT
Collaborator: F. Miller, Jr., Ohio State University
(2:20, S-8, color, silent) 1967

Various diffraction effects of a single slit are shown, using a wavelength spectrometer. First for green light, patterns are shown for slit widths of 0.2 mm and 0.5 mm and for the slit width varying from 0 to 2 mm and back to 0. Finally, the slit width is held constant and patterns shown for red and for blue light. The continuous change of pattern as λ varies over this range and back again is also shown.

EAL, cat. no. 80-2066/1, $15.50

ELECTROMAGNETIC WAVES
Collaborator: George Wolga, MIT; ESI; PSSC
(33 min., 16mm, B/W, sound) 1961

Shows why we believe in the unit of the electromagnetic radiation spectrum. Experiment shows that the radiation arises from accelerated charges and consists of transverse waves that can be polarized. Interference (Young's double slit experiment) is shown in four different regions of electromagnetic spectrum; X-ray, visible light, microwave and radiowave.

MLA, cat. no. 0415, $150.

HEAT AS RADIANT ENERGY
Collaborator: Robert G. Ricard
(15 min., 16mm, B/W, color, sound)

Heat waves are part of the electromagnetic wave spectrum which also includes radio, light, cosmic and ultraviolet rays, to name a few. They all race outward through space at more than 186,000 miles per second but differ in their length. Between radio waves and visible light lie infrared rays which carry heat energy through space. They can be focused, transmitted, reflected or absorbed. The higher the temperature of a heat source, the shorter and more penetrating the waves. But rough, dark surfaces are better radiators (and better absorbers) than white, smooth ones. A number of instruments detect the presence of radiant energy and measure its intensity, the simplest being the thermocouple. Recently developed is the thermistor based on the change in electrical resistance of certain materials exposed to a change in temperature. In the photoelectric cell, radiation striking a selenium coated cathode causes current to flow to an anode in proportion to the radiant energy received. The wartime snooper-scope converts infrared radiation to a visible image, enabling our troops to see in the dark. And, most important, life sustaining heat is transmitted from the sun by means of electromagnetic radiation.

EYE, cat. no. EG536, B/W, $75.; EG537, color, $150.

INTERFERENCE OF PHOTONS
Collaborator: John King, MIT; ESI; PSSC
(13 min., 16mm, B/W, sound) 1959

An experiment in which light exhibits both particle and wave characteristics. A very dim light source, a double slit, and a photomultiplier are used in such a way that less than one photon (on the average) is in the apparatus at any given time. Characteristic interference pattern is painted out by many individual photons hitting at places consistent with the interference pattern. Implications of this are discussed.

MLA, cat. no. 0419, $90.

INTRODUCTION TO OPTICS
Collaborator: E. P. Little; PSSC
(23 min., 16mm, color, sound) 1960

Deals with approximation that light travels in a straight line; shows the four ways in which light can be bent - diffraction, scattering, refraction and reflection; refraction illustrated by underwater photography to show how objects above water appear to a submerged skin diver.

MLA, cat. no. 0201, $180.

LIGHT: WAVE AND QUANTUM THEORIES
(13½ min., 16mm, B/W, color, sound)

Experiments and demonstrations which show clearly and simply the accepted theory of light as consisting both of a wave motion and of discrete bundles, or quanta, of energy.

CORF, B/W, $75.; color, $150.

MEASUREMENT OF THE SPEED OF LIGHT
(8 min., 16mm, B/W, sound)

The toothed-wheel method of Fizeau is described in detail with the aid of a moving light beam. Modification of this method, due to Michelson, is explained by reflecting the light beam from

201

a rotating eight-sided mirror. Motion is slow enough so that the path of light may be understood at all times.

MGHT, cat. no. 626510, $65.

THE NATURE OF LIGHT
(11 min., 16mm, B/W, color, sound)

Shows light as a form of radiant energy, demonstrates the principles of reflection and refraction, and illustrates how they apply in optics.

CORF, B/W, $60.; color, $120.

PHOTONS
Collaborator: John King, MIT; PSSC
(19 min., 16mm, B/W, sound) 1960

Photomultiplier and oscilloscope used to demonstrate that light shows particle behavior; photomultiplier explained, amplification demonstrated, "noise" reduced; reasoning required to understand final outcome carefully discussed.

MLA, cat. no. 0418, $90.

PRESSURE OF LIGHT
Collaborator: Jerrold R. Zacharias, MIT; PSSC
(23 min., 16mm, B/W, sound) 1959

Light pressure on a thin foil suspended in a high vacuum sets the foil into oscillation. The film leads up to this by a discussion of the Crooke's radiometer and the effect - not light pressure - that causes it to rotate. The role of light pressure in the universe is also briefly discussed.

MLA, cat. no. 0202, $120.

SINGLE SLIT
Collaborator: F. Miller, Jr., Kenyon College
(4 min., 16mm, color, sound; 8, color, silent)

The pattern formed by light passing through a single narrow slit changes with the width of the slit and the wavelength of the light. Patterns are shown for green light (5300A) for two slit width, 0.2 mm and 0.5 mm. Then a variable slit is changed from 0 to 2 mm width and back again to zero. Similar patterns are shown in red light (6500A) and in blue light (4700A), first for the 0.2 mm and 0.5 mm slits and then for the variable slit.

MSC, cat. no. 12074, 16mm, $19.; 12072, 8, $9.50

THE SPECTRUM - Light and Color
Collaborator: Gateway Educational Films
(0.45, 8, S-8, color, silent) 1965

A narrow beam of white light meets a prism and is dispersed into the spectrum.

ICF, cat. no. 12220, 8, $10.; 12225, S-8, $13.50

SPEED OF LIGHT
Collaborator: William Siebert, MIT; PSSC
(21 min., 16mm, B/W, sound) 1960

Outdoors at night Dr. Siebert measures the speed of light in air over a 300 meter course using a spark-gap, parabolic mirrors, a photocell and an oscilloscope. In the laboratory he compares the speed of light in air and in water using a high speed rotating mirror.

MLA, cat. no. 0203, $120.

THE SPEED OF LIGHT (Measurement & Application)
Collaborator: Harvey B. Lemon, Museum of Science and Industry, Chicago
(14 min., 16mm, B/W, sound)

Shows how Galileo Fizeau, Roemer, and Michelson contributed to the measurement of the speed of light and indicates some of the most important applications of this constant today. Michelson's famed experiment is shown in animation.

EBF, cat. no. 741, $86.

202

ELEMENTARY PARTICLES: THE ELUSIVE ULTIMATE
Collaborator: Philip Morrison, MIT
(30 min., 16mm, B/W, sound)

The quantum theory relies upon the existence of these truly identical entities, electrons, protons, neutrons and many unstable "particles". Their nature has been illumined, but still only dimly by this theory. We know many particles, of various families. No really crisp results exist about the particles themselves; their compounds, however, are very well understood. No sign of the failure of quantum mechanics has yet appeared, only a frustration of consistent application of the various interactions. It is not expected that the picture of fused cause and chance, of conservation and virtuality will be discarded. The quantum will always remain.

ROB, cat. no. 10, $180.

FRANCK-HERTZ EXPERIMENT
Collaborator: Byron Youtz, Reed College; PSSC
(30 min., 16mm, B/W, sound) 1960

A stream of electrons is accelerated through mercury vapor, and it is shown that the kinetic energy of the electrons is transferred to the mercury atoms only in discrete packets of energy. The association of the quantum of energy with a line in the spectrum of mercury is established. The experiment retraced in this film was one of the earliest indications of the existence of internal energy states within the atom.

MLA, cat. no. 0421, $150.

202

THE FUSION OF CAUSE AND CHANCE
Collaborator: Philip Morrison, MIT
(30 min., 16mm, B/W, sound)

The atomic world of small action is ruled by a fusion of cause and chance. Light is the most commonplace source of events of small action, ruled by the quantum. The eye, the photographic plate, etc. display an atomic form of recording. A grainy, individual reaction is the mode of these light detectors. Light itself can transfer its energy and momentum only in packets, called photons which cannot be split. The stability of the individual photon is never altered. Light has atoms, too. For every photo, the energy and the momentum strictly satisfy the precise laws of conservation, but just where the next photon will strike, just when it will be counted, are matters which obey the mathematical laws of chance.

ROB, cat. no. 4, $180.

THE GRAININESS OF ENERGY
Collaborator: Philip Morrison, MIT
(30 min., 16mm, B/W, sound)

Matter is grainy. Its grains are the atoms which themselves are grainy and which have atoms of their own. The structure of any two atoms of the same element is identical. Also, the atoms of the atom, the electrons outside the binding central nucleus, are also each to each identical. Inside the nucleus, there is also a grainy structure of identical sub-units. The measure of electrical response, or electronic charge, comes in only a one-sized package, one quantum. A particle may bear a single unit of charge, or any integer multiple of that, never a fractional quantity of charge. Mass and charge come in lumps or particles. Measures of motion, quantities like energy, are also found to occur only in the grainy mode. Atoms are not mere rock-hard; they are quantum-rigid; easily changed by a sufficiently large energy packet, totally unmoved by one only a little smaller. The permanence of our world rests on the fact that no energy store can change by less than its smaller quantum.

ROB, cat. no. 2, $180.

MATTER WAVES
Collaborator: Philip Morrison, MIT
(30 min., 16mm, B/W, sound) 1963

In light, the wave is far from tangible, determining a mere probability by its strength; its particles are far from isolated, but deposit their invariable stores of energy in accordance with the probability pattern defined with stringency by the wave-like field. Today we believe that all the particles, from neutrino to uranium, all the wave fields, from sound itself to light, gravitation, and the rest, form wave-like patterns (called quantized wave-field). Mass, energy, momentum, change, etc. are always causally conserved, never missing, never new-born. But when and where these grains of quantity are to be found is ruled by a wave pattern which is always to be found in space and time. How it permits the transfer of one or more of these basic grains is up to chance. Again, this is the fusion of cause and chance.

ROB, cat. no. 5, $180.

THE PHYSICS OF IDENTITY
Collaborator: Philip Morrison, MIT
(30 min., 16mm, B/W, sound)

The grainy nature of quantum systems permits them to be in such states that all representatives, say all electrons spinning parallel to a given axis, or all stable hydrogen atoms, are truly identical, not merely similar, as are peas in a pod. Of course, no direct measurement can establish identity; it can certify merely as to the smallness of differences. The distinction and relation between the single individual and the class is a rich one; the most striking result of quantum mechanics is to have found this very point deep in physics.

ROB, cat. no. 7, $180.

THE QUANTUM OF ACTION
Collaborator: Philip Morrison, MIT
(30 min., 16mm, B/W, sound)

The quantum of action is a measure of motion. On the atomic level, the quantum of action, Planck's constant h, is the sovereign measure. The motion of an electron in an atom, with the velocities appropriate to the motion under electrical forces, has just one, two or three such quanta. As c (the speed of light) parted old space and time from the new relativistic fusion, so h (Planck's constant) parts Newtonian forces and trajectories from the fused cause and chance of the new mechanics.

ROB, cat. no. 3, $180.

THE QUANTUM FABRIC OF MATTER
Collaborator: Philip Morrison, MIT
(30 min., 16mm, B/W, sound)

The whole of the material world, with radiation, falls under the domain of quantum mechanics, from the scale of the nucleus within the atom up to the structures of living beings, wherever nuclear physics or atomic chemistry plays an essential role. Every sort of structure, each nucleus, atom, molecule, crystal, has its proper energy levels, calculable by the laws of quantum mechanics from the nature of the elementary building blocks and their familiar forces of interaction. All matter obeys the structural dictates of the quantum.

ROB, cat. no. 8, $180.

WHY ARE ATOMS UNPREDICTABLE?
(30 min., 16mm, B/W, sound)

A demonstration of the contradictory particle and wave behavior of electrons, an explanation

202

of the scientific approach to the study of subatomic particles, and a discussion of the "uncertainty principle" and the place of statistical method in such inquiry. Emphasis is put upon the fact that statistical method permits successful prediction of many aspects of atomic behavior.

INDU, cat. no. FS-358, $100.

203

THE SPECTROGRAPH
(20 min., 16mm, color, sound) 1954

Through natural photography and animated diagrams, this film demonstrates the nature and principles of the spectrograph. It shows how the range of the spectrogram can be increased through the quartz prism and the diffraction grating and demonstrates the uses of the spectrograph and the qualitative and quantitative detection of impurities for industrial purposes.

MGHT, cat. no. 603501, $200.

THE SPECTRUM OF THE HYDROGEN ATOM
Collaborator: Halas & Batchelor
(3 min., 8, color, silent)

Demonstrates how a line spectrum results from the transfer of discrete quantities of energy when an electron moves from a higher energy level to a lower one. The visible light spectrum is seen.

LGC, cat. no. E/64, $9.

204

ABSORPTION SPECTRA
Collaborator: F. Miller, Jr., Ohio State University
(3:30, S-8, color, silent) 1967
(4 min., 16mm, color, sound; 8, color, silent)

This film shows the absorption spectra obtained for a vapor, a liquid and a solid. The emission spectrum of Na vapor is illustrated, a white light is then switched on and the emission lines become dark absorption lines at the same wavelengths. Broad absorption bands are shown for hemoglobin; the hemoglobin is then oxidized to oxyhemoglobin and the considerable change in the absorption spectrum noted. The complex absorption pattern of didymium glass is also shown. This glass, in conjunction with yellow glass, is used as an efficient filter to transmit the Hg green line.

EAL, cat. no. 80-2025/1, $15.50
MSC, cat. no. 12034, 16mm, $19.; 12032, 8, $9.55

205

INFRARED
(15 min., 16mm, color, sound)

By using animation and art work combined with live action, this film takes the mystery out of infrared. The result is an interesting and informative movie about a subject often misunderstood. A film that entertains as it educates.

AGC, free loan

INFRA-RED SPECTROSCOPY
Collaborator: Perkin-Elmer Corp.
(36 min., 16mm, color, sound) 1959

Fundamental theory; the infra-red spectroscope; sample preparation and handling techniques; qualitative and quantitative procedures; some applications.

See RIC, p. 17

INTERPRETATION OF INFRARED SPECTRA
Collaborator: Norman B. Colthup
(4 hr., 16mm, B/W, sound)

The heart of this course is a detailed study of the interpretation of infrared spectra. The necessary elementary theory is developed, particularly as it applies to spectral interpretation. No previous experience with infrared spectroscopy is required as the course is designed to be of value both to beginners and to people with some experience in infrared spectroscopy. Some knowledge of elementary organic chemistry, college level physics and elementary algebra will be assumed. The course should be of particular value to organic chemists who have made some preliminary use of infrared spectroscopy as a tool for the study of molecular structure and who wish to learn more about the subject. The film course consists of lectures interpersed with problem-solving periods. Each viewer is thus motivated to participate on an active basis. The film course is built around 66 charts, which we have also published in book form. The film and chart book together constitute the course. We strongly urge, therefore, that a personal copy of the chart book be provided to every viewer of the film.

ACS, $750.

*MOLECULAR SPECTROSCOPY
Collaborator: Bryce Crawford, Jr. and John Overend, University of Minnesota
(23 min., 16mm, 8, color, sound) 1962

The film uses laboratory experiments, molecular models, and animation to show details of the infrared light absorption process and its relation to molecular properties. The film stresses the concept of natural vibrational frequencies in molecules. Further, it demonstrates the use of the infrared spectrum in identifying molecules and determining their molecular structure.

MLA, cat. no. 4142, 16mm, $165.; 4842, 8, $140.

210

BRAGG REFLECTION
(10 min., 16mm, B/W, sound)

Waves are scattered from a two-dimensional array (lattice) of small objects producing a strong reflection at the angle defined by 2D sin θ =n. The strong reflection disappears and appears as wavelength and angle of incidence are varied.

UEVA, $60.

BRAGG REFLECTION OF WAVES
Collaborator: ESI
(3:40, S-8, B/W, silent) 1967
(4:05, 16mm, B/W, sound; 8, B/W, silent)

Several bursts of a straight wave are incident on a two-dimensional array of pegs. Waves move right through this lattice, but part is scattered from each peg. Interference of the scattered components produces a strong reflection at the Bragg angle. λ is decreased until strong reflection is destroyed, then further decreased to half its original value, whereupon strong reflection is restored. Finally, without changing λ , effect is shown of shifting lattice position, i.e. changing angle of incidence.

EAL, cat. no. 80-2363/1, $12.50
MSC, cat. no. 12330, 16mm, $10.75; 12329, 8, $6.50

PRINCIPLES OF THE X-RAYS
(15 min., 16mm, B/W, sound) 1960

From a beginning section on the history of the X-ray this film goes on to cover its complete development. Subjects studied are Roentgen's original experiment, the development of radiography, the nature of X-rays, the work of von Laue and Bragg, the generation of X-rays, the line spectra with the "White" band, the X-ray crystal spectrometer, X-ray crystallography, and the applications of X-rays as a research tool into molecular structure.

MGHT, cat. no. 603514, $125.

UNIVERSAL VACUUM X-RAY SPECTROGRAPHY
Collaborator: Philips Electrical Ltd.
(8 min., 16mm, color, sound) 1961

The principles of X-ray Diffraction; construction and operation of the vacuum X-ray spectrography; examples of its use.

See RIC, p. 32

X-RAY CRYSTALLOGRAPHY
(20 min., 16mm, B/W, sound)

Explains the production and properties of X-rays and shows the way in which crystals can be used as diffraction gratings for X-rays. The interpretation of crystal structure from diffraction patterns, and the way in which materials in powder form can be studied are described. The film ends with an example of the use of X-ray crystallography in industry.

MGHT, cat. no. 603509, $120.

211

BETA-RAY SPECTROMETER
(7:05, 16mm, color, sound) 1963

The principles and working of the Coincidence Beta-Ray Spectrometer, a device which is used to measure the intensity and direction of electron emissions known as beta particles. Components of the device are shown and assembled. A source is introduced. Masking for beam direction and size is demonstrated. Detectors are shown and explained.

AEC, free loan

NEUTRON IMAGE DETECTOR
Collaborator: ANL
(5½ min., 16mm, color, sound) 1965

A vacuum tube neutron detector, having a screen one foot in diameter, which can be viewed by means of a closed-circuit television camera.

AEC, free loan

SCINTILLATION SPECTROMETRY
Collaborator: F. Miller, Jr., Ohio State University
(3:10, S-8, color, silent) 1967
(4 min., 16mm, color, sound; 8, color, silent)

The film shows the assembly of a sodium iodide (thallium activated) crystal on the face of a photomultiplier. The gamma rays from a Mn^{56} source produce flashes of light in the scintillation crystal that amplified by the photomultiplier and displayed on the screen of the cathode ray oscilloscope. The gamma-ray spectrum of Mn^{56} is displayed with increasing statistical accuracy. The photopeak, the pulse height of which is proportional to the energy of the original gamma-ray photon, the Compton Edge which is the maximum energy of the Compton recoil electrons and the backscatter associated with the Compton effect are clearly shown on the trace.

EAL, cat. no. 80-2017/1, $15.50
MSC, cat. no. 12024, 16mm, $17.90; 12022, 8, $9.15

213

A IS FOR ATOM
(15½ min., 16mm, color, sound) 1953

More than three hundred secondary schools, colleges and other film libraries to date have replaced the original version of "A is for Atom" with the new, revised version. The film

213

describes the nature and properties of the atom, and reflects man's increasing mastery of nuclear technology. The film also shows today's application of the power of the atom as a servant of mankind.

GE, $120.

ABOUT FALLOUT
(24 min., 16mm, color, sound)

About fallout is the most definitive film on this phenomenon of the Nuclear Age now available to the general public. The film is designed to dispel many of the common myths and fallacies now surrounding the subject in the public mind - and to present the facts, as clearly and simply as possible, in everyday layman's terms. Based on the Government's many intensive scientific studies, it uses both animation and live action to illustrate the basic nature of fallout radiation, its effects on the cells of the body, what it would do to food and water after a nuclear attack, and what simple common sense steps can be taken to guard against its dangers.

DUART, cat. no. DOD-CD3-220, $76.51

ALPHA, BETA AND GAMMA
(44 min., 16mm, B/W, sound) 1962

The orgin and nature of alpha-, beta- and gamma-radiation; the structure of the nucleus.

AEC, free loan

ATOMIC ENERGY
Collaborator: Willard F. Libby, University of Chicago
(11 min., 16mm, B/W, sound) 1949

Identifies, with animated drawings, parts and structure of atoms, defines and contrasts electronic or chemical energy and nuclear energy; explains the three known forms of atomic energy release. Illustrates relationship between atomic energy from the sun and chemical energy stored and released in photosynthesis and combustion.

EBF, cat. no. 370, $70.

ATOMIC ENERGY EXPLAINED
(20 min., 16mm, color, sound) 1962

The structure of the atom; principles of nuclear fission; production of power in a nuclear reactor; uses of radioisotopes in industry and medicine.

See RIC, p. 38

ATOMIC ENERGY-INSIDE THE ATOM
(13 min., 16mm, B/W, color, sound) 1963

Evidence that some atoms disintegrate; detection of fragments; mechanism of radioactive decay; natural and artificial radioactivity; the nuclear reactor; uses of radioisotopes.

EBF, cat. no. 1891, B/W, $75.; 1890, color, $150.

THE ATOMIC FINGERPRINT
Collaborator: Vincent P. Guinn
(13 min., 16mm, B/W, color, sound) 1964

Principles of neutron activation analysis; instruments and methods used; applications.

AEC, free loan

ATOMIC RADIATION
Collaborator: Division of Physical Sciences Institute of Nuclear Studies, University of Chicago
(13 min., 16mm, B/W, sound)

Explains fundamentals of atomic radiation: the dramatic story of its discovery, what it is and does, and why it should be respected rather than feared. Describes how it has been possible to reproduce in the laboratory some of the forms of radiation found in nature. Explains the roles of alpha, beta, gamma, and neutron particles in radioisotope research.

EBF, cat. no. 655, $70.

ATOMOS
Collaborator: Philips Electrical Ltd.
(12 min., 16mm, color, sound) 1962

Man's everlasting quest for more power; the gradual development of atomic theory; the discovery and utilization of atomic energy.

See RIC, p. 39

BIOLOGICAL EFFECTS OF NUCLEAR RADIATION
(4 min., 8, S-8, color, silent) 1964

Alpha, beta and gamma radiations are defined and their effect upon living cells shown. These radiations are shown to cause mutations and to have a cumulative, damaging effect caused by nearly any amount of exposure. This film will assist in an understanding of the emminent dangers of these rays which, however, may be useful in medicine if controlled.

ICF, cat. no. 59640, 8, $16.; S-8, 59645, $19.50

BUILDING BLOCKS OF LIFE
(30 min., 16mm, B/W, sound)

Free radicals-unique molecule fragments that radiation causes in living systems - either kill or seriously injure living cells. Discusses the particles themselves, the damage they do and AEC research about them.

INDU, cat. no. FS-978, $125.

CARBON FOURTEEN
Collaborator: Division of Physical Sciences Institute of Nuclear Studies, University of Chicago
(12 min., 16mm, B/W, sound)

Explains the use of radiocarbon (carbon 14) as a means of determining the age of ancient objects; defines "half-life". Shows how carbon 14 has made possible new approaches to the riddle of photosynthesis, and how it has influenced methods of observation in the life sciences.

EBF, cat. no. 661, $70.

CARBON-14 AND ARCHAEOLOGY
(15 min., 16mm, color, sound) 1963

The technique of radiocarbon dating archaeological specimens.

See RIC, p. 61

CHAIN REACTION-CONTROLLED CHAIN REACTION (Nuclear Reactions)
Collaborator: Halas & Batchelor
($2\frac{1}{2}$ min., 8, S-8, color, silent) 1962

The two films in this loop use animated diagrams to show various stages of a chain reaction and of a controlled chain reaction around a Uranium 235 Nucleus Cluster.

EBF, cat. no. R80206, 8, $16.; S80206, S-8, $17.60

CONQUEST OF THE ATOM
(22 min., 16mm, color, sound) 1965

The story of the splitting of the atom and the determining of its structure began in 1897 with the work of J. J. Thompson, whose experiments with discharge tubes led to his discovery of the electron. In 1911 Ernest Rutherford made discoveries that led to the first splitting of the nitrogen atom in 1919. By 1932 Drs. Cockcroft and Walton developed equipment which raised protons to high velocity. Sir James Chadwock discovered the neutron in 1932, and the theory of the structure of the atom became that which is accepted today. Nuclear fission and the control of atomic energy are explained, as applied by Enrico Fermi in 1942 with the construction of the first atomic pile.

IFB, cat. no. 2 IFB 250, $195.

CONTROLLING ATOMIC ENERGY
($13\frac{1}{2}$ min., 16mm, B/W, color, sound) 1961

This film study clarifies the complexities of the release and control of atomic energy. Animation, diagrams, models and live photography explain the meaning of radioactivity; the nature of alpha, beta and gamma rays; how radioactivity is measured, and how naturally radioactive elements are identified.

UEVA, B/W, $75.; color, $135.

COSMIC RAYS
(27 min., 16mm, B/W, color, sound)

A detailed examination of present concepts of the origin and nature of charged particles reaching the earth from outer space. Recent discoveries-using balloons, rockets and satellites-are presented. The relationship between cosmic ray research and nuclear research is outlined.

MGHT, cat. no. 681109, B/W, $110.; 681122, color, $195.

CREATION AND DESTRUCTION
Collaborator: Philip Morrison, MIT
(30 min., 16mm, B/W, sound)

Stability and form have been emphasized, but change is equally part of the material world, and is equally well treated by the quantum theory. Particles can be created and destroyed under certain restrictions. Electrons, for example, are born or die always twinned with positrons. A photon can pass its energy and momentum on as a legacy to an electron-positron pair, itself disappearing at once. But it cannot do so in free space for the energy and momentum cannot be balanced there. Some external force must be present, and the typical seat of this process is the region near the nucleus where there is a strong electronic field.

ROB, cat. no. 9, $180.

CRITICAL SIZE (Nuclear Reactions)
Collaborator: Halas & Batchelor
($2\frac{1}{4}$ min., 8, S-8, color, silent) 1962

Demonstrates the importance of critical mass in the creation of a nuclear reaction similar to that taking place in an atomic explosion.

EBF, cat. no. R80207, 8, $16.; S80207, S-8, $17.60

DETECTORS (Nuclear Radiation)
Collaborator: Samuel K. Allision, Enrico Fermi Institute, Nuclear Studies, University of Chicago
(15 min., 16mm, B/W, color, sound)

Corpuscular radiation (in the form of alpha and beta particles) and electromagnetic radiation (as gamma rays) are produced as a result of nuclear reactions. Just as we use our own specialized sight and touch to detect light and heat radiation, special techniques and instruments must be used to measure x-rays and nuclear radiation. The most common detector is the Gieger-Mueller counter tube which conducts when a beta or gamma ray ionizes the space between its electrodes. This same ionizing characteristic triggers the scintillation counter and open-air alpha counter and discharges the gold leaf electroscope. The cloud and bubble chambers and special photographic plates all give indications of radiation as visible tracks. The operational principles of each detector is explained with live-action shots and animation so that the peculiar advantages and limitations of each instrument become clearly evident. The up-to-date information in this film is exemplified by the introduction of solid-state radioactivity detectors.

EYE, cat. no. EG512, B/W, $75.; EG513, color, $150.

DETONATION OF THE H-BOMB
(4 min., 8, S-8, B/W, silent)

AFL, cat. no. S-4, 8, $12.50; S-8, $14.50

THE DISCOVERY OF RADIOACTIVITY
(15 min., 16mm, color, sound)

An historical survey of progressive developments leading to our present knowledge of radioactivity, this is the story of Wilhelm Roentgen and his discovery in 1895 that certain crystals become fluorescent when they are subjected to cathode tube rays. It includes Henri Becquerel's discovery that uranium salts give off invisible rays, Marie Curie's isolation of polonium and radium, and the work of Julius Elster and Hans Geitel, who measured the rays of an electroscope. Analyses by Ernest Rutherford revealed alpha, beta, and gamma rays. Further studies showed how a substance decays at a particular rate and that radioactive substances contain a mixture of different atomic elements. The discovery of radioactivity led to a new conception of the structure of the atom and of matter.

IFB, cat. no. 2 IFB 395, $165.

EYE FOR ISOTOPES
(27 min., 16mm, color, sound) 1964

This film shows the well-established techniques in the use of radioisotopes for measuring tracing and control. The film starts by describing the properties of radioisotopes which make them useful, and demonstrates the difference between alpha, beta and gamma radiations and how they can be detected. After showing how radioisotopes are made in a reactor, their uses are shown in detail. As Tracers: Measuring the flow of water, finding leaks in buried pipe-lines and the movement of materials in processing, or of silt in a tidal estuary. As Thickness Gauges: Controlling the thickness of materials such as paper or steel during manufacture. Measuring the level of liquids such as molten glass or carbon dioxide. As Safety Devices: Operating a safety control mechanism in coke oven operation. For Radiography: Radiography of car engine parts or of welds in pipelines. As Back-Scatter Thickness Gauges: Control of a coal-cutter underground. Internal corrosion of pipes. For Analysis: Measuring coating thicknesses in plating. The quick analysis of the contents of alloys or of impurities in oil.

UKAEA, free loan

FALLOUT (Nuclear Radiation)
Collaborator: Samuel K. Allision, Enrico Fermi Institute for Nuclear Studies, University of Chicago
(15 min., 16mm, B/W, color, sound)

With every new nuclear explosion, additional radioactive debris is spread throughout our atmosphere. We've always lived with a certain amount of background radiation from cosmic rays from the atmosphere and unstable elements in the earth. However, with the continual addition of man-made radioactive contamination, the cumulative effect could, in time cause serious and possibly undesirable changes in living tissue for generations to come. Three types of Fallout are produced by an atom bomb: atmospheric, settling in one day within 100 miles; tropospheric, rising to 50,000 feet and spread by prevailing winds to settle in a few weeks; and stratospheric, which will stay up for as long as years. Most components of Fallout have short-half lives and fade rapidly leaving dangerous Strontium 90. Cesium 137 and Carbon 14 to add to the existing air-borne radioactive contamination. Materials emitting alpha and beta rays are dangerous only when ingested or touched by the skin, whereas gamma radiation penetrates the body attacking delicate internal cells. When the sensitive balance in a cell is upset by the passage of a powerful ray, undesirable genetic mutations may be induced or the cell may be destroyed entirely.

EYE, cat. no. EG522, B/W, $75.; EG523, color, $150.

FURTHER EXPERIMENTS IN RADIOACTIVITY
Collaborator: Esso Petroleum Co. Ltd.
(25 min., 16mm, B/W, sound) 1965

The absorption of radiation; deflection by magnetic fields; statistical nature by radioactive decay; measurement of half-life; ionizing properties.

See RIC, p. 35

GEIGER COUNTER
Collaborator: Yale Chem. Films
(7 min., 16mm, color, silent)

The operating principles are explained by diagram and animation, and a radiation counting experiment is demonstrated.

AIM, cat. no. YF-227, $52.50

INTRODUCTION TO RADIOACTIVITY
Collaborator: Esso Petroleum Co. Ltd.
(18 min., 16mm, B/W, sound) 1963

Introductory experiments with electroscope and ionization chamber; principle of the Geiger counter; simple quantitative experiments, using gold-leaf electroscope and pocket dosimeter.

See RIC, p. 35

MEDICAL EFFECTS OF THE ATOMIC BOMB - PART I - PHYSICS, PHYSICAL DESTRUCTION, CASUALTY EFFECTS
(32 min., 16mm, color, sound) 1950

Explanation of nuclear physics, fission and general reaction, thermal energy and mechanical force, nuclear radiation and ionizing effects; portrays physical destruction and casualty effects.

DUART, cat. no. PMF 5058, free loan

THE MOA WAS RADIOACTIVE
(7 min., 16mm, color, sound)

The carbon dioxide method of radiocarbon dating and its use on bones of the now extinct moa and other objects.

See RIC, p. 63

NUCLEAR RADIATION DETECTORS - PARTS I, II, III
(4 min. ea., 8, S-8, color, silent) 1964

Part I - Animation and live action stress the operational principles of the gold leaf electroscope, the ionization chamber, and the Geiger tube as radiation detectors.
Part II - The different types of radiation tracks are observed as they occur in the Wilson cloud chamber, the diffusion cloud chamber and the bubble chamber.
Part III - Cameras view laboratory technicians as they demonstrate open-air, scintillation and solid state radiation detectors. Principles of detection with phosphorus are illustrated in an animated diagram and the effects of radiation on photographic emulsion are seen through microphotography.

ICF, cat. no. 59610, I, 59620, II, 59630, III, 8, $16. ea.; 59615, I, 59625, II, 59635, III, S-8, $19.50 ea.

OUTER SPACE (Nuclear Radiation)
(17 min., 16mm, B/W, color, sound)

Beginning where our atmosphere ends, outer space is full of mysteries which must be resolved before man can venture there and survive. Radiation normally encountered on earth is found there; light, infrared, and ultraviolet rays. Powerful corpuscular radiation, cosmic rays, have been discovered at 600 miles. The film relates this radiation to sun flares and examines the intensity, location and effect of various types of radiation found in space. Various methods used to investigate radiation in space are described and related to manned space vehicles.

JCA, cat. no. 58519, B/W, $75.; color, $150.

PRINCIPLES OF THERMAL, FAST AND BREEDER REACTORS
(9 min., 16mm, color, sound) 1963

Nuclear fission; the chain reaction; control of fission in a reactor; fast and thermal reactors; moderators and reflectors; the breeder principle; plutonium and thorium cycles.

AEC, free loan

RADIATION
(26:28, 16mm, color, sound) 1959

A factual study of radiation for general audiences. From a sun-drenched bathing beach to an awesome "gamma garden", this film explores how heat, radio waves, x-rays and gamma rays affect various forms of life. The film takes you to the x-ray and radiological departments of a modern hospital, to Canada's atomic research center at Chalk River, and to the Brookhaven National Laboratory where plant growth is subjected to gamma rays.

NFBC, cat. no. 0159012, $220.

RADIATION DETECTION BY IONIZATION
(30 min., 16mm, B/W, sound) 1962

Principles of ionization detectors; examples of suitable instruments; detailed discussion of the Geiger counter.

AEC, free loan

RADIATION DETECTION BY SCINTILLATION
(30 min., 16mm, B/W, sound) 1962

Reaction of gamma-radiation with matter; the scintillation process; solid and liquid scintillator detection devices; operation of a pulse-height analyser.

AEC, free loan

RADIATION AND THE POPULATION
(29 min., 16mm, B/W, sound) 1962

Radiation damage to cells; long-term effects; precautions, effects of fallout.

AEC, free loan

213

RADIOACTIVE DECAY
Collaborator: F. Miller, Jr., Ohio State University
(4:20, S-8, color, silent) 1967
(4 min., 16mm, color, sound; 8, color, silent)

This film shows the assembly of a thallium activated, sodium iodide, scintillation detector crystal onto the face of a photomultiplier tube, and shielded so that only gamma rays can reach the crystal and be registered. Two radioactive sources Cu^{64} and Mn^{56} are placed near the crystal, producing a pulse in the photomultiplier, and their spectrum studied. By the use of time-lapse photography, in approximately 2 minutes one half life of Cu^{64} and five lives of Mn^{56} are displayed on the cathode ray oscilloscope screen.

EAL, cat. no. 80-2009/1, $15.50
MSC, cat. no. 12014, 16mm, $23.; 12012, 8, $11.35

RADIOACTIVITY
Collaborator: Don Herbert, Prism Productions and M. H. Shamos, New York University
(4 min., S-8, color, silent)

The student is introduced to three types of radiation, alpha, beta and gamma, in this film. A Geiger tube and ratemeter are used to indicate the presence and strength of the radiation. The radiation from an alpha source is blocked by a sheet of plastic. A beta source causes the meter to respond at a greater distance than the alpha source. Beta radiation is blocked by lead and deflected by a magnet. The gamma source requires many layers of lead shielding to block its radiation. From his observations, the student is asked to identify the radiation from an unknown source when it is introduced.

EAL, cat. no. 80-3346/1, $22.95

RADIOACTIVITY
(12½ min., 16mm, B/W, color, sound) 1963

A description of the basic characteristics of alpha, beta, and gamma radiation and the instruments and methods by which they may be detected and measured in terms of charge and mass. Attention is then focused on the nucleus of the atom as the source of radiation.

MGHT, cat. no. 612004, B/W, $75.; 612016, color, $150.

RADIOCHEMISTRY FOR SCHOOLS
Collaborator: Imperial Chemical Industries
(25 min., 16mm, color, sound) 1965

The basic principles of radioactivity; separation of a short-lived natural radioisotope; measurement of its half-life; production of artificial radioisotopes by means of a portable neutron source; use of I-128 to demonstrate the dynamic nature of chemical equilibrium.

See RIC, p. 68

THE RADIOISOTOPE - PART I - FUNDAMENTALS OF RADIOACTIVITY
(59 min., 16mm, B/W, sound) 1951

Basic concepts of nuclear physics necessary to an understanding of radioisotopes. Describes origins of nuclear radiation and the chain reaction of uranium as a means of producing radioiosotpes.

DUART, cat. no. PMF 5145A, free loan

THE RADIOISOTOPE - PART 2 - PROPERTIES OF RADIATION
(68 min., 16mm, B/W, sound) 1952

Characteristics and properties of primary and secondary nuclear radiations; concepts concerning effect of matter on radiation; terminology and presentation of data as a prerequisite to practical measurement.

DUART, cat. no. PMF 5145B, free loan

THE RADIOISOTOPE - PART 5 - THE PHYSICAL PRINCIPLES OF RADIOLOGICAL SAFETY, SECTIONS 1 AND 2
(51 min., 16mm, B/W, sound) 1954

Ionizing characteristics of alpha, beta and gamma radiation, roentgen and roentgen measurements; maximum permissible exposure; calculation of exposure; problems of exposure, effect of physical decay and biological elimination on dosage rate; and concept of biological and effective half-life.

DUART, cat. no. PMF 5145E, free loan

THE RADIOISOTOPE - PART 13 - GENERAL SCIENCES
(46 min., 16mm, B/W, sound) 1952

Illustrations of the radioisotope as an important research tool adaptable to tracer investigations in all branches of science, including metallurgy, chemistry, biochemistry, and plant physiology.

DUART, cat. no. PMF 5147C, free loan

RADIOLOGICAL SAFETY
(30 min., 16mm, B/W, sound) 1963

Background radiation; action of larger doses; units of measurement; maximum permissible limits; maximum concentration of radioisotopes; reduction of radiation hazard; safety techniques.

AEC, free loan

URANIUM FISSION
(14 min., 16mm, B/W, sound)

A general approach leading to the discovery of uranium fission is reviewed and explained. Developments in the making of the atomic bomb are outlined. Peacetime research and a hopeful look at the future are included.

UEVA, $150.

213

USES IN INDUSTRY (Nuclear Radiation)
Collaborator: Samuel K. Allision, Enrico Fermi Institute for Nuclear Studies, University of Chicago
(15 min., 16mm, B/W, color, sound)

Radioisotopes are sometimes formed when the nuclei of normal atoms are heavily bombarded causing them to pick up extra neutrons. This heavier element is in an unstable condition and tends to revert or "decay" to its original state losing energy in the form of radiation. Three characteristics make radioisotopes immediately useful in industry: they alter their surrounding materials, they can be traced even in minute quantities, and gamma rays pass through almost every substance. When mixed into a complex fluid or mechanical system, these isotopes or "tagged" elements can be traced throughout to measure flow, friction, wear or locate intermittent malfunctions. Conventional x-ray techniques are in some cases being superseded by inexpensive and completely portable radioisotope sources for radiography. Similarly relatively simple gages are now being used based on the isotope "sourcetector" ideal for on-line control of physical dimensions, density, liquid level, and even hydrocarbon content. Irradiation of food and drugs during packaging kills all bacteria eliminating the need for refrigeration. Radioisotopes show especially great promise in almost all the process industries.

EYE, cat. no. EG520, B/W, $75.; EG521, color, $150.

USES IN MEDICINE (Nuclear Radiation)
(15 min., 16mm, B/W, color, sound)

The atomic age has made no greater contribution than to the science of healing. Ordinary atoms bombarded in nuclear reactors become radioactive isotopes of the original chemical. As these isotopes pass through the human body, they are accurately traced with scanning detectors. These "tagged" molecules enable doctors to make quicker and more accurate diagnosis. High intensity sources are used to selectively eliminate malignant growths inside the body without surgery. Clear explanations are provided with animated artwork.

JCA, cat. no. 58515, B/W, $75.; color, $150.

USES IN SPACE STUDIES (Nuclear Radiation)
Collaborator: Samuel K. Allision, Enrico Fermi Institute of Nuclear Studies, University of Chicago
(17 min., 16mm, B/W, color, sound)

Beginning where our atmosphere ends, outer space is full of mysteries which must be resolved before man can venture there and survive. Radiation normally encountered on earth is found there; light, infra-red and ultraviolet rays. In addition, an unusual increase in a powerful form of corpuscular radiation, cosmic rays, has been experienced at 600 miles. During sun flares, streams of protons bombard our outer space with intensity of more than 1,000 to 10,000 times normal cosmic ray intensity on the earth's atmosphere. Balloon-launched rockets have also detected a marked increase in x-rays during solar disturbances. Detector-equipped satellites have established two high radiation areas named Van Allen Belts centering on 2,500 and 10,000 miles off the earth's equator. Radiation levels between 10 and 100 Roentgens per hour exist here in contrast to the 0.15 Roentgens per 40 hours considered safe for man. Radiation hazards will be a major consideration when designing and building man's space vehicles of tomorrow.

EYE, cat. no. EG518, B/W, $75.; EG519, color, $150.

214

BEYOND URANIUM
(29 min., 16mm, B/W, sound) 1956

Dr. Glenn T. Seaborg, University of California, scientist, and his associates discuss the discovery of the first six elements beyond uranium, outline the changes needed in the Periodic Table, show miniature chemical equipment and techniques, demonstrate a chain reaction, and explain the operation of an atomic power plant.

INDU, cat. no. FS-375, $125.

CHEMISTRY FOR THE NUCLEAR AGE
Collaborator: Greenpark Productions Ltd.
(34 min., 16mm, color, sound) 1962

Five stories illustrate the importance of the work of the chemist in the nuclear industry. The first deals with the reprocessing of irradiated fuel elements. The second story covers work on uranium dioxide as fuel for advanced reactor systems. The third story concerns the possible movement of carbon from the graphite core and its deposit in the cooler parts of a reactor circuit. The fourth story deals with corrosion in liquid moderated or cooled reactors and the investigation of organic coolants. The fifth story shows the use of the reactor as a research tool in radioactivation analysis.

UKAEA, free loan

THE NUCLEAR WITNESS
Collaborator: General Dynamics Corp.
(28 min., 16mm, color, sound) 1965

The application of neutron activation analysis to the investigation of crime.

AEC, free loan

214

USES IN EARTH STUDIES (Nuclear Radiation)
(15 min., 16mm, B/W, color, sound)

The nuclear radiation detector has drastically changed the nature of man's eternal search for rich resources in the earth's crust. Geiger-Mueller and scintillation counters are used to measure corpuscular and electromagnetic radiation given off during the decomposition process of naturally occurring radioisotopes. Terms such as alpha, beta, and gamma rays, daughter elements, half-life, and isotope are defined and explained. The Carbon-14 method of dating fossil remains is explained and applied to historical research.

JCA, cat. no. 58517, B/W, $75.; color, $150.

216

PHOTOCHEMICAL PROPERTIES OF PHYTOCHROME
Collaborator: Iowa State University
(3:40, S-8, color, silent) 1967

A solution of phytochrome shows subtle and reversible shifts in color when irradiated alternately with red light and far-red light. Absorption spectra of the two pigment forms are recorded and compared and then related to the visible color differences.

EAL, cat. no. 81-5548/1, $21.50

PHOTOCONDUCTIVE EFFECT
(16 min., 16mm, B/W, sound) 1961

The film opens by showing how the photoconductive cell is highly sensitive to heat radiation. Various methods of detecting and measuring infra-red radiation are illustrated. The history of the research into the photoconductive effect follows. Then the composition of a photoconductive cell is shown and its working explained. The application of this research is illustrated in the operation of guided missiles, steel furnaces and medical analysis. The film ends with a summary of the teaching points made.

MGHT, cat. no. 603518, $95.

THE PHOTOELECTRIC EFFECT
Collaborator: A. E. Walters, Rutgers
(4:05, S-8, color, silent)

This film demonstrates that photons with a frequency above that of visible light may provide sufficient energy to charges on the surface of a clean zinc surface so that they overcome the potential energy barrier of the surface and leave the metal entirely. Since it is only negatively charged electrons which are affected in this manner, the loop also provides an excellent demonstration of a fundamental difference between the two types of charge, i.e. the mobility of the negative charge. A zinc disc, freshly abraded on one side, is mounted on the top of an electroscope and charged negative by contact. When a mercury vapor light is pointed at the plate, the electroscope discharges. When the same rod is used to charge the plate positive by induction, however, the electroscope is not discharged. The remainder of the film is devoted to an examination of the type of light which produces this effect and the importance of the surface condition of the metal. When an incandescent lamp is substituted for the mercury light, no effect is produced. It is then shown that the active (ultraviolet) component of the light fails to pass through cardboard and ordinary window glass but passes readily through quartz. Next, the zinc plate is turned around and the ultraviolet light allowed to fall on the dull oxidized side. The light fails to discharge the electroscope. When, however, the zinc disc is removed and the oxidized side polished with emery cloth before being replaced, the photoelectric effect is again observed.

EAL, cat. no. 80-2884/1, $21.50

PHOTOELECTRIC EFFECT
Collaborator: John Strong, John Hopkins University, PSSC
(28 min., 16mm, color, sound) 1962

Qualitative demonstrations of the photoelectric effect are shown using the sun and a carbon arc as sources. A quantitative experiment is performed measuring the kinetic energy of the photoelectrons emitted from a potassium surface. The data are interpreted in a careful analysis.

MLA, cat. no. 0417, $220.

PHOTO-EMISSION
(19 min., 16mm, B/W, sound) 1959

By means of experiments, the film develops the data from which the two laws of photo-emission are deduced. Using animation, it then shows how the quantum theory explains these two phenomena. The film ends by showing several applications of photo-emission.

MGHT, cat. no. 603512, $115.

PHOTO EMISSION OF ELECTRONS
Collaborator: A. P. French, MIT
(4 min., 16mm, B/W, sound) 1966

A current is detected when light falls on a negatively charged photo-sensitive surface; no current appears when the potential on the photocathode is reversed.

MLA, cat. no. 0470, $25.

SOLAR ENERGY
Collaborator: Gerald L. Pearson, Bell Telephone Laboratories
(22½ min., 16mm, B/W, sound)

Mr. Pearson demonstrates the solar battery, explains how conversion of light into electrical energy takes place in the p-n junction, reviews the development of the battery as the joint effort of chemist, electrical engineer, and physicist, illustrates how silicon "wafers" are

216

prepared, and discusses with Dr. Earl S. Herald the tremendous amount of energy reaching the earth from the sun. Other devices for utilizing this energy are shown along with experimental applications of the solar battery.

ALFI, $125.

217

*ANALYSIS BY MASS
(27 min., 16mm, color, sound) 1962

Due to rapid development of the Mass Spectrometer in this century any compound can now be identified quickly - sometime in minutes. It has become a most important tool in medicine, geology, chemistry and metallurgy. The basic principle of the Spectrometer is simply illustrated. The film shows how various size wooden balls, each with an identical iron core, are deflected by a magnet as they roll by gravity down an incline. In the Mass Spectrometer, the gas or vapor of a solid or liquid to be identified is first ionized then subjected to a magnetic field at a bend in the tube which deflects the atoms and molecules according to the individual mass. Each stream comes to focus near the detector and peaks are registered on a graph. The graph information, subjected to detailed calculations with the aid of an oscilloscope and referenced to established mass tables, indicates the number and kinds of atoms in the molecule. From detailed study of the spectrum showing how the molecule broke apart, the precise structure can be built up and the compound accurately identified. Uses of the Spectrometer in analyzing various liquid, solid and gaseous substances show the versatility and importance of this new and efficient scientific tool.

IFB, cat. no. 3 IFB 349, $225.

ANALYSIS OF SOLIDS
(5 min., 16mm, color, sound) 1961

The use of a mass spectrometer, sensitive to one part in 10^{o}, for the rapid analysis of a sample of alloy steel.

See RIC, p. 16

ASTON'S MASS SPECTROGRAPH
Collaborator: Halas & Batchelor
($2\frac{1}{4}$ min., 8, S-8, color, silent) 1962

Shows the original mass spectrograph (and others) developed by the English scientist, Francis William Aston, and follows the principles of its operation.

EBF, cat. no. R80209, 8, $16.; S80209, S-8, $17.60

ORGANIC MASS SPECTROMETRY
(16 min., 16mm, color, sound) 1966

The use of the MS9 and MS12 mass spectrometers in organic chemistry and biochemistry.

See RIC, p. 18

PRINCIPLES OF MASS SPECTROMETER-ANIMATION SEQUENCES
Collaborator: Yale Chem. Films
(11 min., 16mm, color, silent)

Shows the basic behavior of charged particles in magnetic and electric fields and in combinations of these fields.

AIM, cat. no. YF-256, $82.50

218

CONQUEST OF LIGHT
Collaborator: Bell Telephone Labs
(10 min., 16mm, color, sound)

In non-technical language this film explains the revolutionary concepts of the laser, what it is, and how it works. As the film depicts, Bell Telephone Labs are looking closely at the future potentialities of the laser in communications transmission.

STER, free loan

THE LASER: A LIGHT FANTASTIC
(21 min., 16mm, color, sound)

This film offers a general introduction to the laser - a revolutionary invention which produces a useful form of light. The light we usually see is a combination of many frequencies, directions and phases. The laser, however, produces coherent light; that is, all the light waves travel simultaneously in exactly the same frequency. This organized beam of light is: used in making precise measurement; in melting and welding metals, diamonds, and other materials; in communication; in surgery; and even to produce a new sort of three-dimensional image, called a hologram. Although so far we have used the laser's most obvious properties. On day, laser light may have as many uses as electricity does today.

FAC, $225.

LASER-MIRACLES WITH LIGHT
(24 min., 16mm, B/W, sound) 1965

Describes properties and action of the laser beam, a device which generates coherent, non-chromatic light. Shows military applications of the laser in rangefinders, target detection radar, night vision and illumination devices, missile guidance and control, communication, and as a welding and cutting tool. Covers the use of laser in medicine and scientific research.

DUART, free loan

217

PRINCIPLES OF THE OPTICAL MASER
Collaborator: Bell Telephone Labs
(30 min., 16mm, color, sound) 1963

This is a college level film on the basic concepts of the optical maser. Included in the film are descriptions of the principal types of gas and solid state optical masers as well as laboratory demonstration and animation.

STER, free loan

301

BUBBLE MODEL OF A CRYSTAL: DEFORMATION AND DISLOCATIONS
(3 min., S-8, B/W, silent) 1967

This film examines elastic and plastic deformation of metal structures. The film begins with a comparison of an actual strip of metal being bent elastically and, a constrained bubble raft being compressed elastically by a movable wall. It then shows a similar comparison for plastic deformation. As the bubble raft is thus deformed, rapidly moving dislocations are easily observed. These dislocations are then examined in greater detail with the help of animation and superimposed vector diagrams. This film, together with its companion 84-0116/1, was adapted from the classic film, "Bubble Model of a Metal Structure".

EAL, cat. no. 84-0124/1, $15.50

CRYSTALS
Collaborator: Alan Holden, Bell Telephone Labs
(25 min., 16mm, B/W, color) 1958

Demonstrates the nature of crystals, how they are formed and why they are shaped as they are. Shows actual growth of crystals under a microscope; discusses how they may be grown. Relates these phenomena to the concept of atoms.

MLA, cat. no. 0114, B/W, $135.; color, $190.

CRYSTALS AND THEIR GROWTH
Collaborator: Paul Wright, Wheaton College, Illinois
(11 min., 16mm, B/W, color, sound)

The transparent brilliance of a quartz crystal, the jewel-like patterns of snowflakes and salt crystals growing before your eyes - these help to illustrate the nature of crystals and how they grow. Methods are shown for growing several types of crystals. Scenes of industrial uses of crystals indicate their importance in present-day science and technology.

CORF, B/W, $60.; color, $120.

GLASS
(21 min., 16mm, B/W, sound) 1962

Crystalline and amorphour solids; types of glass; manufacture of soda glass; special glasses; X-ray examination; the structure of glass; its special properties.

See RIC, p. 123

GROWTH OF CRYSTALS
Collaborator: Nuffield Foundation
(2-5 min., 8, color, silent) 1966

See RIC, p. 225

HEAT EXPANDS METALS
(3½ min., 8, S-8, color, silent) 1964

This film shows the familiar ball and ring experiment, a sagging wire apparatus, and a bimetallic strip. The bi-metallic strip provides a unique take-off point for a discussion of different rates of expansion.

ICF, cat. no. 13030, 8, $16.; 13035, S-8, $19.50

HOMOGENOUS NUCLEATION AND THE POLAR NATURE OF ICE CRYSTALS
(3:30, S-8, B/W, silent)

This film was designed as a sequel to the film Nucleation of Supercooled Clouds to show the rapid growth of ice crystals in air which expands. The effect of an electric field on the orientation of the crystals is also shown.

EYE, cat. no. 8063, $12.50

IDENTIFYING SOLIDS BY DENSITY
Collaborator: Don Herbert, Prism Productions and M. H. Shamos, New York University
(4 min., S-8, color, silent)

An experiment is conducted which demonstrates the utility of density as a means of identifying solids. Students are asked to identify different plastics from their densities. A graduated density column is constructed by layering various mixtures of carbon tetrachloride and benzene. The column is calibrated with water droplets which form small spheres at a level equal to a density of 1.0. One by one the plastic pieces are dropped into the column, each sinking to its appropriate density level. By comparing the position of the object in the column with a density table provided in the film notes, the plastic is identified.

EAL, cat. no. 80-3262/1, $22.95

301

KRYSTALLOS
Collaborator: Bell Telephone Labs
(11 min., 16mm, color, sound) 1960

Crystal quartz-created by nature, recreated by man. "Krystallos" is the story of how Bell Telephone Labs and Western Electric pooled their talents to develop a method of "growing" quartz crystals. These crystals are used today in the manufacture of tiny quartz plates which act as electronic filters for telephone and other communications media. How to keep the cost down and furnish an unlimited supply was the challenge given to chemists and engineers. This film offers a fascinating insight into how early experiments led to the final perfection of the process which grows crystal more perfect than nature itself.

STER, free loan

MOST SOLIDS MELT
(4 min., 8, S-8, color, silent) 1964

Some solids are viewed as they are heated and melted. Lead, bismuth, sulfur, ice and paraffin are the solids melted. This film will be useful in illustrating the general concept that changes in the state of matter are accompanied by a gain or loss of heat.

ICF, cat. no. 13010, 8, $16.; 13015, S-8, $19.50

MOVEMENT IN CRYSTAL GROWTH
Collaborator: Yale Chem. Films
(5 min., 16mm, color, sound)

The film demonstrates fractional crystallization for the purification of an organic compound. The particular compound used shows a unique phenomenon in which the crystals roll up and fly apart as they grow. Crystal strains are shown in polarized illumination.

AIM, cat. no. YF-234, $47.50

QUARTZ CRYSTAL GROWING
Collaborator: Western Electric
($15\frac{1}{2}$ min., 16mm, color, sound)

The engineering required to convert a successful laboratory development into a manufacturing process is colorfully portrayed. Initial research by Bell Telephone Labs for artificially growing quartz crystals used in communications is depicted, followed by Western Electric's establishment of a fullscale manufacturing operation.

STER, free loan

SNOW
Collaborator: National Film Board of Canada
(13 min., 16mm, B/W, sound) 1961

An old and sometimes bitter opponent, snow, as it appears in this film about the growth and decay of snow crystals, has a character, charm and frailty that excites far warmer feeling than you might expect. You observe that snow has a kind of life; that it changes form or "ripens" the better to survive; that its very whiteness serves a purpose. You see frost shaping into delicate filigree flakes which, settling on the ground, by sheer weight of numbers clog roads and driveways. The film shows why "powder" snow is a favorite of skiers, while the congealing crystals of "corn" snow may, in high places, warn of an avalanche.

FAC, $75.

A STUDY OF CRYSTALS (Crystal Growth)
(17 min., 16mm, color, sound) 1961

Fusion methods in chemical research, with animation, micro-photography, and live-action.

JOUR, $165.

SULPHUR CRYSTALS
Collaborator: Nuffield Foundation
(2-5 min., 8, color, silent) 1966

See RIC, p. 225

THERMAL EXPANSION OF SOLIDS
Collaborator: Don Herbert, Prism Productions and M. H. Shamos, New York University
(4 min., S-8, color, silent)

Two experiments demonstrate the thermal expansion of a solid. A strip of aluminum foil under tension is heated with a match flame. A soda straw indicator graphically demonstrates the expansion of the metal with increasing temperature. This sequence is followed by a quantitative experiment designed to obtain the volume co-efficient of the thermal expansion of a metal block by measuring its apparent change in weight as it is heated in an oil bath while suspended from the arm of a sensitive balance. The co-efficient of expansion of the metal, necessary for determining the volume co-efficient of the oil, is given in the film notes.

EAL, cat. no. 80-3296/1, $22.95

302

BEADING OF WATER COLUMN
(4 min., S-8, color, silent)

The opening sequence shows the beading of water flowing from a faucet. The beading is then seen in slow motion - the action is slowed down 200 times. Close-ups reveal the formation and the oscillation of the drops as they fall.

EYE, cat. no. 8081, $15.50

BOUNDARY LAYER FORMATION (FM-6)
Collaborator: Edited from the Fluid Dynamics of Drag
(4 min., 8, S-8, B/W, silent)

Dyed fluid lines on surface of glycerine in open channel show: (i) formation of Rayleigh boundary layer, (ii) no-slip condition at wall, and (iii) thickening of boundary layer with reduced speed or increased viscosity.

EBF, cat. no. RFM006, 8, $9.50; SFM006, S-8, $12.50

BREAKUP OF LIQUID INTO DROPS (FM-76)
Collaborator: Edited from Surface Tension in Fluid Mechanics
(4 min., 8, S-8, color, silent)

Demonstrates that the pressure differences caused by curved liquid surfaces can lead to breakup into drops. Experiments include the breakup of a water jet and a radially expanding sheet of water, the rupture of a soap bubble, and the impact of a milk drop on a fluid surface, all seen in slow motion.

EBF, cat. no. RFM076, 8, $9.50; SFM076, S-8, $12.50

EXAMPLES OF SURFACE TENSION (FM-72)
Collaborator: Edited from Surface Tension in Fluid Mechanics
(4 min., 8, S-8, color, silent)

A number of experiments illustrate the existence of surface tensile forces. Included are: Water drops on faucet, soap film expanded by pulling its edge, water sheet resulting from jet impingement on concave solid, capillary rise, rupture of soap bubble, impact of milk drop on fluid surface, water drops on waterproof cloth.

EBF, cat. no. RFM072, 8, $9.50; SFM072, S-8, $12.50

HEAT EXPANDS LIQUIDS
(4 min., 8, S-8, color, silent) 1964

That liquids have the same general tendency to expand as do solids is vividly illustrated by heating colored water in a flask. The notion that warm water is less dense than cold water is displayed by weighing equal volumes of both.

ICF, cat. no. 13040, 8, $16.; 13045, S-8, $19.50

IDENTIFYING LIQUIDS BY DENSITY
Collaborator: Don Herbert, Prism Productions and M. H. Shamos, New York University
(4 min., S-8, color, silent)

An experiment is conducted to demonstrate the utility of density as a means of identifying liquids. The density of water is obtained by weighing 100 ml. of water in a two-pan balance. The densities of two other liquids, one more and one less dense, are obtained by balancing each against an equal volume of water and adding weights as necessary. A second experiment illustrates the construction and calibration of a hydrometer for measuring liquid density directly. A long light bulb is lowered into each of the liquids and calibrated. With this instrument, two additional liquids are measured. All five liquids are then identified by comparing these densities to others found in a density table in the film notes.

EAL, cat. no. 80-3270/1, $22.95

LIQUIDS EVAPORATE
(4 min., 8, S-8, color, silent) 1964

This film shows that the application of heat to various liquids causes them to vaporize. The student is provided with further evidence for building the concept that changes of state are accomplished by a gain or loss of heat.

ICF, cat. no. 13020, 8, $16.; 13025, S-8, $19.50

MOTIONS CAUSED BY COMPOSITION GRADIENTS (FM-77)
Collaborator: Edited from Surface Tension in Fluid Mechanics
(4 min., 8, S-8, color, silent)

Local gradients in surface tension caused by soap, camphor, ether vapor and alcohol result in motion of a loop of string, a model boat, a water film, and "wine tears" on a glass.

EBF, cat. no. RFM077, 8, $9.50; SFM077, S-8, $12.50

MOTIONS CAUSED BY TEMPERATURE GRADIENTS ALONG LIQUID SURFACES (FM-79)
Collaborator: Edited from Surface Tension in Fluid Mechanics
(4 min., 8, S-8, color, silent)

The experiments show the effect of hot and cold spots on a thin layer of silicone, the motion of an air bubble in a temperature gradient, and "dancing" vapor bubbles on a heated wire in a liquid mixture.

EBF, cat. no. RFM079, 8, $9.50; SFM079, S-8, $12.50

SHEAR DEFORMATION OF VISCOUS FLUIDS (FM-3)
Collaborator: Edited from Fluid Dynamics of Drag
(4 min., 8, S-8, color, silent)

Dyed fluid lines mark surface of an annular container. Rotation of inner cylinder shows (i) no slip at wall, (ii) diffusion of vorticity, (iii) deformation of fluid square.

EBF, cat. no. RFM003, 8, $9.50; SFM003, S-8, $12.50

302

SURFACE TENSION AND CONTACT ANGLES (FM-73)
Collaborator: Edited from Surface Tension in Fluid Mechanics
(4 min., 8, S-8, color, silent)

Experiments show: intersecting soap films; instability of four soap films intersecting; water drops on wax, on soap, on waterproof cloth; and mercury drops on glass.

EBF, cat. no. RFM073, 8, $9.50; SFM073, S-8, $12.50

SURFACE TENSION AND CURVED SURFACES (FM-75)
Collaborator: Edited from Surface Tension in Fluid Mechanics
(4 min., 8, S-8, color, silent)

Ejection of smoke from soap bubble, water drop on faucet, comparison of capillary rise of water and alcohol, and waterjet breakup demonstrate the existence of a pressure difference across curved liquid surfaces.

EBF, cat. no. RFM075, 8, $9.50; SFM075, S-8, $12.50

*SURFACE TENSION IN FLUID MECHANICS
(29 min., 16mm, color, sound)

Experiments illustrating effects of surface tension, including soap film intersections, breakup of jets and sheets into droplets, capillary action, wetting and non-wetting droplets, splashing of a drop in slow motion, chemical and electric effects, wine tears, generation of bubbles in boiling water and carbonated liquids, and bubble motion in temperature gradients.

EBF, cat. no. 21610, $225.

THERMAL EXPANSION OF LIQUIDS
Collaborator: Don Herbert, Prism Productions and M. H. Shamos, New York University
(4 min., S-8, color, silent)

A small medicine bottle filled with water is heated in a water bath until the bottle shatters. The student may then measure the thermal expansion of three different liquids. Syringes containing water, oil and carbon tetrachloride are heated in a water bath and the student may plot the volume of each liquid as a function of temperature. Finally, three medicine bottles labeled A, B and C are heated in a water bath. Each shatters at a different time and hence, a different temperature. From the information obtained earlier, the student may identify the liquids in the medicine bottles.

EAL, cat. no. 80-3304/1, $22.95

303

BOYLE'S LAW
Collaborator: Don Herbert, Prism Productions and M. H. Shamos, New York University
(4 min., S-8, color, silent)

By experiment and analogy, the student is led to understand the relationship between the pressure and volume in a gas at a constant temperature. The experiment involves the student in measuring the volume of air in a syringe as a function of the force applied to its plunger. Given the cross-sectional area of the plunger, the student can plot the volume as a function of pressure. The analog of the syringe of air is a cylinder containing steel balls which are agitated by a piston at the bottom. As successive weights are added to a plunger at the top of the cylinder, the volume decreases. The student can plot the volume occupied by the vibrating steel balls as a function of this force or pressure.

EAL, cat. no. 80-3387/1, $22.95

FINDING ABSOLUTE ZERO
Collaborator: Don Herbert, Prism Productions and M. H. Shamos, New York University
(4 min., S-8, color, silent)

A hollow metal sphere containing air at atmospheric pressure is placed in successive baths of boiling water, ice water and alcohol-dry ice mixture. In each case the pressure inside the sphere and the temperature of the bath are displayed so the student can plot a temperature vs. pressure curve. While the sphere is at its lowest temperature (-65°C), the relief valve is opened to provide a new pressure level. The experiment is repeated. The student can find the linear relationship between pressure and temperature at a constant volume and, by extrapolation, find the temperature at which the pressure would reduce to zero.

EAL, cat. no. 80-3395/1, $22.95

GAS PRESSURE AND TEMPERATURE
(2 min., 8, S-8, color, silent) 1968

Laboratory apparatus is used to demonstrate the effects of temperature on a fixed volume of gas. Room temperature, boiling water, dry ice, and liquid nitrogen are used for temperature variances. Charting the results is also illustrated.

ICF, cat. no., 13240, 8, $11.; 13245, S-8, $14.50

GASES CONDENSE AS THEY COOL
(3½ min., 8, S-8, color, silent) 1964

In this film the tendency of gases to change from a vapor state to liquid state when cooled is illustrated. Unanswered questions can be explored through simple follow-up experiments.

ICF, cat. no. 13060, 8, $14.; 13065, S-8, $17.50

303

HEAT AFFECTS THE PRESSURE OF GASES
(2½ min., 8, S-8, color, silent) 1964

The motion of gases expanding when heated, and contracting when cooled is carried to its next logical step in this film. The familiar "collapsing can" experiment is shown, along with an expanding balloon. The role of atmospheric pressure is hinted at by a girl sipping a soda through a straw.

ICF, cat. no. 13080, 8, $14.; 13085, S-8, $17.50

HEAT EXPANDS GASES
(3½ min., 8, S-8, color, silent) 1964

The tendency of solids and liquids to expand when heated is extended to gases. An air thermometer and a rubber balloon placed on the mouth of a flask are used to illustrate this principle.

ICF, cat. no. 13050, 8, $14.; 13055, S-8, $17.50

IDENTIFYING GASES BY DENSITY
Collaborator: Don Herbert, Prism Productions and M. H. Shamos, New York University
(4 min., S-8, color, silent)

An experiment demonstrates the use of density as a means of identifying gases. A flask is evacuated and weighed on a sensitive torsion balance. The vernier scale reading is carefully noted and recorded. This procedure is repeated for three unknown gases. The film notes give the weight of one liter of air at STP, so the student can determine the volume of the flask by comparing the weight of the air in the flask to the weight of one liter of air. With this information, the student may then obtain the density of the air and each of the unknown gases. A table of gas densities is provided in the film notes to permit the student to identify the unknowns.

EAL, cat. no. 80-3288/1, $22.95

PRESSURE AND MOLECULAR MOTION
(2 min., 8, S-8, color, silent) 1968

Through the use of models, and actual laboratory setup of pressure chamber, pump, and gauge, plus charting the results of the demonstrations, the relationships between pressure, molecule motion, and Boyle's law are well illustrated.

ICF, cat. no. 13230, 8, $11.; 13235, S-8, $14.50

THERMAL EXPANSION OF GASES
Collaborator: Don Herbert, Prism Productions and M. H. Shamos, New York University
(4 min., S-8, color, silent)

A simple Galilean air thermometer shows that gases expand when heated. The student becomes involved in an experiment in which a syringe containing air and another containing helium are heated in an oil bath. The student is asked to plot the volume of each gas as a function of temperature. Having arrived at the conclusion that all gases undergo the same thermal expansion, he is confronted with a puzzle in which two gases apparently behave differently when heated. On further consideration, he should conclude that the oil baths in which the gas syringes are being heated are at two different temperatures. Furthermore, he can determine the bath temperatures from the plots made earlier.

EAL, cat. no. 80-3312/1, $22.95

304

BOILING POINT AND PRESSURE
Collaborator: Don Herbert, Prism Productions and M. H. Shamos, New York University
(4 min., S-8, color, silent)

By experiment and analogy, this film investigates the relationship between the boiling point of water and the pressure of gas above its surface. In a quantitative experiment, the boiling point of water is plotted as a function of vapor pressure. The analog of the boiling water consists of a transparent cylinder containing plastic balls, vibrated by a piston at the bottom. Suspended in the space near the top of the cylinder are other balls representing molecules of gas in the atmosphere. As the "water molecules" escape, they scatter a light beam into a photoelectric detector. As a number of molecules in the "atmosphere" increases, the "temperature" (as indicated by the voltage applied to the piston motor) must be increased to bring the water to a boil.

EAL, cat. no. 80-3403/1, $22.95

BOILING POINTS OF WATER
(3:45, 8, S-8, color, silent) 1964

The effect of pressure on the boiling point of water is shown in this film. After it has stopped boiling, a flask of water is stoppered and cooled, causing it to boil vigorously again.

ICF, cat. no. 13090, 8, $16.; 13095, S-8, $19.50

CHANGE OF STATE
Collaborator: Esso Petroleum Co. Ltd.
(20 min., 16mm, color, sound) 1962

Simple phenomena; Brownian movement, kinetic theory and its effects; evaporation and distillation, applications.

See RIC, p. 5

CONDENSATION FROM AIR
Collaborator: Yale Chem. Films
(1 min., 16mm, color, sound)

Shows how droplets of liquid oxygen can be obtained directly from the air by collecting them on a metallic surface cooled with liquid nitrogen.

AIM, cat. no. YF-218, $9.50

CONDENSATION NUCLEI
Collaborator: Bernard Vonnegut, State University of New York, Albany
(4 min., 8, color, silent) 1966

Laboratory and field experiments are utilized to show that water-droplet clouds, similar to those of the natural variety, may be formed if sufficient numbers of small liquid or solid particles are present in air that is cooled below its dew point. These particles, normally present in large quantities in the atmosphere as the result of such processes as combustion and the evaporation of salt spray, act as centers or nuclei on which water vapor can condense and thus permit the natural condensation process which gives rise to fog and cloud. When such nuclei are not present in sufficient quantity, the moisture condenses to form an almost invisible cloud that consists of only a few large cloud droplets. This is dramatically illustrated in the film by the production of a fog trail from a lighted cigarette which is held in the very clean air near the surface of a hot pool in Yellowstone National Park in mid-winter.

MLA, cat. no. 1851, $12.50

THE CRITICAL POINT
(4 min., 8, color, silent)

Definition, demonstration, and a suggested problem dealing with the critical point is shown.

LBF, cat. no. 16, $15.

CRITICAL TEMPERATURE
Collaborator: F. Miller, Jr., Ohio State University
(4:20, S-8, color, silent) 1964-67
(4 min., 16mm, color, sound; 8, color, silent)

A glass tube containing ether is heated above the critical temperature of ether (194 C) and allowed to cool. The system cools a few degrees below the critical temperature before a violent condensation occurs, and a well defined liquid gas interface is formed. During super cooling the first appearance of the liquid formation is apparent from the "blue haze" which is in all probability caused by the light scattering effect of the microscopic drops present.

EAL, cat. no. 80-2058/1, $15.50
MSC, cat. no. 12064, 16mm, $31.; 12062, 8, $11.25

DISTILLATION FROM LIQUID AIR
Collaborator: Yale Chem. Films
(2 min., 16mm, color, sound)

Shows the different boiling points of nitrogen and oxygen to separate the two elements. Liquid air is floated on water in a beaker; the nitrogen boils way first, leaving oxygen.

AIM, cat. no. YF-217, $19.

EFFECT OF HEAT
Collaborator: Robert G. Picard
(15 min., 16mm, B/W, color, sound) 1962

Heat and the absence of heat, cold, affect everything around us, regardless of its composition. Heat causes matter to expand, cold to contract. Freezing or solidification and melting are reverse processes. In a crystalline pure substance (such as water), the freezing point and melting point are identical. Non-crystalline, impure substances (such as butter) melt and freeze at two different temperatures. When liquids cool and reach their freezing point, they contract. With the exception of water, they contract further upon freezing. On the other hand, at 4°C water's density is greatest and its volume smallest. Upon freezing at 0°C, it becomes lighter; thus ice forms at the top of a lake and stays there. Other changes of state brought on by heat are vaporization, when a liquid becomes a gas, and condensation, the reverse process. When air is warmed, it increases in volume and decreases in density, thus causing it to rise being replaced by cooler air. From this come the "fronts" or dividing lines between cold and warm air masses which are so important in the study of weather.

EYE, cat. no. EG530, B/W, $75.; EG531, color, $150.

EVAPORATION CAUSES COOLING
(2:45, 8, S-8, color, silent) 1964

A wet cloth is placed on a thermometer bulb which is placed in front of an electric fan until a temperature drop is recorded. The experiment is repeated with alcohol. The class may simply learn the general principle, or delve deeply into the molecular motion involved.

ICF, cat. no. 13070, 8, $14.; 13075, S-8, $17.50

EXPLAINING MATTER: MOLECULES IN MOTION
Collaborator: George Gamow, University of Colorado
(11 min., 16mm, B/W, color, sound) 1960

Shows that the rate of molecular movement determines whether matter exists in a solid, liquid, or gaseous state. Molecular movement is increased by heat and decreased by cold.

EBF, cat. no. 1676, B/W, $70.; 1675, color, $135.

304

FORMATION OF BUBBLES (FM-74)
Collaborator: Edited from Surface Tension in Fluid Mechanics
(4 min., 8, S-8, color, silent)

Demonstrates how bubbles are usually formed as pinched-off enlargements of bubbles which grow from vapor pockets remaining in cracks on the surface of solids. Bubble formation in boiling water, in a model nucleation cavity, and in a glass of beer are shown.

EBF, cat. no. RFM074, 8, $9.50; SFM074, S-8, $12.50

FORMATION OF RAINDROPS
Collaborator: Louis J. Battan, University of Arizona; Patrick Squires and J. Doyne Sartor, National Center for Atomic Research
(26 min., 16mm, color, sound) 1966

Beginning with the condensation of water vapor on water soluble nuclei in the atmosphere to form cloud droplets, this film describes and develops the two mechanisms known to be responsible for the growth of cloud droplets to the size of raindrops, i.e. coalescence and glaciation. Current experimental techniques are employed to show that cloud droplets can never reach raindrop size by condensation alone that larger cloud droplets can combine or coalesce with slower falling smaller ones when electrical forces of attraction are present, and that the transfer of water vapor from supercooled cloud droplets to ice nuclei can result in the formation of ice crystals and snow. Natural and lapse time photography of clouds is employed to illustrate the results of these processes.

MLA, cat. no. 1802, $195.

HOMOGENEOUS NUCLEATION AND DIELECTRIC NATURE OF ICE CRYSTALS
Collaborator: Vincent Schaefer, State University of New York, Albany
(4 min., 8, B/W, silent) 1966

A sequel to Nucleation of Supercooled Clouds this film continues the cold chamber experiments of Dr. Schaefer. In this film, the rapid cooling produced by the rupture and subsequent expansion of air from a small plastic bubble, is shown to be sufficient to produce a cloud of ice crystals in the path of escaping air. As before, these crystals then grow rapidly in size due to the transfer of water vapor from the supercooled water cloud droplets to the ice crystals. The second part of the film shows the change in the orientation of ice crystals that can be produced by an electric field. A charged comb is moved through the crystals in the cold chamber giving rise to changes in the intensity of light which is reflected from the crystals. The effect is due to the dielectric nature of ice.

MLA, cat. no. 1852, $9.

LE CHATELIER'S PRINCIPLE
Collaborator: Yale Chem. Films
(3 min., 16mm, color, silent)

In stop-motion photography, a weighted wire is shown cutting through a block of ice which refreezes after the wire passes through. A diagram explains the phenomenon by relating water-ice equilibrium to the pressure.

AIM, cat. no. YF-225, $22.50

LIQUID AIR FRACTIONATION
Collaborator: Nuffield Foundation
(2-5 min., 8, color, silent) 1966

See RIC, p. 224

THE MELTING TEMPERATURE OF A PURE SUBSTANCE
Collaborator: Don Herbert, Prism Productions and M. H. Shamos, New York University
(3:40, S-8, color, silent)

A student takes data from this film to learn how to find the melting points of substances. Paradichlorobenzene is melted under controlled conditions while the temperature is presented. By graphing this data, a student can see the melting point. The procedure for recording, displaying, and interpreting the data is clearly described in the film notes.

EAL, cat. no. 80-3411/1, $22.95

NUCLEATION OF SUPERCOOLED CLOUDS
Collaborator: Vincent J. Schaefer, State University of New York, Albany
(4 min., 8, B/W, silent) 1966

Striking laboratory photography is employed to illustrate the process by which supercooled fog or cloud droplets can be transformed to ice crystals by seeding or nucleating the fog with particles of dry ice. The intensely cold temperature of the dry ice causes the formation of myriads of ice embryos when its fragments fall through moist air supersaturated with respect to ice. The resulting ice crystals then grow quickly in size as water molecules deposit on the embryos to form ice crystals. If supercooled cloud droplets are present, they evaporate as the crystals grow and the cloud or fog rapidly disappears. The process, of fundamental importance in cloud modification, is known as homogeneous nucleations, since ice crystals themselves are the nuclei on which further growth occurs. Heteorogeneous nucleation involves the introduction of foreign substance nuclei on which ice crystals can grow.

MLA, cat. no. 1850, $9.

NUCLEATION OF SUPER COOLED WATER DROPLETS
(4 min., S-8, B/W, silent)

This film was produced to illustrate the process by which supercooled fog or droplets can

304

be transformed to ice crystals by seeding or nucleating the fog with particles of dry ice.

EYE, cat. no. 8062, $12.50

PHASE CHANGE (Change of State)
Collaborator: Carl Clader, New Trier Township High School, Winnetka, Illinois and L. Carroll King, Northwestern University
(3½ min., 8, S-8, color, silent) 1966

By means of laboratory experimentation, the constant temperature of water at a phase change (melting and boiling) is illustrated. Demonstrates that by increasing the pressure during a phase change (boiling) the temperature of the boiling point of water can be raised.

EBF, cat. no. R80601, 8, $20.; S80601, S-8, $22.

PHASE DEMONSTRATION
Collaborator: Yale Chem. Films
(1 min., 16mm, color, silent)

Naphthalene powder is heated to produce three phases, then cooled to show crystal condensation from vapor.

AIM, cat. no. YF-238, $7.50

PHASE DIAGRAM FOR Bi-Cd ALLOY
(4 min., 8, color, silent)

Cooling curves for bismuth-cadium alloys are derived and data presented for the construction of the phase diagram - a demonstrated experiment from which the student may construct a phase diagram.

LBF, cat. no. 3, $15.

SULFUR, ITS PHYSICAL STATES AND PROPERTIES
Collaborator: Yale Chem. Films
(9 min., 16mm, color, sound)

Illustrates that the physical transformation of sulfur are functions of both temperature and time. These changes are explained in molecular terms by animated sequences.

AIM, cat. no. YF-249, $85.50

TRIPLE POINT DETERMINATION
Collaborator: Yale Chem. Films
(15 min., 16mm, color, sound)

Using the preparation of a temperature reference standard the film shows the practical use of the triple point of water to standardize a platinum resistance thermometer.

AIM, cat. no. YF-233, $142.50

VERY LOW TEMPERATURES
(15 min., 16mm, B/W, color, sound)

Cryogenics deals with very low temperatures, much colder than our normal wintertime and refrigerator temperatures. Liquid air is nearly 200°C colder than ice. Liquid hydrogen is even colder, -239°C. Discussion continues on "absolute zero" and use of the Kelvin temperature scale. Pressure and volume of gas are related, leading to a definition of "critical pressure". Methods for storing and handling liquid gases are illustrated. In conclusion, changes of characteristics at low temperatures are demonstrated and unusual applications discussed.

JCA, cat. no. 58535, B/W, $75.; color, $150.

THE WORLD OF MOLECULES
(11 min., 16mm, B/W, color, sound) 1963

The size of molecules; their behavior; molecules in solids, liquids and gases; change of state.

CHUR, B/W, $60.; color, $120.

305

DYNAMICS OF SOLUTION
(14¼ min., 16mm, B/W, color, sound) 1961

The differences between saturated, unsaturated and supersaturated solutions are demonstrated. Characteristics of solutions, proof that solutions are non-static, and the nature of dynamic equilibriums are clearly presented.

MGHT, cat. no. 612005, B/W, $85.; 512017, color, $170.

IDENTIFYING FABRICS BY SOLUBILITY
Collaborator: Don Herbert, Prism Productions and M. H. Shamos, New York University
(4 min., S-8, color, silent)

Solubility is a characteristic property useful in identifying materials. Four samples, one of wool, cotton, nylon and acetate are placed in separate test tubes containing acetic acid, sulfuric acid, hydrochloric acid, and bleach. The students observe the reaction of each fabric with each solvent and are asked to prepare a solubility table. In the final sequence, samples of unknown red and white fabric are placed in the four solvents and the student is asked to identify the two constituents of the fabric. This experiment was adapted from industrial tests for fabrics as described in "Textile World".

EAL, cat. no. 80-3320/1, $22.95

305

PRINCIPLES OF IONIZATION
Collaborator: Thomas Sumner, University of Akron
($13\frac{1}{2}$ min., 16mm, B/W, color, sound)

Shows the effects of different types of solutes on the boiling point of water; demonstrates electrical conductivity of solutions, and shows ion migration during electrolysis.

CORF, B/W, $62.50; color, $125.

SOLUTIONS
(16 min., 16mm, B/W, color, sound)

The more important characteristics of solutions are presented by means of laboratory demonstrations. Solutions are defined, both ionic and non-ionic, and the common types visualized. We learn of the factors which influence solubility such as temperature, pressure, and composition. In conclusion, see some of the practical applications of solutions in the chemistry of everyday life.

CORF, B/W, $90.; color, $180.

SOLUTIONS
(3 min., 8, color, silent)

Explains, through animation and subtitles, the molecular and ionic process of water dissolving salt crystals.

SUTH, $12.

305/306

LIQUIDS IN SOLUTION
(11 min., 16mm, B/W, color, sound) 1961

A study of the theoretical basis for understanding why some liquids are miscible and some are immiscible, and how this may explain the formation of emulsions, as well as the process of liquid extraction.

MGHT, cat. no. 612002, B/W, $80.; 612014, color, $160.

PROPERTIES OF SOLUTION
Collaborator: Thomas Sumner, University of Akron
(28 min., 16mm, B/W, color, sound)

Discusses the nature of solutes; the factors influencing solution of one liquid in another; saturation; and the principle of extraction.

CORF, B/W, $125.; color, $250.

SOLUBILITY
(21 min., 16mm, B/W, sound) 1962

The principles of solubility; gas mixtures; solutions of gases in liquids; Henry's law; liquid-liquid relationships; solids in liquids; partition law; solid solutions; eutectic mixtures.

See RIC, p. 9

VOLUME CHANGES ON MIXING LIQUIDS I AND II
(4 min., 8, color, silent)

Measured volumes of two liquids are mixed together. The difference between the final volume after mixing, and the arithmetical sum of the initial volumes, is observed. The way in which this difference depends upon the constituent ratios is investigated by the continuous variation technique. Systems shown are: HCL(aq)/NaOH(aq); C_2H_5OH/H_2O; Toluene/Kerosene; $H_2SO_4(aq)/H_2O$.

UNESCO, cat. no. 2, I, $6.; 3, II, $6.

306

SOLID SOLUTIONS (Bronze Manufacture)
(4 min., 8, color, silent)

The manufacture of bronze in Thailand is presented as a study of some of the properties of, and the production of, solid solutions.

UNESCO, cat. no. 7, $6.

SOLUTION, EVAPORATION, AND CRYSTALLIZATION
Collaborator: Yale Chem. Films
(3 min., 16mm, color, silent)

Sulfur powder is dissolved with carbon disulfide, then allowed to evaporate in a hood. Stop-motion and close-up photography are used to observe the formation of crystals.

AIM, cat. no. YF-239, $22.50

307

BROWNIAN MOTION
(3 min., 8, S-8, color, silent) 1968

Brownian motion is demonstrated through the use of models, microscopic views of fat grains in water, and a hydrocarbon system interpreted on the screen of an electron microscope. Application of heat is seen to increase action and cigarette smoke illustrates the motion in gas.

ICF, cat. no. 13220, 8, $15.; 13225, S-8, $18.50

THE COLLOIDAL STATE
(16 min., 16mm, B/W, color, sound) 1962

The products of colloidal matter are of major significance in a multitude of chemical processes. This film introduces us to the colloidal state through a series of carefully controlled laboratory experiments and demonstrations. It defines colloids, and their several kinds, shows how they differ from solutions and suspensions, how they may be prepared and destroyed, and points out the many uses of colloids in the

307

chemistry of everyday life.

CORF, B/W, $90.; color, $180.

COLLOIDS
Collaborator: Hermann I. Schlesinger and Warren C. Johnson, University of Chicago
(11 min., 16mm, B/W, sound) 1962

Clarifies the concepts of colloidal state and portrays examples of different types of colloids. Reveals differences between colloids and true solutions. Explains how particle size affects filtration and sedimentation. Demonstrates Tyndall effect, Brownian movement, cataphoresis, and the Cottrell process.

EBF, cat. no. 201, $70.

FLOCCULATION OF SOLS
(4 min., 8, color, silent)

Effect of concentration of mono, di-, tri, and tetravalent electrolytes on the flocculation or sign reversal of iron oxide, arsenic sulfide, and gold sols using time-lapse photography.

LBF, cat. no. 10, $15.

401

ISOTOPES
(15 min., 16mm, color, sound) 1959

The film shows uranium being separated into two isotopes - U-238 and U-235. It explains how J. J. Thompson first demonstrated the existence of isotopes and how Aston developed the first mass spectrometer. It then shows two methods of separating isotopes and concludes by illustrating the uses of radioisotopes.

MGHT, cat. no. 603517, $180.

MASS OF AN ATOM
Collaborator: Don Herbert, Prism Productions and M. H. Shamos, New York University
(4 min., S-8, color, silent)

This film first demonstrates that when an electric current passes through a copper sulfate solution, metallic copper is deposited on one of the electrodes. In the quantitative portion of the experiment, this electrode is suspended from a sensitive torsion balance. A known current is passed through the solution for a known period of time. The mass of the copper deposited on the electrode is measured with the balance. Given the information that each copper ion requires two electrons to form an atom of metallic copper and given the charge of an electron, the student can calculate the mass of a single atom of copper to within an accuracy of four percent of the known value.

EAL, cat. no. 80-3353/1, $22.95

THE MASS OF ATOMS (Parts I and II)
Collaborator: Raymond Hertz and Charles Brewer, Monsanto Research Corp.
(20 min., (I), 27 min. (II), 16mm, B/W, sound) 1966

An experiment is performed in which the masses of a helium atom and a polonium atom are determined. A sample of helium is prepared by collecting the alpha particles decaying from a weighed sample of polonium. By counting the total number of particles collected and determining the mass of the sample, the mass of a helium atom is calculated. From the rate of the polonium decay and the mass of the polonium which produced the helium, the mass of a polonium atom is calculated. Throughout the film the various laboratory techniques and the precautions necessary for these measurements are shown.

MLA, cat. no. 0117 (I), $100.; 0118 (II), $150.

401/402

DETERMINATION OF ATOMIC WEIGHT
Collaborator: Thomas Sumner, University of Akron
(18½ min., 16mm, B/W, color, sound)

Experimental determinations of specific heat and equivalent weight of copper lead to calculation of actual atomic weight of copper.

CORF, B/W, $87.50; color, $175.

402

GRAMS-ATOMS
Collaborator: Nuffield Foundation
(2-5 min., 8, color, silent) 1966

See RIC, p. 224

MODEL FOR WEIGHT RELATIONS IN CHEMICAL REACTIONS
(4 min., 16mm, B/W, silent)

Shows in a highly stylized fashion examples of weight and molar relations in chemical reactions. The significance of and distinction between a molecule and molecular weight can be discussed following the film.

AIM , cat. no. YF-253, $14.

MOLECULAR WEIGHT OF OXYGEN
Collaborator: Thomas Sumner, University of Akron
(11 min., 16mm, B/W, color, sound)

The loss of weight of potassium chlorate after heating is determined and the molecular weight of oxygen is calculated.

CORF, B/W, $50.; color, $100.

404

DETERMINING A MOLECULAR FORMULA
($12\frac{1}{2}$ min., 16mm, B/W, color, sound) 1961

An experiment shows how the molecular weight and formula of a compound may be determined through knowledge of the percentage composition by weight of the compound and by the application of Avogadro's Law.

MGHT, cat. no. 612008, B/W, $75.; 612020, color, $150.

SYNTHESIS OF A COMPOUND
Collaborator: Thomas Sumner, University of Akron
($13\frac{1}{2}$ min., 16mm, B/W, color, sound)

The simplest formula of cuprous sulfide is derived by determining the weight ratio, then performing the conventional calculations.

CORF, B/W, $62.60; color, $125.

408

FLUE GAS ANALYSIS (ORSAT APPARATUS)
(19 min., 16mm, B/W, sound) 1944

How to set up the Orsat gas analyzer; collect an air-free sample of flue gas; absorb and measure the amounts of carbon dioxide, oxygen, and carbon monoxide in the sample; and calculate the amount of nitrogen.

DUART, cat. no. OE367, $25.99

GASES AND HOW THEY COMBINE
Collaborator: CHEM Study; George C. Pimentel, University of California
(22 min., 16mm, 8, color, sound) 1962

First, some properties that distinguish gases are shown. Then, the volumes of ammonia and hydrogen chloride that combine are measured quantitatively. The volume ratio is found to be 1.0 in a similar way, simple integer volume ratios are measured for the combination of hydrogen and oxygen, of nitric oxide and oxygen, and of hydrogen and chlorine. These simple integer ratios lead, logically, to Avogadro's Hypothesis.

MLA, cat. no. 4103, 16mm, $165.; 4803, 8, $140.

TEACHER TRAINING INTRODUCTION to "Gases and How they Combine"
Collaborator: CHEM Study Teacher Training Films-Lesson 1
(12 min., 16mm, B/W, sound) 1966

Professor Campbell briefly outlines the history of CHEM study and emphasizes that the course is based on experimental evidence. Professor Pimentel discusses why the concept of combining volumes of gases is used as the principle evidence for the atomic theory when it is first introduced. He explains CHEM Study's somewhat unusual approach to quantitative problems and suggests methods of teaching chemical symbols and equations.

MLA, cat. no. 4003, $65.

408/409

STANDARD SOLUTIONS AND TITRATION
Collaborator: Thomas Sumner, University of Akron
(21 min., 16mm, B/W, color, sound)

A sodium hydroxide solution is used to determine the acetic acid concentration of a sample of white vinegar.

CORF, B/W, $100.; color, $200.

410

MOLECULAR WEIGHT OF SOLUTES
Collaborator: Thomas Sumner, University of Akron
(8 min., 16mm, B/W, color, sound)

Discusses methods for the determination of molecular weights of non-volatile solutes.

CORF, B/W, $37.50; color, $75.

501

AN APPROACH TO KINETIC THEORY
Collaborator: Esso Petroleum Co. Ltd.
(19 min., 16mm, color, sound) 1966

The particulate nature of matter; gases as particles in rapid motion; visualization with the help of models; use for making quantitative predictions; experimental tests of these predictions.

See RIC, p.22

KINETIC-MOLECULAR THEORY
($8\frac{1}{2}$ min., 16mm, B/W, color, sound) 1961

An introduction to kinetic-molecular theory. Demonstrates dealing with molecules in motion and the factors that determine kinetic energy are provided. The film serves as an excellent preparation for the further study of gas laws.

MGHT, cat. no. 612006, B/W, $60.; 612018, color, $120.

*A MODEL OF THE KINETIC-MOLECULAR CONCEPT
(4 min., 8, color, silent)

A glass-bead model demonstrates the solid, liquid and gas states; the velocity distributions in the gas state are compared to the Maxwell distribution; an optional student assignment is offered.

LBF, cat. no. 15, $15.

501

MOLECULAR THEORY OF MATTER (2nd Edition)
Collaborator: Margaret Nicholson, Assoc. Editor CHEM Study text, "Chemistry: An Experimental Science" and Chemistry Dept., Carleton University, Ottawa, Canada
(11 min., 16mm, B/W, color, sound)

Demonstrates kinetic molecular theory of matter by showing diffusion of gases in air; the condensation of steam; the evaporation of liquids; and the transformation of liquids into solids. Brownian movement is also demonstrated.

EBF, cat. no. 2228, B/W, $70.; 2227, color, $135.

502

BEHAVIOR OF GASES
Collaborator: Lee Grodzins, MIT
(15 min., 16mm, B/W, sound) 1959

The Brownian motion of smoke particles is shown by photo-micrography and compared with a mechanical analogue. This evidence for molecules in chaotic motion is contrasted with the orderly behavior of gases as shown by Boyle's Law experiment. Animation and mechanical analogues are then used to develop a model for gas pressure based on chaotic molecular motion.

MLA, cat. no. 0115, $90.

DEMONSTRATING THE GAS LAWS
Collaborator: Thomas Sumner, University of Akron
(21 min., 16mm, B/W, color, sound)

In discussion and laboratory demonstrations, this film presents the various gas laws and how they were derived.

CORF, B/W, $100.; color, $200.

GAS LAWS AND THEIR APPLICATION (Boyle, Charles, and Gay-Lussac)
Collaborator: S. Ralph Powers, Columbia University
(13 min., 16mm, B/W, sound)

Demonstrates some of the early research which led to the discovery of the relationships between the temperature, volume and pressure of gases. Applications of the gas laws are shown in compression, refrigeration, heat engines, and low temperature research.

EBF, cat. no. 779, $86.

THE LAWS OF GASES
(11 min., 16mm, B/W, sound)

The Gas Laws of Boyle, Charles, Dalton, and Avogadro are explained and their importance to physical science is emphasized. Animation clearly illustrates relationships between pressure, volume and temperature of confined gas, the law or partial pressures, and the determining of the molecular weight of a gas.

CORF, B/W, $60.; color, $120.

PROPERTIES OF GASES
Collaborator: H. A. Daw, New Mexico State University
(3:20, S-8, color, silent)

Pucks on an air table are used to study the bulk properties of a gas in this two dimensional analogue. The effect on pressure due to changes in the number of particles, the volume occupied, and the temperature are all studied. In order to change the working area of the table, a specially-prepared piston is moved in and out and agitated at the same rate as the walls. The measurements of the force per unit length along one wall are made by counting the pucks hitting that wall during a 15-second time interval. The last part of the film shows the effect of isothermal and adiabatic compression and expansion on a single puck and a full population of pucks.

EAL, cat. no. 2967/1, $21.50

503

DIFFUSION PUMP - MERCURY VAPOR
Collaborator: Yale Chem. Films
(2 min., 16mm, color, sound)

An animated film showing how gas molecules are bombarded by heavy mercury atoms to obtain pumping action. The use of traps and fore pumps is included.

AIM, cat. no. YF-260, $19.

*MAXWELLIAN SPEED DISTRIBUTION
Collaborator: Harold A. Daw, New Mexico State University
(4 min., S-8, color, silent) 1967

Speed distribution is studied with a "hot gas" of 27 pucks moving randomly in equilibrium with the "hot" walls of the Air Table. The speed of the pucks is measured by superimposed animation so that each puck leaves behind a trail for 1 second. The distance moved in 1 second is superimposed beside each trail, and these speeds are collected in tabular form. The author plots $N_{(v)}$, the number of pucks in a velocity interval, versus the velocity and shows that after a suitable number of runs, this histogram approaches the Maxwell Distribution function for a two-dimensional gas. Further runs then show that the distribution curve shifts to the right when the temperature of the gas is raised by moving the walls faster.

EAL, cat. no. 80-2918/1, $21.50

503

MECHANICAL ENERGY AND THERMAL ENERGY
Collaborator: Jerrold R. Zacharias, MIT; PSSC
(22 min., 16mm, B/W, sound) 1959

This film shows several models to help students visualize both bulk motion and random motion of molecules. It shows their interconnection as the energy of bulk motion. Demonstrates that random motion can average out to a smooth effect. Shows model of thermal conduction. Demonstrates a model using dry ice disc and small steel balls, in which bulk mechanical energy of the disc is converted to "thermal" energy of random motion of the balls. Develops a temperature scale by immersing canisters of two gases in baths of various temperatures, reading the resulting pressure; through this, explains the origin of the absolute temperature scale.

MLA, cat. no. 0312, $120.

*MOLECULAR MOTIONS
Collaborator: CHEM Study; J. Arthur Campbell, Harvey Mudd College
(13 min., 16mm, 8, color, sound) 1963

Many properties of matter such as fluidity, vaporization and rates of chemical reactions, indicate that molecular motion must be occurring, and that the freedom of motion increases in going from the solid to the liquid to the gaseous state. The concepts of translational, rotational, and vibrational molecular motions allow the interpretation of the observed properties. The use of animation and dynamic models makes clear how the observed properties depend on the types of motion occurring at the molecular level.

MLA, cat. no. 4115, 16mm, $105.; 4815, 8, $89.

MOTION OF A MOLECULE
Collaborator: Don Herbert, Prism Productions and M. H. Shamos, New York University
(4 min., S-8, color, silent)

The random motion of gases is illustrated through a game-of-chance analogy. Initially, the camera focuses on some soap bubbles and the question is raised: "What keeps the soap bubbles inflated?" In the first of two analogs, several small steel balls in a circular container are vibrated. The path of the red ball can be seen to wander randomly about the container, suggesting that its direction and distance of travel between collisions is determined by chance. In the following analogue, numbered poker chips and a spinner are used to dictate the direction and length of a broken line to be drawn to represent the path of an individual molecule within a bubble. A collection of these random "walks" reveals the continual bombardment of the bubble walls, illustrating the source of gas pressure.

EAL, cat. no. 80-3361/1, $22.95

MOVEMENT OF MOLECULES
Collaborator: Nuffield Foundation
(2-5 min., 8, color, silent)

See RIC, p. 224

PERIODIC MOTION
Collaborator: Patterson Hume and Donald Ivey, University of Toronto; PSSC
(33 min., 16mm, B/W, sound) 1961

From a number of periodic motions simple harmonic motion is selected for detailed examination; a pen moving in SHM plots its own displacement - time graph: graph of velocity and acceleration versus time are derived from it. The formula for the period of SHM is derived from one component of circular motion; the dynamics and period of SHM checked experimentally by oscillation of dry ice puck mounted between springs.

MLA, cat. no. 0306, $150.

RANDOM WALK AND BROWNIAN MOTION
Collaborator: Harold A. Daw, New Mexico State University
(3:50, S-8, color, silent) 1967

Random walk is studied by following a single red puck moving in a hot gas of yellow pucks. The irregular motion is recorded by using a special red puck with a light attached. From a polaroid photograph of the moving light the author constructs a table of path lengths, and from these, a histogram is made of N(l), the number of paths in the length interval L to L + Δ L, as a function of L. The histogram is shown to approximate a theoretical random walk distribution. This run is compared with a second where the density is made greater by adding pucks. The effect of increasing the mass of the study particle is also investigated until the situation approximates Brownian motion. The film closes with a shot of small particles exhibiting Brownian motion.

EAL, cat. no. 80-2926/1, $21.50

*VIBRATION OF MOLECULES
Collaborator: Linus Pauling and Richard Badger, California Institute of Technology; Earl Mortensen, University of Utah; CHEM Study
(12 min., 16mm, 8, color, sound) 1959
(11 min., 16mm, color, sound)

All animation. The film shows the relationship between the structure of a molecule and its vibrational motions. Water, carbon dioxide, and methane are discussed in detail. The forms of the vibrations have been accurately calculated from spectral data. All vibrations have been slowed down by a factor of 10^{14}. The effect of molecular collision, or absorption of light, on molecular vibrations is illustrated. Determination of the number of possible vibrations and the analysis of complex vibrations

503

in terms of simple harmonic motions are explained.

MLA, cat. no. 4118, 16mm, $90.; 4818, 8, $76. SUTH, $90.

504

DIFFUSION
Collaborator: Harold A. Daw, New Mexico State University
(3 min., S-8, color, silent) 1967

A population of small, yellow pucks is in temperature equilibrium on an air table, when pucks of a different color are suddenly added along one side. The time required by the first of these pucks to arrive at the far side of the table is measured with a stop-clock. The diffusion time is compared with similar runs in which the mass and size of the diffusing pucks are varied. Also considered is the steady state, spatial distribution of diffusing pucks. A film made while pucks were being continuously added on one side of the table and removed from the other is frozen periodically and divided into strips parallel to the high concentration and low concentration sides of the table. A histogram is developed for the density gradient across the table and the theoretical distribution superimposed.

EAL, cat. no. 80-2959/1, $21.50

DIFFUSION EXPLAINED
(3 min., 8, S-8, color, silent) 1968

Diffusion is graphically illustrated in the film by both actual and model demonstrations. Through the use of time-lapse photography a copper sulfate solution and clear water are seen to diffuse completely. Nitrogen dioxide gas and air are used to illustrate diffusion of gases.

ICF, cat. no. 13210, 8, $15.; 13215, S-8, $18.50

DIFFUSION VELOCITIES
(2 min., 8, S-8, color, silent) 1968

The actual diffusion rates of two gases, hydrogen chloride and ammonia, are seen as they move from opposite ends of a tube and meet, forming a white visible ring of ammonium chloride. Measurements and methods of calculating velocities and ratios are illustrated.

ICF, cat. no. 13250, 8, $11.; 13255, S-8, $14.50

GAS DIFFUSION RATES
Collaborator: Don Herbert, Prism Productions and M. H. Shamos, New York University
(4 min., S-8, color, silent)

First, a time-lapse camera is employed to show the different rates of collapse of two balloons, each filled with a different gas. Next, a cylinder containing small balls representing molecules, agitated by a piston at the bottom is introduced as a model of the gas-filled balloon. The "molecules" can escape through the "pores" at the top. A number of timed runs are made for steel balls and plastic balls, the number diffusing each case being tabulated. For a given "temperature" as determined by the agitation rate, the balls with greater mass move at lower velocities and diffuse more slowly. Knowing this, and the molecular weight of gases as given in the film notes, the student is asked to identify the gases in the balloons first shown.

EAL, cat. no. 80-3379/1, $22.95

GAS PRESSURE AND MOLECULAR COLLISIONS
Collaborator: J. Arthur Campbell, Harvey Mudd College
(21 min., 16mm, 8, B/W, sound)

The film explores the relationship between gaseous pressure and molecular collisions. The effects of varying the number of molecules per unit of volume and of varying the temperature are studied. The experimental study of the relative rates of effusion of hydrogen, oxygen, carbon dioxide and sulfur hexafluoride leads to the quantitative relationship between molecular weight, molecular velocity and absolute temperature.

MLA, cat. no. 4106, $120.

505

COLLISIONS OF HARD SPHERES
Collaborator: James Strickland; PSSC
(19 min., 16mm, B/W, sound)

This is a laboratory instruction film dealing with conservation of momentum primarily intended for teachers. This film is a demonstration of the adjustments and operation of the Collision in 2-D apparatus used in the PSSC Lab III-10. The conservation of momentum is demonstrated for both equal and unequal mass spheres.

MLA, cat. no. 0319, $120.

CONSERVATION OF LINEAR AND ANGULAR MOMENTUM
Collaborator: H. F. Meiners, Rensselaer, Polytechnic Institute
(3:40, S-8, color, silent) 1967

Two frictionless dry ice pucks are connected by a light rod. When struck at the center of mass, the system translates without rotating. When struck off center, the system rotates and translates. After two qualitative demonstrations of these effects, quantitative experiments are conducted from which the student can calculate predicted and observed linear and angular velocities for the system. The momentum imparted to the system by a small ball from a spring launcher is determined by means of a ballistic pendulum. Spark paper records

505

the motion of the center mass of the system and the path of one of the pucks. Data from these records enable the student to check the observed velocities against his predictions.

EAL, cat. no. 80-3023/1, $21.50

CONSERVATION OF MOMENTUM - ELASTIC COLLISIONS
Collaborator: J. L. Stull, Alfred University
(4:15, S-8, color, silent) 1967

Elastic and inelastic collisions are first contrasted, using sequences shot in real and reversed time. Several examples of elastic collisions are then introduced as problems. Finally, a "projectile" glider is projected at a stationary "target" glider, their motions are subsequently "frozen", and their respective distances from the impact point are measured.

EAL, cat. no. 80-2777/1, $21.50

CONSERVATION OF MOMENTUM - INELASTIC COLLISIONS
Collaborator: J. L. Stull, Alfred University
(3:55, S-8, color, silent) 1967

Inelastic collisions (between gliders which stick together) are contrasted with elastic collisions (between gliders with spring bumpers). Then, in a series of quantitative demonstrations, a "projectile" glider is projected at a stationary "target" glider. One clock records the time the projected glider takes to travel a given distance. A second clock records the time both gliders take to travel an equal distance after impact. Readings are taken for various mass ratios.

EAL, cat. no. 80-2751/1, $21.50

COUPLED OSCILLATORS: EQUAL MASES
Collaborator: F. Miller, Jr., Ohio State University
(3:30, S-8, color, silent) 1967

This film shows two small carts connected together by one spring and attached to solid uprights by two others; the whole system arranged in a straight line. The frequency with which each cart vibrates when the other is at rest is determined. There are only two normal modes in which both masses vibrate at the same time, in simple harmonic motion, with the same frequency - one "in-phase" mode and one "out-of-phase" mode; these are studied on film. All other motions are linear combinations of these. One of the infinite number of mixed modes is shown at the end of the film. In the film notes supplied an analogy is drawn between these vibrations and splitting of the energy levels of atoms vibrating in a crystal.

EAL, cat. no. 80-2108/1, $15.50

COUPLED OSCILLATORS - UNEQUAL MASSES
Collaborator: F. Miller, Jr., Ohio State University
(3:45, S-8, color, silent) 1967

This film shows the oscillations of two coupled carts of mass 735 gm and 463 gm, joined together, and to two fixed uprights, by three springs. The oscillations are maintained by supplying a small periodic driving force to compensate for frictional losses. In comparison with the coupled oscillations of equal masses, it can be seen that in the "in-phase mode" the length of the central spring has a small periodic extension, and in the "out-of-phase mode" the mode point of the spring is not at its center but displaces towards the larger cart. A mixed mode is also shown in which the larger mass "hesitates" and becomes more nearly stationary before commencing to oscillate again than does the smaller mass, which has a larger amplitude of vibration.

EAL, cat. no. 80-2116/1, $15.50

ELASTIC COLLISIONS AND STORED ENERGY
Collaborator: James Strickland; PSSC
(27 min., 16mm, B/W, sound) 1962

Various collisions between two dry ice pucks are demonstrated. Cylindrical magnets are mounted on the pucks producing a repelling force. Careful measurements of the kinetic energy of the pucks during an interaction lead to the concept of stored or potential energy.

MLA, cat. no. 0318, $150.

EQUIPARTITION OF ENERGY
Collaborator: Harold A. Daw, New Mexico State University
(2:55, S-8, color, silent) 1967

Two populations of pucks with masses of M and 2M are studied at a constant "temperature", T, by using the white trail velocity measuring technique, introduced in 80-2918/1, Maxwellian Speed Distribution. Velocity histograms with superimposed, theoretical curves are prepared for the two populations. Then the mean square velocities, V^2, are compared. When V^2 for the small pucks turns out to be twice V^2 for the large pucks, further data is collected for mass 4 pucks, verifying that MV^2=KT is a general law for mixed puck populations.

EAL, cat. no. 80-2934/1, $21.50

506

*VELOCITY DISTRIBUTION OF ATOMS IN A BEAM
Collaborator: John King, MIT
(16 min., 16mm, B/W, sound; S-8, B/W, silent)

A beam of potassium atoms emerging from a hot oven is chopped by rotating drum. A distribution of flight times for the atoms in transiting between the drum slit and a hot wire de-

506

tector is measured. From these data the velocity distribution of the atoms in the beam is determined.

UEVA, 16mm, $120.; S-8, $95.

507

OXIDATION-REDUCTION
($9\frac{1}{2}$ min., 16mm, B/W, color, sound) 1962

Examples of oxidation and reduction demonstrate the complementary relationship and the differences between the two. A basic and broadened explanation of this type of reaction in terms of electron transfer is provided.

MGHT, cat. no. 612007, B/W, $60.; 612019, color, $120.

508

COMBUSTION
Collaborator: Norris Rakestraw, University of California and Elbert C. Weaver, Philips Academy, Andover, Mass.
($14\frac{1}{2}$ min., 16mm, color, sound)

A convincing answer to the question "What is fire?" All live footage is photographed as close to the action as possible to give the student the opportunity to observe the action as though it were on his own bench. Film content: Combustion and the fire triangle. Rate of reaching kindling temperature. Factors which determine rate of combustion. Spontaneous ignition. Partial and complete combustion. Results of combustion. Measurement of heat.

SUTH, $135.

ENERGY AND REACTION
($14\frac{1}{2}$ min., 16mm, B/W, color, sound) 1961

The relationship between energy, in its various manifestations, and chemical reactions shown. This is then related to such fundamental concepts as the making and breaking of chemical bonds, activational energy, and rate of reaction.

MGHT, cat. no. 612011, B/W, $90.; 612023, color, $180.

*INTRODUCTION TO REACTION KINETICS
Collaborator: Henry Eyring and Earl M. Mortensen, University of Utah
(13 min., 16mm, 8, color, sound) 1959

All animation. The film illustrates the mechanism of some simple chemical reactions. It explains the effect of temperature, activation energy, geometry of collision, and catalysis upon the rate of reaction. The reaction between hydrogen and chlorine, and hydrogen and iodine are used to illustrate the concepts of the film. The speed of the action has been slowed down by a factor of 10^{14}. Potential energy curves clarify the relationship between the energy required for a reaction to occur and the relative position of the reaction particles before, during and after the collision.

MLA, cat. no. 4121, 16mm, $105.; 4821, 8, $89. SUTH, $105.

TEACHER TRAINING INTRODUCTION to "Reaction Kinetics"
Collaborator: CHEM Study Teacher Training Films - Lesson 3
(16 min., 16mm, B/W, sound) 1966

Professor Campbell shows some chemical reactions and discusses them in terms of the concepts presented in the CHEM Study Film. These concepts include collision, orientation of the colliding molecules, and activation energy. The effect of concentration on reaction rate and the idea of the rate-determining step are demonstrated using the oxygen-dextrose-methylene blue system. The role of activation energy in breaking or weakening bonds of the reacting molecules is related to the reaction $2H_2 + O_2 \rightarrow 2H_2O$.

MLA, cat. no. 4021, $90.

MEASURING RATE OF PHOTOSYNTHESIS
Collaborator: John W. Kimball, Phillips Academy, Andover, Mass.
(4 min., S-8, color, silent) 1967

The technique illustrated is both simple and versatile. In this film, it is used to examine the effect of light intensity on photosynthesis, but it can be used to study the influence of other variables as well. Disks are cut away from a bean leaf and floated on a buffered sodium bicarbonate solution (which serves as a source of carbon dioxide). The air in the spongy layer of the leaf disks is removed with an aspirator and replaced with the solution. This causes the disks to sink. The disks are illuminated and, as photosynthesis goes on, oxygen is evolved and displaces the solution from the spongy layer. The disks become buoyant again and rise to the top of the solution. The average time it takes the disks to rise is determined. From this a rate for the process at that light intensity is computed.

EAL, cat. no. 81-5639/1, $21.50

RATE OF COMBUSTION
(3 min., 8, color, silent)

The rapid oxidation of a fuel is explained through close-up photography, animation and subtitles. The five general factors which determine the rate of combustion are shown.

SUTH, $12.

508

SPEED OF CHEMICAL CHANGE
Collaborator: Iwanami Film
(15 min., 16mm, color, sound) 1968

The film opens with an experiment demonstrating that the same chemical reaction can occur at different speeds. Since every chemical change involves the recombination of atoms to form new molecules, how is this possible? The film investigates the problem inductively. It presents a mechanical model of a reaction in which the atoms are represented. Experiments with this model help formulate hypotheses concerning factors that might influence the speed of chemical change. These hypotheses are tested by experiments.

FAC, cat. no. 16-253, $175.

VELOCITY OF CHEMICAL REACTIONS
Collaborator: Herman I. Schlesinger and Warren C. Johnson, University of Chicago
(11 min., 16mm, B/W, sound)

Shows how the nature, concentration, and temperature of reacting substances affect the velocity of molecules, spheres of influence, and vibrational energy of chemical reactions. Animation explains reversible reactions and simplifies the abstract processes of chemical equilibrium.

EBF, cat. no. 253, $70.

509

*CATALYSIS
Collaborator: Richard E. Powell, University of California and J. Arthur Campbell, Harvey Mudd College; CHEM Study
(17 min.. 16mm, 8, color, sound) 1961

The film emphasizes that catalysts are typical chemical reactants, being unique only in that catalysts are regenerated during the reaction. It demonstrates and interprets three simple catalyzed reactions: the decomposition of formic acid, using sulfuric acid as catalyst; the reaction between hydrogen and oxygen, using pure platinum as catalyst; and the reaction between acidified benzidine and hydrogen peroxide using peroxidase in human blood as catalyst. Animation shows what takes place on the molecular level in a catalyzed reaction. Potential energy curves shows the relationship between uncatalyzed and catalyzed reactions.

MLA, cat. no. 4127, 16mm, $135.; 4827, 8, $115.
SUTh, $135.

TEACHER TRAINING INTRODUCTION to "Catalysis"
Collaborator: CHEM Study Teacher Training Films - Lesson 4
(13 min., 16mm, B/W, sound) 1966

Professor Pimentel emphasizes the importance of reaction rate in determining the utility of chemical reactions. The reaction $H_2 + I_2 \rightarrow 2HI$ is discussed in terms of activation energy and collision geometry. The reaction $4HBr + O_2 \rightarrow 2H_2O + 2Br_2$ is shown to proceed by a series of two particle collisions. The reaction $2I \rightarrow I_2$ is used as an example of a reaction in which a third particle must be involved in the collision to carry off the energy, or an alternate reaction path must be provided. The role of I_2 in catalyzing this reaction is explained.

MLA, cat. no. 4027, $70.

CATALYSIS IN INDUSTRY
Collaborator: Nuffield Foundation
(2-5 min., 8, color, silent) 1966

See RIC, p. 224

CATALYTIC DECOMPOSITION OF HYDROGEN PEROXIDE
Collaborator: Yale Chem. Films
(2 min., 16mm, color, sound)

Illustrates how hydrogen peroxide is stable when pure, but the addition of a catalyst, manganese dioxide, causes immediate decomposition of the compound and produces oxygen.

AIM, cat. no. YF-214, $19.

CATALYTIC DECOMPOSITION OF POTASSIUM CHLORATE
Collaborator: Yale Chem. Films
(3 min., 16mm, color, sound)

Potassium chlorate is heated, first without, and then with, a catalyst, delivering oxygen to an inverted, water-filled collecting tube.

AIM, cat. no. YF-215, $28.50

511

HYDROGEN FOUNTAIN
Collaborator: Yale Chem. Films
(3 min., 16mm, color, silent)

Demonstrates the differing permeability of a clay bacterial filter to hydrogen and air. Hydrogen permeates the filter faster, raising the interior pressure and ejecting water with sufficient force to operate a pinwheel. In conclusion, the experiment is shown in diagrammatic form.

AIM, cat. no. YF-222, $22.50

ION PUMP
Collaborator: Yale Chem. Films
(4 min., 16mm, color, sound)

Perspective drawings and animation are used to show how dry, no-moving-parts ion pumping is achieved. The special design features, including ion deceleration and titanium gettering, are explained.

AIM, cat. no. YF-263, $38.

511

KINETICS OF FLOWING DISPERSIONS
(4 min., 8, color, silent)

Orientation and distortions of particles produced by velocity gradients in flowing systems.

LBF, cat. no. 9, $15.

MOMENTUM OF ELECTRONS
Collaborator: John King, MIT
(10 min., 16mm, B/W, color, sound; S-8, color, silent)

This film demonstrates an experiment in which a beam of electrons pushes on the vane of a torsion pendulum. The apparatus is enclosed in a solder glass vacuum tube. The electron beam is pushed at the natural frequency of the pendulum, thus gradually increasing the amplitude of the pendulum oscillation. The data obtained in the experiment is tabulated and the method used to compute the force per second exerted on the vane by the electron beam is outlined. Actual derivations and computations are left to the student.

UEVA, 16mm, B/W, $40.; color, $75.; S-8, $59.

PROTON MOTIONS IN ICE
Collaborator: Yale Chem. Films
(5 min., 16mm, color, sound)

Shows in animation an explanation of the dielectric and conduction behavior of ice crystals in terms of two kinds of proton motion arising from thermal agitation: Bjerrum faults and proton jumps.

AIM, cat. no. YF-248, $47.50

TEMPERATURE AND MATTER
(15 min., 16mm, B/W, color, sound) 1962

Variation of the properties of matter with change of temperature; behavior of liquid sulphur; phenomena at very low temperature; kinetic interpretation.

MGHT, cat. no. 612003, B/W, $90.; 612015, color, $180.

601

THE BOMB CALORIMETER
Collaborator: Yale Chem. Films
(9 min., 16mm, color, sound)

Step-by-step this film shows how heat of combustion is measured with a bomb calorimeter. An animation sequence explains the rationale of the calculations required.

AIM, cat. no. YF-223, $85.50

DR. BLACK'S OBSERVATIONS ON HEAT
Collaborator: Yale Chem. Films
(7 min., 16mm, color, sound)

Presents some fundamental experiments on heat and calorimetry - differentiation of heat and temperature, thermal equilibrium, heat capacity, and heating rates - using excerpts from Dr. Black's lectures. (Work sheets)

AIM, cat. no. YF-246, $66.50

VERY HIGH TEMPERATURES
(15 min., 16mm, B/W, color, sound)

For many years, man considered 1500°C, the melting point of iron, a high temperature having only coal and charcoal to work with as fuels. With discovery of the electric arc furnace, temperatures well over 3000°C are attained. Temperatures of 6000°C are developed with thermal energy in the solar furnace. Measuring devices, such as the optical pyrometer, and others measuring electrical resistance or heat radiated are explained and demonstrated. The conclusion discusses "plasma", and "fusion reactions", relating these to man's need for fuels.

JCA, cat. no. 58533, B/W, $75.; color, $150.

602

CARNOT CYCLE (KELVIN TEMPERATURE SCALE)
(8 min., 16mm, B/W, sound) 1951

The motion of a piston in a cylinder and a moving point on a pressure-volume diagram are used in explaining the four ideal processes which constitute the Carnot cycle. Shows how heat is absorbed and rejected during the cycle and defines the Kelvin temperature scale. Discusses the efficiency of a Carnot engine.

MGHT, cat. no. 626509, $60.

CHAOS AND EVOLUTION
(30 min., 16mm, B/W, sound)

In examing the trend of chemistry over evolutionary time, we find that one such trend is the creation and evolution of life. Life is a localized affair, occupying only part of this planet and interacting very considerably with other parts. The energy of the sun is the driving force which enables life to increase its order. We live and evolve in a photochemical world. The evolution of life is closely connected with the evolution of the atmosphere. Life could only arise when quantities of relatively complex organic molecules were available, and these were probably formed while the atmosphere was in its earlier reduced form. Is the life of man merely a complex example of chemical change, subject to the same laws and predictable? Certainly economics, psychology and the social sciences are subject to the same basic laws as chemistry. As to predictability, the situation is quite different; the number of similar bodies is relatively small and the laws of disorder have become correspondingly less exact. In spite of the fact that the removal of one molecule from a million will have no observable effect, the removal of one man may change the course of history.

ROB, $180.

CHEMISTRY AND LIGHT
(30 min., 16mm, B/W, sound)

Most chemical changes are brought about by thermal reactions, where the molecules have an energy depending only on the temperature. Some reactions or changes occur under the influence of light; when a molecule absorbs light it is so profoundly changed that it is best to think of it as a new molecule altogether. Light singles out just a few molecules for special treatment and has no effect on the others. The most common and most important of all chemical reactions, that which provides our food and our fuels, is a photochemical reaction. Once a molecule has absorbed a quantum of light it may: emit light as fluorescence; degrade the energy of the quantum as heat; passing it on in a single step to a second molecule, or reacting chemically. In photosynthesis, the light quanta absorbed by the molecules of chlorophyll provide the energy for the conversion of CO_2 and H_2O into sugars and other high energy substances. Photochemical reactions are particularly useful for bringing about specific changes in the molecules of the living cell.

ROB, $180.

CONVERSION OF HEAT INTO USEFUL WORK
Collaborator: Robert G. Picard
(15 min., 16mm, B/W, color, sound)

Atomic, electrical, mechanical, solar and chemical energy all produce heat - but heat alone is not useful. When uncontrolled, fire can destroy, ravage and consume other useful matter. Man must harness heat and convert it to power. Enough heat energy transferred to water produces vapor or "steam". Through an arrangement of valves, a piston and cylinder, and a connection rod and flywheel called a steam engine, energy in the steam is converted to rotary mechanical power. In the steam turbine, a high pressure jet of steam is directed at a multi-bladed wheel which turns a shaft. Aiming at higher thermal efficiency, engineers put the fire right in the cylinder by exploding gasoline or diesel oil. The fuel is compressed then ignited, the resultant pressure pushing rapidly down. Another stroke of the piston exhausts the spent gases and draws in new fuel to start the cycle over again. Thermal efficiency of the gasoline engine reaches 25%, the diesel 36% as compared to only 12% in a steam locomotive. Today new methods of converting heat directly to electricity use the thermocouple and isotope generator for man's exploration of space.

EYE, cat. no. EG528, B/W, $75.; EG529, color, $150.

ENERGY CHANGES IN HCl FORMATION
Collaborator: Nuffield Foundation
(2-5 min., 8, color, silent) 1966

See RIC, p. 224

ENERGY CONVERSION
Collaborator: Don Herbert, Prism Productions and M. H. Shamos, New York University
(4 min. S-8, color, silent)

A gasoline engine converts the stored chemical energy in the gasoline into thermal energy which in turn is converted to mechanical energy. The rotational mechanical energy is geared, by a bicycle wheel, to a bicycle generator which converts the mechanical energy to electrical energy. An electric light then converts the electrical energy to electromagnetic energy which is, in turn, converted to electrical energy by a photoelectric cell. The cell output is converted through magnetic energy in an electric motor to mechanical energy of position. Information is provided to enable the student to calculate how much initial chemical energy was needed to raise the weight.

EAL, cat. no. 80-3437/1, $22.95

ENERGY TRANSFORMATIONS I AND II
(3 min. and 2 min., 8, color, silent)

The idea that energy derived from a chemical reaction may appear as thermal energy and as work is presented, using the zinc/silver nitrate solution system.

UNESCO, cat. no. 8, $6.; 9, $6.

EQUILIBRIUM - THE LIMIT OF DISORDER
(30 min., 16mm, B/W, sound)

Equilibrium is a state of balance between the conflicting requirements for minimum internal energy and maximum entropy of a system. The property of a system which will tell us the direction of change and the position of equilibrium itself is a dynamic affair. To the individual molecule, it matters little whether the system is in equilibrium or not. It sees only a restless conflict of forward and backward change, a battle which rages as furiously at equilibrium as under other conditions, but one which has then reached a complete stalemate.

ROB, $180.

FUELS - THEIR NATURE AND USE (2nd Edition)
Collaborator: O. W. Eshbach, Northwestern University
(11 min., 16mm, B/W, sound)

Investigates the principle kinds of fuels used in homes and industry; traces the source of most conventional fuels to the sun; and explains the history of fuels. Animation is used to explain how heat is transferred to mechanical energy in steam, gasoline, and diesel engines.

EBF, cat. no. 1609, $70.

602

HEAT CAN DO WORK
(2:45 min., 8, S-8, color, silent) 1964

The principles of expansion and pressure are shown through the use of steam. Steam forces a cork out of a tube, and a jet of steam turns the vanes of two turbines. The principle of equal and opposite reaction is also illustrated.

ICF, cat. no. 13140, 8, $14.; 13145, S-8, $17.50

HEAT OF FUSION
Collaborator: Don Herbert, Prism Productions and M. H. Shamos, New York University
(4 min., S-8, color, silent)

This is a data taking film to teach students to experimentally determine the heat of fusion of a substance. The heat of fusion is the heat absorbed when liquid, in this case water, turns to solid. The closeup capability of film brings the student to the experiment. The full explanation of heat of fusion and of the procedure for recording and interpreting data in the film notes allows the student to find the heat of fusion of ice.

EAL, cat. no. 80-3429/1, $22.95

MOLECULES IN MOTION
(30 min., 16mm, B/W, sound)

Change is not entirely a matter of substance, it is accompanied by exchange of energy or heat. Heat is another word for the random kinetic energy of molecules in motion and is, therfore, a form of energy. When heat or other forms of energy such as potential, chemical or electrical energy are converted one to the other the total amount is always conserved - this is the first law of thermodynamics, "the law of conservation of energy".

ROB, $180.

MOLECULES AT WORK
(30 min., 16mm, B/W, sound)

A chemical reaction is usually carried out either for the manufacture of a useful chemical substance, or for the production of energy. The production of energy is by far the most important because most of the energy used by man is derived from chemical reactions. Any spontaneous change can be made to do useful work, and the maximum work attainable is equal to the free energy available from the change. The usual procedure is to convert the chemical energy into heat and then to convert this heat into work as efficiently as possible. This conversion of heat into useful work is ruled by the Second Law of Thermodynamics.

ROB, $180.

PATTERNS OF CHANGE
(30 min., 16mm, B/W, sound)

Molecules may react alone (unimolecular reaction) or in pairs (bimolecular reaction); the chance of three or more molecules coming together at the same time is very small. If molecules react alone in a single one-step reaction, halving the number of molecules will halve the number reacting in a given time; if they react in pairs halving the number of molecules in any volume will quarter the rate of reaction. The building of a big molecule, like nearly all chemical changes, occurs in steps or stages, each step involving one or two molecules which react to form double and then multiple units which eventually link up to form molecules of one hundred or more units in length. This is the way the complex molecules of biological substances are constructed in nature. Rates of changes may be affected by substances which are not themselves changes in the process but which merely act as catalysts. In nature, enzymes catalyze complex biological reactions, reactions on whose exactness and completeness life depends, in the most specific and immaculate of chemical changes. The chemist, in industrial research, is concerned with a quest for better catalysts.

ROB, $180.

THE SECOND LAW
(30 min., 16mm, B/W, sound)

The second law of thermodynamics is "Every system which is left to itself will, on the average, change towards a position of maximum probability". This law can be restated as follows: "In any spontaneous change the total entropy increases" or "Heat cannot flow spontaneously from a colder to a warmer body". It is a fact that this law of thermodynamics applies equally well to a barrel rolling downhill and to the complex chemistry of a biological change. Why is it that entropy and disorder always increase with time? The only answer that science can give is "because time goes forward". The inevitable increase of disorder implies an irreversible trend toward total chaos and a heat death of timeless equilibrium in the universe itself. But science has learned to view long extrapolations of this kind with caution. It is a long step from the disorder of molecular motion to the chaos of the cosmos.

ROB, $180.

THE STATIC AND DYNAMIC WORLDS
Collaborator: BBC
(30 min., 16mm, B/W, sound)

Chemistry is a description of the world at the atomic and molecular level. It is concerned with only two things, the structure of chemical substances (chemical statics) and the way in which one substance or structure changes into another (chemical dynamics). A study of the molecular world must begin with a description of the shape and structure of the molecules themselves. Chemistry owes its phenomenal success to the use of models which may be used

602

to represent the arrangement of atoms within a single molecule or the arrangement of molecules in bulk materials. Since these are static models of a static world, they are not quite correct since the world is not static, least of all the restless world of the molecule. Change cannot occur without movement and therefore, when molecules change they must move. Even in the absence of change, molecules are in ceaseless motion, equilibrium itself is a dynamic affair and the life we live is the totality of this molecular motion.

ROB, $180.

TIMES OF CHANGE
(30 min., 16mm, B/W, sound)

In any change, we want to know which way it will go and how fast. The second law of thermodynamics tells us the direction of change when it occurs. Time is very relevant to the motions of the molecules themselves, and therefore, it is at the molecular level that we must seek an explanation of rates of change. Chemical change is a rearrangement of atoms within molecules and of the electrons within these atoms. We know that most reactions go faster when the substances are hot because the molecules move faster and have more energy. The dependence on temperature is mainly caused by the presence of an energy barrier to reaction. The modern theory of reaction rate uses the powerful methods of thermodynamics. It considers the molecules on top of the activation energy barrier as a new state (transition state) and calculates their properties as if the transition state were, in most respects, a normal stable molecule in equilibrium with the reacting substance. Although this theory is good in principle in practice it is very approximate and is not able to give a reliable production of the rates of chemical change.

ROB, $180.

604

ENTROPY
(30 min., 16mm, B/W, sound)

What are the laws which govern the direction of a spontaneous change? Since disorder (randomness, chaos, mixed-upness) is the natural condition of life, it must determine the direction of all change and to make it useful, we must be able to measure it. The greater the number of ways in which a state can arise, the more disordered is that state - and the more probably will it occur.

ROB, $180.

606

THE DEVELOPMENT OF ELECTROCHEMISTRY
Collaborator: Statens Filmsentral, Norway for OECD with International Council for Educational Films
(19 min., 16mm, color, sound) 1963-65

This historical survey of the production of an electric current by chemical action covers the work of Allessandro Volta, Sir Humphrey Davy, Hans Christian Oersted, Michael Faraday, van't Hoff and others in Europe and America. The voltaic pile and Volta's contact theory for producing an electric current are demonstrated. Diagrams and demonstrations recreate Sir Humphrey Davy's decomposition of water into hydrogen and oxygen. In the 1820's discoveries in electrochemistry were supplemented by Oersted's proof of the relationship between electricity and magnetism. Oersted's and Faraday's experiments in electromagnetism are demonstrated, linking them with Faraday's theory of electrolysis. Next, the progressive development of electrochemistry from van't Hoff's work on chemical reactions to recent investigations into catalysis is traced. Reference is made to the contributions of Ostwald, Arrhenius, Heroult, and Hall - who built on the previous investigations. The final scenes illustrate some modern technological applications of electrochemistry.

IFB, cat. no. 2 IFB 393, $195.

THE DIODE: PRINCIPLES AND APPLICATIONS
(17 min., 16mm, B/W, sound)

Principles of electron flow across a gap; basic features of the diode tube; control of electron flow in the tube; photoelectric cells; X-ray tubes; and the diode as a rectifier.

DUART, cat. no. OE176, $24.06

DISCHARGE THROUGH GASES
(12 min., 16mm, B/W, sound) 1955

A film demonstration of the discharge patterns which occur when pressure is progressively reduced as well as a clear explanation of the theory of discharge rarefied gases.

MGHT, cat. no. 603506, $70.

THE ELECTRON - AN INTRODUCTION
(16 min., 16mm, B/W, sound)

Nature of electrons; electron flow in solid conductors; electromotive force; types and control of electron flow; electron flow and magnetic fields; and induced electron flow.

DUART, cat. no. OE175, $22.14

606

*ELECTRONS
Collaborator: Harvey Lemon, University of Chicago
(11 min., 16mm, B/W, sound)

Interprets graphically the hypothesis that electricity consists of unit elementary charges. The meaning of the hypothesis is clarified by the use of animated drawings and natural photography. Demonstrations of the following are included: conduction of electricity through solutions, gases, and vacuum; Faraday's laws; valence; movement of charges in vacuum tubes; operation of photoelectric cells; and reproduction of sound on film.

EBF, cat. no. 258, $70.

GAP ENERGY AND RECOMBINATION LIGHT IN GERMANIUM
Collaborator: ESI
(37 min., 16mm, B/W, sound) 1965

Optical experiments to demonstrate the existence of gap energy in semi-conductors; measurement of wavelength and intensity of the light emitted by recombined excess-hole electron pairs near a p-n junction of a germanium bar.

See RIC, p. 113

PRINCIPLES OF THE TRANSISTOR
(20 min., 16mm, B/W, sound) 1957

After a brief review of the early crystal set, the invention of the valve and its development up to recent times, this film gives a detailed explanation of how the germanium diode and the transistor function, with details concerning the crystal lattice, "p" and "n" type germanium and hole conduction. The film ends with some of the present applications of the transistor and its advantages over the thermionic valve.

MGHT, cat. no. 603507, $120.

THE WORLD OF SEMICONDUCTORS
Collaborator: Assoc. Electrical Industries Ltd.
(38 min., 16mm, color, sound) 1962

The properties of semi-conductors; effect of adding controlled amounts of impurity; manufacture and uses; applications of semiconductor devices; possible future developments.

See RIC, p. 114

606/607

OXIDATION-REDUCTION
Collaborator: Norris W. Rakestraw, University of California and Elbert C. Weaver, Phillips Academy
(16 min., 16mm, color, sound) 1962

Live action experiments involving oxidation-reduction are followed by animation sequences which explain the chemical reactions taking place.

Film content: Simplified and graphic explanation of the transfer of electrons from a reducing agent to an oxidizing agent of manganese. Examples of oxidation-reduction: 1. with oxygen; 2. without oxygen. Effects of alkalinity, acidity, and temperature upon the oxidation level. An experiment demonstrating a simple cell in which oxidation-reduction provides the electric current. An electrolysis experiment demonstrating that electric current from an outside source passing through a liquid causes oxidation-reduction. Metals as reducing agents. Acids as oxidizing agents.

SUTH, $135.

607

ACID BASE REACTION IN ELECTROLYSIS OF WATER
Collaborator: Yale Chem. Films
(2 min., 16mm, color, silent)

This film demonstrates the electrolysis of water in the Hoffman apparatus. By addition of dye indicators it is shown that base accumulates around the negative and acid around the positive electrode.

AIM, cat. no. YF-230, $15.

COUNTING ELECTRICAL CHARGES IN MOTION
Collaborator: James Strickland: PSSC
(22 min., 16mm, B/W, sound)

This film shows how an electrolysis experiment enables us to count the number of elementary charges passing through an electric circuit in a given time and thus calibrate an ammeter. Demonstrates the random nature of motion of elementary charges, with a current of only a few charges per second.

MLA, cat. no. 0408, $120.

ELECTROLYSIS OF WATER
Collaborator: Yale Chem. Films
(3 min., 16mm, color, sound)

A common industrial preparation of oxygen, using a Hoffman apparatus, demonstrates electrolysis. The need for an electrolyte, the 2/1 ratio of the gases collected, and methods of testing are shown.

AIM, cat. no. YF-219, $28.50

ELECTROPLATING WITH TIN-NICKEL ALLOY
Collaborator: Tin Research Institute
(17 min., 16mm, color, sound) 1964

Process of plating with tin-nickel alloy; its physical properties; resistance to corrosion; industrial applications.

See RIC, p. 25

607

FARADAY'S LAW
(15½ min., 16mm, B/W, color, sound) 1961

By quantitative experiment, this film demonstrates Faraday's two electrochemical laws and, at the same time, the mechanism of electrolysis. Animation is used to make the explanation of electrolysis more vivid to the student.

MGHT, cat. no. 612009, B/W, $95.; 612021, color, $190.

LEAD BROMIDE ELECTROLYSIS
Collaborator: Nuffield Foundation
(2-5 min., 8, color, silent) 1966

See RIC, p. 224

NICKEL PLATING
Collaborator: International Nickel Ltd.
(27 min., 16mm, color, sound) 1966

Ionic compounds and ionization; simple theory of electrolysis; electrochemical principles of nickel plating.

See RIC, p. 9

608

ELECTRICAL POTENTIAL ENERGY AND POTENTIAL DIFFERENCE (Part I and II)
Collaborator: Nathaniel Frank, MIT; PSSC
(54 min., 16mm, B/W, sound) 1962

In Part I of this film, the mechanism by which a battery establishes an electric field in a circuit is analyzed and the electric potential energy stored in such a system is measured experimentally and explained theoretically. In Part II, it is shown how the energy transformations in a steady current-carrying circuit can be obtained from measurements of potential difference and electric current, including the energy dissipated internally in the batteries used.

MLA, cat. no. 0431, I: 0432, II; $300. each

*ELECTROCHEMICAL CELLS
Collaborator: J. Arthur Campbell, Harvey Mudd College and June S. Ewing, CHEM Study Staff
(22 min., 16mm, color, sound) 1964

The construction and operation of an electrochemical cell are shown. Time lapse photography of the changes at the electrodes, and animation of the cell processes show the nature of the electrode reactions, the motion of the electron and ion currents, and the relationship between concentrations and cell voltage. Extreme close-ups of a hydrogen electrode illustrate its operation and lead to a discussion of the table of E^o values.

MLA, cat. no. 4133, 16mm, $165.; 4833, 8, $140.

TEACHER TRAINING INTRODUCTION to "Electrochemical Cells"
Collaborator: CHEM Study Teacher Training Films - Lesson 6
(8 min., 16mm, B/W, sound) 1966

Dr. Merrill discusses the structure of Chapters 7-12 of the CHEM Study text in which reaction energies, reaction rates, and equilibrium are introduced and then applied to systems of solubility, acid-base, and oxidation-reduction.

MLA, cat. no. 4033, $45.

THE ELECTROMOTIVE FORCE SERIES
(12 min., 16mm, B/W, color, sound) 1962

Shows how single electrode potentials can be determined against a reference electrode, the construction of the EMF series, the relationship between this series and chemical activity, and the relationship between single electrode potentials and the voltage of a galvanic cell.

MGHT, cat. no. 612001, B/W, $75.; 612013, color, $150.

EMF
Collaborator: Nathaniel Frank, MIT; PSSC
(20 min., 16mm, B/W, sound)

Here it is shown that the energy transfers demonstrated in film 0409 - Elementary Charges and Transfer of Kinetic Energy - are independent of the geometry of the electrodes in the diode. It is further demonstrated that the energy per elementary charge delivered by a battery (its EMF) depends only on the chemical constitution of the battery. The concept of EMF is extended to describe any device which transforms energy by separating elementary charges. This discussion leads directly to the subject of the next film 0431 - Electrical Potential Energy and Potential Difference.

MLA, cat. no. 0430, $120.

LEAD-ACID STORAGE BATTERY
(3 min., 8, S-8, color, silent) 1964

The operation of the lead-sulfuric acid storage battery is illustrated. Two lead electrodes immersed in dilute sulphuric acid are connected in series with a voltage source until current flows and one of the electrodes acquires a brown coating (lead oxide). The voltage source is removed and when the circuit is completed, current flows.

ICF, cat. no. 10100, 8, $14.; 10105, S-8, $17.50

THE PRIMARY CELL
Collaborator: Morris Meister, High School of Science, New York
(11 min., 16mm, B/W, sound)

Describes the construction, characteristics, operation, and utilization of primary electric

608

cells. Demonstrates that electricity is a form of energy which may be derived from chemical energy, and shows that electricity from primary cells can be converted to light, heat, and mechanical energy.

EBF, cat. no. 247, $70.

VOLTAIC CELLS
(4 min., 8, S-8, color, silent) 1964

Two dissimilar metals in a conducting solution are shown to generate electrical energy through a chemical reaction. Pairs of electrodes made of dissimilar metals are treated and tested with a galvanometer. Voltages are generated when different electrodes are used, and none with similar electrodes.

ICF, cat. no. 10080, 8, $16.; 10085, S-8, $19.50

701

*EQUILIBRIUM
Collaborator: George C. Pimentel, University of California; CHEM Study
(24 min., 16mm, 8, color, sound) 1961

The film deals with three questions: What is chemical equilibrium? How does the chemist recognize it? How does he explain it? In answering the questions the film stresses the dynamic nature of equilibrium. Radioactive iodine tracers are used to demonstrate the dynamic molecular behavior of the substances at equilibrium in a closed system. An analogy in terms of fish population in two connected bowls, and animation using molecular models, present the concepts with striking simplicity.

MLA, cat. no. 4124, 16mm, $180.; 4824, 8, $153.

TEACHER TRAINING INTRODUCTION to "Equilibrium"
Collaborator: CHEM Study Teacher Training Films-Lesson 5
(7 min., 16mm, B/W, sound) 1966

The treatment of equilibrium in CHEM Study is characterized by emphasis on the quantitative aspects and on the dynamic microscopic processes involved. Professor Pimentel demonstrates that in order to explain equilibrium, one needs not only the idea of a tendency toward minimum potential energy, but also the idea of a tendency, implemented by temperature, toward greater randomness.

MLA, cat. no. 4024, $40.

IONIZATION AND IONIC EQUILIBRIUM
(15 min., 16mm, B/W, color, sound) 1960

This film develops the concepts of electrovalent and covalent ionization, ionic equilibrium, and the part played by the water dipole in ionization and dissociation. Also introduces the mathematical determination of ionization constants and the concept of buffered solutions.

INDU, cat. no. FS-427, B/W, $75.; FSC-427, color, $150.

702

DECOMPOSITION OF MERCURIC OXIDE
Collaborator: Yale Chem. Films
(3 min., 16mm, color, sound)

Based on a reversible reaction used in Priestley's 1774 experiment through which he discovered oxygen. Mercuric oxide is decomposed in a closed system, releasing oxygen and mercury vapor.

AIM, cat. no. YF-216, $28.50

LIQUID/GAS EQUILIBRIUM
Collaborator: Nuffield Foundation
(2-5 min., 8, B/W, silent) 1966

See RIC, p. 224

SOLID/LIQUID EQUILIBRIUM
Collaborator: Nuffield Foundation
(2-5 min., 8, B/W, silent) 1966

See RIC, p. 225

SOLUBILITY PRODUCT
Collaborator: Yale Chem. Films
(7 min., 16mm, color, sound)

Shows the effect of varying ionic concentrations and adding a common ion on the solubility of lead chloride. Using work-sheets the student compares the results with the predictions of the solubility product principle. Supplementary notes for the teacher explore activity and complex ion formation and their effect on the solubility product.

AIM, cat. no. YF-237, $66.50

VAPOR PRESSURE
Collaborator: Yale Chem. Films
(7 min., 16mm, color, sound)

Serves as an introduction to molecular behavior. It shows that the equilibrium in a closed container of solid iodine and its vapor is a function of temperature. Measurable vapor pressure is explained by molecular motion - (animation). Vapor pressure measurement with a mercury barometer is demonstrated with four liquids.

AIM, cat. no. YF-250, $66.50

703

*ACID-BASE INDICATORS
Collaborator: J. Arthur Campbell, Harvey Mudd College; CHEM Study
(19 min., 16mm, 8, color, sound) 1962

Proton-donor-acceptor theory is used to interpret the experimental behavior of acid-base indicators. Experiments and animation show the effects on indicators of changing acidity. Equilibrium constants of four indicators are determined and the indicators arranged in order of decreasing acid strength. The competition among bases for protons is shown by mixing the indicators and showing that each changes color at different total acidity.

MLA, cat. no. 4130, 16mm, $150.; 4830, 8, $128.

ACIDS, BASES AND SALTS
(21 min., 16mm, B/W, color, sound)

Explores the properties and use of the important chemical compounds whose water solutions contain ions. Surveys theories of Arrhenius, Bronsted and Lowry, and Lewis.

CORF, B/W, $120.; color, $240.

AMMONIA
Collaborator: Thomas Sumner, University of Akron
($18\frac{1}{2}$ min., 16mm, B/W, color, sound)

Ammonia is prepared from ammonium chloride and the physical and chemical properties are illustrated by means of various reactions.

CORF, B/W, $87.50; color, $175.

AMMONIA FOUNTAIN
Collaborator: Yale Chem. Films
(2 min., 16mm, color, silent)

The absorption of ammonia in water reduces the pressure inside a closed flask to create a fountain. Acid-base changes are observed using dye indicators.

AIM, cat. no. YF-220, $15.

GAS REACTIONS II (THE AMMONIA/HYDROGEN CHLORIDE)
(4 min., 8, color, silent)

A continuous variation investigation of the ammonia/hydrogen chloride system is shown.

UNESCO, cat. no. 10, $6.

ION REMOVAL BY METATHESIS
Collaborator: Yale Chem. Films
(4 min., 16mm, color, sound)

Uses dye indicators and electrical conductivity as tests for neutralization of barium hydroxide by sulfuric acid. The key steps are repeated and the student asked to observe and explain the phenomenon on a worksheet.

AIM, cat. no. YF-236, $38.

PROPERTIES OF ACIDS, BASES AND SALTS
Collaborator: Thomas Sumner, University of Akron
(28 min., 16mm, B/W, color, sound)

Illustrates the properties of solutions of acids and bases, and demonstrates the formation of salts.

CORF, B/W, $125.; color, $250.

*TITRATION CURVES
(4 min., 8, color, silent)

Automatic potantiometric titration is illustrated, titration curves are produced for mono and polyprotic acids, and the curves are analyzed for endpoints.

LBF, cat. no. 6, $15.

705

THE ART OF SEPARATION
(30 min., 16mm, B/W, sound) 1962

The basic principles of chromatography - separation of chemical compounds into basic substances of purest form - are explained. Actual separation of a chemical compound is shown.

INDU, cat. no. FS-982, $125.

GAS CHROMATOGRAPHY
Collaborator: Perkin-Elmer Corp.
(25 min., 16mm, color, sound) 1962

Principles of gas chromatography; thermal conductivity and ionization detectors; choice of column, use in quantitative analysis.

See RIC, p. 17

AN INTRODUCTION TO ION EXCHANGE
Collaborator: Permutit Co. Ltd.
(27 min., 16mm, color, sound) 1960

The structure and properties of ion-exchange resins; the nature of the ion-exchange process; its use for separation, substitution and removal of ions; deionization of water by the two-bed and mixed-bed systems; uses of ion exchange in industry.

See RIC, p. 8

ION EXCHANGE
(20 min., 16mm, B/W, sound) 1962

Principle of ion exchange; base exchange in the soil; water softening; production and properties of ion-exchange resins; demineralization of

705

water; regeneration of resins; use in analytical and preparative chemistry; electrodialysis; ion-exchange chromatography.

See RIC, p. 8

*PRINCIPLES OF CHROMATOGRAPHY
(20 min., 16mm, color, sound) 1955

This film demonstrates recently developed techniques of chromatography, which are invaluable in enabling the quick and easy separation of substances so closely related chemically that any other method would involve months of laborious work. Four methods are clearly illustrated and described; separation by absorption, by partition, separation on filter paper, and separation by two-way paper chromatography.

MGHT, cat. no. 603503, $200.

WATER RISE IN BLOTTER STRIPS EXPOSED AND ENCLOSED
(4 min., S-8, color, silent)

A summary of a capillarity experiment with controlled evaporation is presented in time-lapse. The film shows capillary absorption of water by two blotters, one exposed to room air, and one enclosed in a clear plastic tube. The height of rise over the 12-hour period shown is greater in the enclosed blotter than in the exposed blotter. From this one can speculate about the effects of evaporation and condensation on the rate of absorption.

EYE, cat. no. 8083, $15.50

WATER RISE IN BLOTTERS OF GRADED WIDTHS
(4 min., S-8, color, silent)

An experiment showing the effects of capillarity and evaporation is presented. Blotter strips of varied widths are cut and placed in a tank of water. As the water is absorbed by the strips at varying rates a graph is drawn recording the experiment. Time-lapse photography shows the changes in the absorbing-evaporating system over a 12-hour period.

EYE, cat. no. 8082, $15.50

801

*CHEMICAL FAMILIES
Collaborator: J. Leland Hollenberg, the University of Redlands and J. Arthur Campbell, Harvey Mudd College; CHEM Study
(22 min., 16mm, 8, color, sound) 1962

Starting with a display of actual samples of over 70 elements, the film demonstrates methods by which chemical similarities among the elements have provided the basis for dividing them logically into families. By experiment and observation, the elements are classified as metals or non-metals, and some are found to be difficult to classify. Experimentally it is shown that under the same conditions, some gases are chemically reactive, while others are inert. The fact that elements with atomic numbers one less and one more than the atomic numbers of the inert gases are highly reactive, provides the clue for finding the halogen and alkali metal families. The film demonstrates how atomic numbers have provided the key to the ordering of the elements in the periodic table. A suffix to the film demonstrates a recently discovered reaction between xenon and fluorine.

MLA, cat. no. 4112, 16mm, $165.; 4812, 8, $140.

TEACHER TRAINING INTRODUCTION to "Chemical Families"
Collaborator: CHEM Study Teacher Training Films - Lesson 2
(7 min., 16mm, B/W, sound)

Professor Campbell discusses the background of the development of the periodic table pointing out that its correlations and regularities, while useful, are not perfect. He then illustrates the kinds of trends and relationships that are evident in periods and families, and among the elements surrounding any given element.

MLA, cat. no. 4012, $40.

ELECTRONEGATIVITY
Collaborator: Yale Chem. Films
(4 min., 16mm, color, sound)

Defines the electronegativity scale and relates it to the periodic table. Using chlorine, bromine, and iodine and their salts, the replacement of a less by a more-electronegative halogen is demonstrated. Worksheets give an advanced discussion and problems for solution.

AIM, cat. no. YF-244, $38.

MELTING POINTS-DETERMINATION AND TRENDS
Collaborator: Yale Chem. Films
(9 min., 16mm, color, sound)

Employs the periodic table to correlate the melting points of elements and demonstrates how to make determination on bromine, chlorine and alkali metals.

AIM, cat. no. YF-224, $85.50

MELTING POINTS (RELATION TO PERIODIC TABLE - SUMMARY)
Collaborator: Yale Chem. Films
(3 min., 16mm, color, sound)

Correlates melting points of elements with position in the periodic table through an animated three dimensional bar graph. The general trends (and major exceptions) are pointed out by the moving camera.

AIM, cat. no. YF-255, $28.50

801

METALS AND NON-METALS
Collaborator: Yale Chem. Films
(9 min., 16mm, color, sound)

By using specific examples from each group, the film shows characteristic properties that distinguish one group from the other. The periodic table is used to organize this information.

AIM, cat. no. YF-247, $85.50

METALS AND NON-METALS
($13\frac{1}{2}$ min., 16mm, B/W, color, sound)

Differences in the physical properties of metals and non-metals are shown in this film to be related to the tendency of metals to lose electrons, while non-metals tend to gain electrons. The film explains the chemical properties and the positions of these two groups in the periodic table, and illustrates closest-packing of atoms in metals.

CORF, B/W, $75.; color, $150.

802

PREPARATION AND PROPERTIES OF HYDROGEN
Collaborator: Thomas Sumner, University of Akron
($18\frac{1}{2}$ min., 16mm, B/W, color, sound)

Demonstrates the electrolysis of water and the following reactions: sodium and calcium with water, several metals with hydrochloric acid, and several acids with zinc.

CORF, B/W, $87.50; color, $175.

SODIUM PEROXIDE AND WATER
Collaborator: Yale Chem. Films
(2 min., 16mm, color, sound)

Close-up photography shows decomposition of sodium peroxide into sodium hydroxide and oxygen when water is added.

AIM, cat. no. YF-213, $19.

VERY FAST REACTION-AMMONIUM DICHROMATE
Collaborator: Yale Chem. Films
(1 min., 16mm, color, silent)

Orange ammonium dichromate crystals produce a miniature volcano when liquid leaving a cone of gray-green ash.

AIM, cat. no. YF-243, $7.50

803

THE SODIUM FAMILY
(16 min., 16mm, B/W, color, sound)

The physical and chemical properties of the alkali metals are related to their atomic structures, and their compounds are shown through laboratory demonstrations, including the rarely performed reaction between sodium and chlorine. The Downs Cell, Solvay process, salt formation by neutralization, water softening and flame tests are included, in addition to a number of important new uses.

CORF, B/W, $90.; color, $180.

804

CHROMIUM AND MANGANESE
Collaborator: Thomas Sumner, University of Akron
($37\frac{1}{2}$ min., 16mm, B/W, color, sound)

The chemistry of these elements is discussed and demonstrated, with oxidation-reduction as the central theme.

CORF, B/W, $175.; color, $350.

HIGH TEMPERATURE RESEARCH
Collaborator: Paul W. Gilles, University of Kansas
(19 min., 16mm, 8, color, sound) 1963

Why do we know more today than we did yesterday? One reason is that scientists engage in research. The excitement of discovering new knowledge through research is illustrated by studying the bond strength of gaseous titanium monosulfide. Its gaseous molecules as well as gaseous titanium and sulfur atoms are produced by the vaporization of the high melting crystalline titanium monosulfide at temperatures near 2000°K. The procedures for producing and measuring temperatures in this region are shown. A mass spectrometer identifies the gaseous species. Analysis of the mass spectrum gives the relative concentrations of atomic Ti and S, and of TiS molecules. A torsion effusion apparatus gives data on the total gas pressure at a series of temperatures. The partial pressure of each gaseous species is then calculated. Through Le Chatelier's Principle, measurements at different temperatures give the bond strength of gaseous TiS. But at least as many new questions are raised as are answered. We don't run out of questions in research.

MLA, cat. no. 4175, 16mm, $150.; 4875, 8, $128.

METALS OF THE NUCLEAR AGE
Collaborator: Greenpark Productions Ltd.
(34 min., 16mm, color, sound) 1958

An account of some of the important problems involved in developing special metals for nuclear use.

UKAEA, free loan

804

VANADIUM-A TRANSITION ELEMENT
Collaborator: Robert Brasted, University of Minnesota
(22 min., 16mm, 8, color, sound) 1962

Vanadium is studied as a typical transition element. The different oxidation states of vanadium and the corresponding colors are observed and then identified by means of a quantitative titration of vanadium (II) solution with cerium (IV) solution. The oxidation states and the observed colors are correlated with the electronic structures using an orbital board. The reaction with hydroxide ion and the formation of complex ions containing vanadium in different oxidation states are demonstrated. The variations in chemical properties are discussed in terms of ion size and charge density.

MLA, cat. no. 4172, 16mm, $165.; 4872, 8, $140.

TEACHER TRAINING INTRODUCTION to "Vanadium-A Transition Element"
Collaborator: CHEM Study Teacher Training Films - Lesson 14
(7 min., 16mm, B/W, sound) 1962

Using Chromium as an example, Professor Campbell shows that the transition metals are characterized by valence electrons in closely spaced energy levels. He then comments upon the difference in color between aqueous chromium nitrate solution and aqueous chromium chloride solution. The color difference and the incomplete precipitation of chloride from the latter solution is related to the formation of complex ions.

MLA, cat. no. 4072, $40.

806

AMMONIA-USES
Collaborator: Nuffield Foundation
(2-5 min., 8, color, silent) 1966

See RIC, p. 229

BROMINE-ELEMENT FROM THE SEA
Collaborator: J. Leland Hollenberg, the University of Redlands and James E. Magner, Dow Chemical Co.
(22 min., 16mm, 8, color, sound) 1963

The high chemical reactivity of bromine plus the high solubilities of bromine compounds result in most of the world's bromine being in the oceans. For this reason the chemistry of an aqueous solution of bromine is explored. The process for recovering elemental bromine from sea water is then developed on a laboratory scale. The essential steps are 1) oxidation of bromide ion with chlorine 2) concentration by reduction with sulfur dioxide to hydrogen bromide, and 3) reoxidation followed by separation of the bromide by steam distillation. The same steps are then shown in an industrial bromine plant.

MLA, cat. no. 4169, 16mm, $165.; 4869, 8, $140.

BROMINE-USES
Collaborator: Nuffield Foundation
(2-5 min., 8, color, silent) 1966

See RIC, p. 228

CHLORINE-A REPRESENTATIVE HALOGEN
Collaborator: Norris Rakestraw, University of California and Elbert Weaver, Phillips Academy
(15 min., 16mm, color, sound)

The only human element on the screen is the hands of the demonstrator at a laboratory bench. Animation is used to show ionic movement and similar phenomena. Film content: Laboratory and industrial preparation of chlorine. Physical and chemical properties. Reactions with other elements and with compounds. Use of chlorine. Chemical oxidation. Oxidation by electrolysis. Opportunities for chlorine research.

SUTH, $135.

COMBUSTION II - BURNING PHOSPHORUS
Collaborator: Halas & Batchelor
(2:45, 8, color, silent) 1963

The various stages of an experiment using phosphorus are shown together with the precautions necessary in handling this chemical.

MGHT, cat. no. 669027, $10.95

COMMERCIAL PRODUCTION OF CHLORINE
(9¼ min., 16mm, color, sound)

A demonstration in a college laboratory proves water to be a very poor conductor of electricity but with the addition of an electrolyte such as salt, the electrolytic solution proves its ability to carry a large current. The film then moves to a large commercial plant where brine is electrolyzed and shows commercial manufacture of chlorine from extraction of brine from the earth to shipment by rail or by barge.

AIM, cat. no. S-369, $58.

THE FAMILY OF HALOGENS
(12½ min., 16mm, B/W, color, sound) 1961

The film shows the similarity and gradation of properties of the halogens, and explains both the similarities and differences in degree on the basis of atomic structure. Valuable in developing the general use of the Periodic Table.

MGHT, cat. no. 612000, B/W, $75.; 612025, color, $150.

FLUORINE COMPOUNDS-USES
Collaborator: Nuffield Foundation
(2-5 min., 8, color, silent) 1966

See RIC, p. 228

THE HALOGENS
(16 min., 16mm, B/W, color, sound)

The highly reactive halogens combine with metallic elements to form ionic compounds, and with non-metallic elements to form covalent compounds. Uses such as silver bromide on film and newer developments such as Teflon coating are shown. The combining of fluorine with the noble gases is also illustrated. Animation and laboratory demonstrations show how atomic structure is related to the high reactivity of halogen elements and to the stability of their compounds.

CORF, B/W, $90.; color, $180.

IODINE-USES
Collaborator: Nuffield Foundation
(2-5 min., 8, color, silent) 1966

See RIC, p. 229

NITRIC ACID
Collaborator: Harry H. Sisler, University of Florida and J. A. Campbell, Harvery Mudd College; MCA; CHEM Study
(18 min., 16mm, 8, color, sound) 1962

Nitric acid acts as an acid in the manufacture of chemical fertilizers; it acts as a base in the manufacture of nitro compounds; it acts as an oxidizing agent in many systems. In making the fertilizer, ammonium nitrate, from nitric acid, it is necessary to neutralize the acidity of HNO_3. This is accomplished by addition of NH_3. In nitration reactions, such as the making of nitrobenzene, nitric acid is made to act as a base in the presence of sulfuric acid and forms nitronium ion which is the reactive intermediate in the nitration reaction. As an oxidizing agent, nitric acid can be reduced to a number of different products. The temperature of the system helps to determine which reaction predominates. The manufacture of nitric acid is a process which starts with the oxidation of ammonia, and includes several steps. Le Chatelier's principle is applied in achieving a maximum yield of acid.

MLA, cat. no. 4136, 16mm, $135.; 4836, 8, $115.

NITRIC ACID COMPOUNDS AND THE NITROGEN CYCLE
($18\frac{1}{2}$ min., 16mm, B/W, color, sound)

We learn how nitric acid, one of the most important of the nitrogen compounds, can be derived in the laboratory and industrially. Lab experiments demonstrate its properties and we see some of the many important uses of nitric acid compounds in the manufacture of explosives, paints, photographic chemicals and fertilizers. Finally, the nitrogen cycle, basic to life on earth, is illustrated as part of the overall concept of nitrogen fixation, both by nature and by man.

CORF, B/W, $105.; color, $210.

NITROGEN AND AMMONIA
(16 min., 16mm, B/W, color, sound)

Using laboratory demonstrations, the film examines the properties of molecular nitrogen, and some of the simple compounds of nitrogen, oxides, and nitrides. Most important of the simple nitrogen compounds is ammonia. We are shown how it is prepared in the laboratory and in industry, what its important properties are, and examples of its many uses in industry, in the home, and in its major use, ammonium compounds for fertilizers.

CORF, B/W, $90.; color, $180.

NITROUS ACID AND SODIUM NITRITE
($18\frac{1}{2}$ min., 16mm, B/W, color, sound)

Shows preparation of sodium nitrite, illustrates it in acidified solutions, and demonstrates several chemical properties of nitrous acid.

CORF, B/W, $87.50; color, $175.

O FOR OXYGEN
Collaborator: British Oxygen Co. Ltd.
($16\frac{1}{2}$ min., 16mm, color, sound) 1961

The discovery of oxygen; commercial production by fractional distillation of liquid air; some present-day uses of oxygen.

FAC, $175.

OXIDES OF NITROGEN
Collaborator: Thomas Sumner, University of Akron
(16 min., 16mm, B/W, color, sound)

Demonstrates physical and chemical properties of nitrous oxide, nitric oxide, and nitrogen dioxide.

CORF, B/W, $75.; color, $150.

OXYGEN
(11 min., 16mm, B/W, color, sound)

Laboratory demonstrations show the uses and significance to man of oxygen and its compounds. Explanations of electrolysis, oxidation, and forms of oxygen help develop a scientific vocabulary. Experiments, like the electrolytic decomposition of water, are treated fully and in detail. A survey of the preparation, properties, and characteristics of this element is also presented.

CORF, B/W, $60.; color, $120.

806

PARAMAGNETISM OF LIQUID OXYGEN
Collaborator: F. Miller, Jr., Ohio State University
(3:20, 8, color, silent) 1967
(4 min., 16mm, color, sound; 8, color, silent)

Liquid oxygen is strongly paramagnetic and adheres to the pole pieces of a magnet; liquid nitrogen, which is not paramagnetic is used for comparison. Liquid oxygen is poured over the pole pieces of a permanent magnet and some of it is seen to cling to the pole pieces. Liquid nitrogen is the poured over the same magnet, it does not adhere to the pole pieces. The experiment is repeated using a strong electromagnet with conical pole pieces.

EAL, cat. no. 80-2041/1, $15.50
MSC, cat. no. 12054, 16mm, $18.65; 8, $9.25

PHOSPHINE SMOKE RINGS
Collaborator: Yale Chem. Films
(2 min., 16mm, color, silent)

Elementary white phosphorous is heated in strong sodium hydroxide solution to produce phosphine PH_3, which escapes from a jet under water. It ignites in air, forming spectacular smoke rings.

AIM, cat. no. YF-221, $15.

PHOSPHORUS
Collaborator: Thomas Sumner, University of Akron
(18½ min., 16mm, B/W, color, sound)

Red and white phosphorus are considered, and their physical and chemical properties are compared and contrasted.

CORF, B/W, $87.50; color, $175.

PREPARATION AND PROPERTIES OF THE HALOGENS
Collaborator: Thomas Sumner, University of Akron
(32 min., 16mm, B/W, color, sound)

Discussed physical and chemical properties of iodine, bromine, and chlorine, and demonstrates methods for preparing them.

CORF, B/W, $150.; color, $300.

PREPARATION AND PROPERTIES OF NITRIC ACID
Collaborator: Thomas Sumner, University of Akron
(21 min., 16mm, B/W, color, sound)

Shows preparation of nitric acid, properties of nitric acid in water, and reduction products of nitric acid solutions of various concentrations.

CORF, B/W, $100.; color, $200.

SILICON AND ITS COMPOUNDS
(13½ min., 16mm, B/W, color, sound)

Basic chemical facts about silicon are presented in this film, showing its atomic structure and analyzing its place in the periodic table. Long used by man in making glass and in building materials, silicon compounds display a wide variety of properties which are providing an ever-increasing source of materials, such as lubricants, paints, polishes, silcone plastics and rubber.

CORF, B/W, $75.; color, $150.

SULFUR AND ITS COMPOUNDS
(13½ min., 16mm, B/W, color, sound)

Using molecular models, animation, and time-lapse photography, this 2nd edition film demonstrates the chemical and physical properties of sulfur, including the formation of its allotropic forms. The film describes the Frasch process, and emphasizes the importance of sulfur and its compounds, especially sulfuric acid, in modern industry, medicine, and agriculture.

CORF, B/W, $75.; color, $150.

SULFUR AND HYDROGEN SULFIDE
Collaborator: Thomas Sumner, University of Akron
(21 min., 16mm, B/W, color, sound)

Illustrates preparation of rhombic, monoclinic, and amorphous sulfur as well as properties of hydrogen sulfide.

CORF, B/W, $100.; color, $200.

807

CHEMICAL SOMERSAULT
(29 min., 16mm, B/W, sound) 1965

Reversal of the accepted view that the noble gases do not form compounds; preparation of xenon fluorides.

AEC, free loan

INERT GASES
Collaborator: Philips Electrical Ltd.
(23 min., 16mm, color, sound) 1965

Discovery and current uses of the inert gases.

See RIC, p. 113

*A RESEARCH PROBLEM: INERT(?) GAS COMPOUNDS
Collaborator: George C. Pimentel, University of California and J. J. Turner, Cambridge University
(19 min., 16mm, 8, color, sound) 1963

This film conveys the intense excitement and deep personal involvement of research in the

807

stimulating context of the first synthesis of one of the inert gas compounds. An actual research problem, the first synthesis of krypton difluoride, is traced from its inspiration to the first tentative success. A train for the pyrolutic preparation of XeF_4 is shown. In extreme closeup, the colorful reaction of XeF_4 with water is displayed and a crystal of XeO_3 is detonated by tickling with a piece of tissue. Krypton difluoride is prepared by photolysis of fluorine in solid krypton at the temperature of liquid hydrogen and identified by its infrared spectrum.

MLA, cat. no. 4160, 16mm, $150.; 4860, 8, $128.

808

HARD WATER
Collaborator: Thomas Sumner, University of Akron
(28 min., 16mm, B/W, color, sound)

Shows the operation of an ion exchange column in preparing "soft" water and demonstrates methods for determining hardness of tap water.

CORF, B/W, $125.; color, $250.

HYDROGEN GENERATOR - MARSH TEST
Collaborator: Yale Chem. Films
(7 min., 16mm, B/W, sound)

An effective and safe method for setting up a hydrogen generator is demonstrated; this generator is then used to conduct the Marsh test for arsenic.

AIM, cat. no. YF-229, $35.

809

THE ALCHEMIST'S DREAM
(29 min., 16mm, B/W, sound) 1965

Transmutation of elements by nuclear science; conversion of curium into berkelium by bombardment with deuterons from a cyclotron.

AEC, free loan

THE ATOM IN PHYSICAL SCIENCE
(26 min., 16mm, B/W, sound) 1964

Techniques and equipment used in the discovery of the early transuranium elements; production of the elements of higher atomic number; possibilities of producing still further elements; application of radioisotopes to chemical program.

AEC, free loan

CHEMICAL PROPERTIES OF WATER
(13½ min., 16mm, B/W, color, sound)

The chemical properties of water, our most common chemical compound, are explained in terms of the polar nature of the water molecule. The broad range of chemical reactions of water with metals, metal oxides, non-metal oxides, and salts is demonstrated. We see how water, in its important role of a solvent, promotes other chemical reactions.

CORF, B/W, $75.; color, $150.

*CHEMISTRY OF WATER
Collaborator: Norris W. Rakestraw, University of California and Elbert C. Weaver, Phillips Academy
(14 min., 16mm, color, sound)

The unique properties of water and the structure and behavior of water molecules are explained with animation. Film content: Structure of the water molecule. Charge distribution in the molecule and the formation of hydrogen bonds. Simplified and graphic explanation of the characteristics of water molecules in ice, ice water, water at its maximum density, boiling water, and water vapor. Detailed graphic explanation of the behavior of water molecules in dissolving a salt. Explanation of the water of crystallization, or water of hydration. Examples of water as a chemically reactive substance with certain metals. Examples of water reacting with non-metallic oxides and with hydrogen chloride. Water reacting with itself to form an acid and a base at the same time.

SUTH, $135.

CORROSION I - FILIFORM CORROSION
(4 min., 8, color, silent)

Time-lapse views and mechanism of filiform corrosion are shown.

LBF, cat. no. 12, $15.

CORROSION II - HYDROGEN EMBRITTLEMENT
(4 min., 8, color, silent)

The use of prestressed steel for testing corrosion inhibitors is demonstrated. This also shows the role of interstitial hydrogen in corrosion.

LBF, cat. no. 13, $15.

CORROSION III - ALUMINUM
(4 min., 8, color, silent)

Time-lapse views of the corrosion of aluminum.

LBF, cat. no. 14, $15.

FAST REACTION - MERCURY AND SILVER NITRATE
Collaborator: Yale Chem. Films
(5 min., 16mm, color, silent)

Mercury is squeezed from a hook-neck dropper into a beaker of silver nitrate, forming a

809

grape-sized silver ball. The physical characteristics of the ball are examined.

AIM, cat. no. YF-242, $37.50

FERROMAGNETIC DOMAIN WALL MOTION
Collaborator: F. Miller, Jr., Ohio State University
(4:20, S-8, color, silent) 1967
(4 min., 16mm, color, sound; 8, color, silent)

This film gives a brief insight into the nature and intrinsic magnetic properties of a ferromagnetic material by showing a microscopic view of a domain wall, subjected to a varying external magnetic field. The domains are formed in a single-crystal iron whisker by the hydrogen reduction of ferrous bromide. The domain walls are made visible by covering the whisker with a colloidal suspension of magnetite and the whisker is placed in the field of an electromagnet. Distortion of the domain walls is evident as the field changes in intensity and direction, and small displacements are shown to be reversible. However, in a strong magnetic field the domain walls are unstable and collapse.

EAL, cat. no. 80-2033/1, $15.50
MSC, cat. no. 12044, 16mm, $23.; 12042, 8, $11.20

HYDROGEN
(13½ min., 16mm, B/W, color, sound)

The student is introduced to one of the most important of the industrial gases. The film presentation gives some historical background of the discovery of hydrogen, shows how it is produced in the laboratory and commercially, and reviews its properties, including the electron theory of covalence. An account of important industrial uses includes new development utilizing hydrogen in the field of nuclear energy.

CORF, B/W, $75.; color, $150.

IRON EXTRACTION
Collaborator: Nuffield Foundation
(2-5 min., 8, color, silent) 1966

See RIC, p. 227

LEAD - THE ENDURING METAL
Collaborator: Lead Development Association
(28 min., 16mm, color, sound) 1959

History and ancient usage of lead; occurrence and mining of lead ore; smelting and refining; current uses of lead and lead compounds.

See RIC, p. 102

A MAGNET LABORATORY
Collaborator: Francis Bitter, MIT and John Waymouth, Sylvania Elec. Prod. Corp.; ESI
(21 min., 16mm, B/W, sound)

Professor Bitter's large magnet laboratory at MIT shows equipment used in producing strong magnetic fields; demonstrates magnetic effects of currents and the magnetism of iron.

MLA, cat. no. 0411, $120.

MAKING ELEMENTS
(29 min., 16mm, B/W, sound)

A team of scientists re-enact their former synthesis, isolation, and identification of element 101 (mendelevium). Special equipment and methods for handling radioactive materials are demonstrated, and films of the actual work of discovery and separation of elements 99 and 100 are shown.

INDU, cat. no. FS-376, $125.

THE MERCURY BEATING HEART
(4 min., 8, color, silent)

This classical phenomenon is demonstrated and its chemistry is explained by animation.

LBF, cat. no. 11, $15.

METALLURGICAL TECHNIQUES
Collaborator: Nuffield Foundation
(2-5 min., 8, color, silent) 1966

See RIC, p. 227

METALS - MECHANICAL PROPERTIES
Collaborator: Nuffield Foundation
(2-5 min., 8, color, silent) 1966

See RIC, p. 227

MODERN ALCHEMY
(29 min., 16mm, B/W, sound)

Dr. Glenn T. Seaborg, University of California, scientist, and his associates describe the discovery of the four "missing elements" (technetium, astatine, francium, and promethium); eight-inch cyclotron to the mammoth bevatron; and tell of their operation, development and importance.

INDU, cat. no. FS-374, $125.

MOTIONS CAUSED BY ELECTRICAL AND CHEMICAL EFFECTS ON LIQUID SURFACES (FM-78)
Collaborator: Edited from Surface Tension in Fluid Mechanics
(4 min., 8, S-8, color, silent)

A pool of mercury in a dish of dilute acid

809

oscillates like a "beating heart" when touched by an iron nail. In another experiment, mercury drops "chase" particles of potassium dichromate.

EBF, cat. no. RFM078, 8, $9.50; SFM078, S-8, $12.50

REPROCESSING NUCLEAR FUEL
(20 min., 16mm, color, sound) 1964

This film describes the new plant at the Authority's Windscale Works in which irradiated fuel elements, after they have been in a reactor, are treated for the separation of uranium, plutonium and fission products.

UKAEA - free loan

THE RUSTING OF IRON
Collaborator: Halas & Batchelor
(2:15, 8, color, silent) 1963

Time lapse photography shows the rusting of iron and mild steel over a period of some weeks.

MGHT, cat. no. 669028, $10.95

SLOW REACTION - IRON AND OXYGEN
Collaborator: Yale Chem. Films
(2 min., 16mm, color, silent)

As steel wool rusts over a 36-hour period, stop-motion photography observes oxygen combining with iron in an inverted, water-sealed tube.

AIM, cat. no. YF-241, $15.

*TRANSURANIUM ELEMENTS
Collaborator: Glenn T. Seaborg
(23 min., 16mm, 8, color, sound) 1965

This film, produced in the Lawrence Radiation Laboratory of the University of California, Berkeley, features four scientists who were principals in the discovery and identification of several of the transuranium elements. Glenn Seaborg reviews the historical problem of the placement of the transuranium elements in the periodic table. Burris Cunningham performs experiments showing that neptunium, plutonium and americium have chemical properties similar to those of uranium, but that under the same experimental conditions curium behaves like its rare-earth homolog, gadolinium. Stanley Thompson demonstrates how the ion-exchange separation technique is used in identification, using actual solutions of curium, berkelium, californium and einsteinium. Albert Ghiorso discussed the methods used in the synthesis of elements 102 and 103, and proposes a similar type of reaction which may lead to the discovery of element 104.

MLA, cat. no. 4178, 16mm, $180.; 4878, 8, $153.

VACUUM MELTED METALS
(28 min., 16mm, color, sound) 1964

Techniques employed in the manufacture of new alloys by vacuum induction and vacuum consumable-electrode arc melting processes, or a combination of both; special applications of vacuum melted metals.

See RIC, p. 32

901

CARBON AND ITS COMPOUNDS
(11 min., 16mm, B/W, color, sound)

Using familiar objects, the film explains carbon's simple compounds and introduces hydrocarbons and chain and ring compounds.

CORF, B/W, $60.; color, $120.

CRACKING HYDROCARBONS
Collaborator: Nuffield Foundation
(2-5 min., 8, color, silent) 1966

See RIC, p. 229

HYDROCARBONS AND THEIR STRUCTURES
(12½ min., 16mm, B/W, color, sound)

Laboratory demonstration, animation, and structural and scale models are used to explain the five homologous series of hydrocarbons and to show how members of each series differ from the others. The film describes the bonding properties of the carbon atom which make possible the tremendous number of hydrocarbons, and discusses some of the wide varieties of these compounds and their uses.

CORF, B/W, $75.; color, $150.

PETROLEUM FRACTIONATION
Collaborator: Nuffield Foundation
(2-5 min., 8, color, silent) 1966

See RIC, p. 229

904

ACETIC ACID ACHIEVEMENT
(28 min., 16mm, color, sound) 1964

History of acetic acid production; development of a process of manufacture in one step from petroleum construction and operation of the plant conversion to acetic esters.

See RIC, p. 154

THE B.R.L. NEW PENICILLINS
Collaborator: Beecham Research Lab Ltd.
(14 min., 16mm, color, sound) 1964

The limited scope of therapy with only pen'

904

cillins G and V; isolation of the common "nucleus" in 1957; synthesis of new penicillins; description and clinical application.

See RIC, p. 160

GAS AND CHEMISTRY IN UZBEKISTAN
Collaborator: Moscow Popular Science Studies
(20 min., 16mm, color, sound) 1965

The production of natural gas; conversion into a variety of products.

See RIC, p. 155

THE GREAT SYNTHESIS
Collaborator: British Petroleum Co. Ltd.
(13 min., 16mm, color, sound) 1964

The orgins of the petroleum chemical industry and its place in the present day world.

See RIC, p. 155

905

*MECHANISM OF AN ORGANIC REACTION
Collaborator: Henry Rapoport, University of California and Philip Eaton, University of Chicago; CHEM Study
(20 min., 16mm, 8, color, sound) 1963

A study of the hydrolysis of an ester, methyl benzoate, shows that the discovery of a reaction mechanism includes a determination of the chemical equation, the structures of the reactants and products, the fate of each atom of the reactants, and the structures of the intermediate molecules. The concepts of bond polarity and the effect of varying the structure of the ester also provide valuable hints. The use of the oxygen-18 and its detection on a mass spectrometer provide critical experimental data for the mechanism of the hydroxide-catalyzed hydrolysis of methyl benzoate.

MLA, cat. no. 4166, 16mm, $150.; 4866, 8, $128.

TEACHER TRAINING INTRODUCTION to "Mechanism of an Organic Reaction"
Collaborator: CHEM Study Teacher Training Films - Lesson 15
(9 min., 16mm, B/W, sound) 1966

Professor Rapoport discussed the importance to the organic chemist of general principles which apply to chemistry as a whole. He stresses the importance of understanding the relationship between structure and properties and of understanding reaction mechanisms. He reviews some of the means that have been used by organic chemists to determine mechanisms, such as substitution of tracer isotopes and the modification of molecular shapes. These techniques are utilized in the classroom film.

MLA, cat. no. 4066, $50.

906

MIRACLE MATERIALS
Collaborator: Howard G. Vesper and Earl S. Herald, Standard Oil Co. of California
($22\frac{1}{2}$ min., 16mm, B/W, sound)

Vesper and Herald demonstrate the characteristics of a variety of plastics, describe the chemistry of polymerization, and show how the wide range of chemical and physical properties have been combined to bring about new products to meet special needs of consumers.

ALFI, $125.

ORIGIN AND SYNTHESIS OF PLASTICS MATERIALS
(16 min., 16mm, B/W, sound)

Organic origin of plastics and the resemblance of synthetic compounds to natural substances; synthesis of plastics from natural substances; forms in which plastics are produced; and typical plastics products.

DUART, cat. no. OE466, $22.14

*PHYSICAL CHEMISTRY OF POLYMERS
Collaborator: Bell Telephone Lab
(22 min., 16mm, color, sound) 1963

Discussed in the film are molecular size and shape, the way molecules pack together and the strength of forces between molecules that affect the physical properties of polymers. The film depicts numerous experiments and demonstrations.

STER, free loan

PLASTICS
Collaborator: Nuffield Foundation
(2-5 min., 8, color, silent) 1966

See RIC, p. 230

PLASTICS - THEIR STRUCTURE AND PROPERTIES
(17 min., 16mm, color, sound) 1960

The principles of polymer formation; structure and properties of plastics, influence of temperature; applications.

See RIC, p. 176

POLYURETHANES PROGRESS
Collaborator: Shell Chemical Co. Ltd.
(22 min., 16mm, color, sound) 1964

Molecular structure of polyurethanes; manufacture in the form of rigid or flexible foam by moulding and spraying; applications.

See RIC, p. 177

906

RAYON - FIRST AMONG FIBRES
(25 min., 16mm, color, sound) 1966

Early attempts to produce artificial fibres; introduction of viscose rayon; present-day manufacture; molecular structure; production of modified rayons; applications.

See RIC, p. 179

RUBBER FROM OIL
Collaborator: Esso Research and Eng. Co.
(22 min., 16mm, color, sound) 1960

The development of butyl rubber; its manufacture from oil refinery by-products; comparison of its properties with those of natural rubber; some of its uses.

See RIC, p. 174

907

DETERGENTS UP TO DATE
Collaborator: Shell Chemical Co. Ltd.
(19 min., 16mm, B/W, color, sound) 1965

The action of a detergent; structure and behavior of the detergent molecule; the problem of persistent foam; successful search for a biologically soft detergent base; tests by the Water Pollution Research Board.

See RIC, p. 157

WHAT IS SOAP?
Collaborator: Unilever Ltd.
(13 min., 16mm, color, sound) 1962

The conversion of vegetable oil or animal fat, by reaction with a caustic alkali, into soap and glycerol.

See RIC, p. 158

WHISKY DISTILLATION
Collaborator: Nuffield Foundation
(2-5 min., 8, color, silent) 1966

See RIC, p. 230

1000

ANTIBIOTIC FROM THE SEA
(24 min., 16mm, color, sound) 1965

Discovery of the sephalosporins; production of improved analogues; development of the wide-spectrum antibiotic "Ceporin".

See RIC, p. 159

ANTIGEN ANALYSIS BY CELLULOSE CHROMATOGRAPHY AND GEL DIFFUSION OF HYDATID FLUID
(27 min., 16mm, color, sound)

A visual report of a research project on the analysis of antigens in hydatid fluid, demonstrating the techniques of cellulose chromatography and gel diffusion. Recommended for professional use.

DUART, cat. no. M-545, $83.17

BACTERIAL SENSITIVITY TO RADIATION
Collaborator: Joseph C. Daniel, Jr., University of Colorado
(2½ min., 16mm, color, sound)
(3:05 min., 8, S-8, color, silent)

Exposure to radiation may cause death or genetic alteration among many kinds of living organisms. This film shows the effect of varying amounts of ultraviolet light on Serratia marcescens bacteria.

THORNE, 16mm, $40.; 8, S-8, cat. no. 50, $18.50

BACTERIAL TRANSFORMATION
Collaborator: Joseph C. Daniel, Jr., University of Colorado
(6½ min., 16mm, color, sound)

Demonstrates that a strain of Pneumococcus pneumonia bacteria, sensitive to streptomycin, may become resistant when grown on a medium supplemented with DNA from a resistant strain.

THORNE, $78.

*BIOCHEMISTRY AND MOLECULAR STRUCTURE
Collaborator: Donald E. Rounds, Pasadena Foundation for Medical Research
(22 min., 16mm, 8, color, sound) 1964

The film demonstrates the role of molecular structure in determining biological activity. Correlation of the structure and biological activity of sulfanilamide with a vitamin essential for bacterial growth leads to a more general investigation of the biochemical nature of growth. Paper chromatography is used to separate some of the compounds which make up human cells. It is proposed that compounds similar to those found in cell chromosomes may stop cell growth and thus be useful in controlling cancer. The technique of time-lapse microphotography is used to demonstrate the effect of one such compound, 5-FU (5-fluorouracil), on cancer cells.

MLA, cat. no. 4181, 16mm, $165.; 4881, 8, $140.

TEACHER TRAINING INTRODUCTION to "Biochemistry and Molecular Structure"
Collaborator: CHEM Study Teacher Training Films - Lesson 16
(7 min., 16mm, B/W, sound)

Professor Campbell explores relationships between structure and properties found in biochemical systems. He relates the stiffness of plant tissue, which is primarily carbohydrate, to the abundance of hydrogen bonds between molecules. He contrasts this with the suppleness and relative scarcity of hydrogen bonds between the protein molecules of which animal tissue is largely composed.

MLA, cat. no. 4081, $40.

CALORIES AND PROTEINS
Collaborator: H. J. Heinz Co. Ltd.
(11 min., 16mm, color, sound) 1962

The cell structure of the body; breakdown of foods during digestion; synthesis of proteins in the body; determination of the energy content of foods; rate of caloric expenditure; estimation of daily food needs.

See RIC, p. 187

CELL DIVISION - MITOSIS
Collaborator: Halas & Batchelor
($2\frac{1}{2}$ min., 8, S-8, color, silent)

Film uses a generalized animal cell in the interphase resting stage to show the division of the nucleus which proceeds the fission of the whole cell.

EBF, cat. no. R80051, 8, $16.; S80051, S-8, $17.60

CELL REPRODUCTION (MITOSIS)
Collaborator: H. Burr Roney, University of Houston
(28 min., 16mm, B/W, color, sound; 8, color, sound)

Describes the various stages of cell reproduction. Stresses the importance of cell reproduction in maintaining life on earth, and emphasizes the role of DNA in controlling cell reproduction.

MGHT, cat. no. 613110, B/W, $150.; 613230, color, $300.; 8, $180.

CELL RESPIRATION
Collaborator: H. Burr Roney, University of Houston
(28 min., 16mm, B/W, color, sound; 8, color, sound)

Describes respiration as the power producing part of cell metabolism. Explains the function of ATP molecules in cell respiration and relates this to cell nutrition and synthesis.

MGHT, cat. no. 613104, B/W, $150.; 613224, color, $300.; 8, $180.

A CELL'S CHEMICAL ORGANIZATION
Collaborator: H. Burr Roney, University of Houston
(28 min., 16mm, B/W, color, sound; 8, color, sound)

Describes complex cell activity at molecular and atomic levels. Presents composition of cell nutrients and cell chemicals. Relates the origin and use of energy within the cell to various cell functions.

MGHT, cat. no. 613103, B/W, $150.; 613223, color, $300.; 8, $180.

CHEMICAL MACHINERY
Collaborator: Ingrith Deyrup, Barnard College
(28 min., 16mm, B/W, color, sound; 8, color, sound)

Refers to organelles and enzyme systems within cells, emphasizing products produced by chemical machinery. Discusses amino acids, explains lock-and-key theory of enzymes and presents highlights of glucose respiration.

MGHT, cat. no. 613140, B/W, $150.; 613260, color, $300.; 8, $180.

CHEMISTRY OF THE CELL - I: THE STRUCTURE OF PROTEINS AND NUCLEIC ACIDS
(21 min., 16mm, color, sound) 1965

Using animation, diagrams, molecular models and live action, this film points out the major chemical constituents of a cell and stresses the need for these materials to be synthesized anew following each cell division. It discusses the nature of amino acids, proteins and DNA and explores the need for and means of their exact duplication. Peptide linkages, chemical analysis of proteins, polypeptide chains, X-ray analysis of the third order of structure (or folding), action of enzymes on protein, sequence of bases in RNA, and Transfer RNA are only some of the concepts introduced, explained and examined in this informative film.

MGHT, cat. no. 603419, $250.

CHEMISTRY OF THE CELL - II: FUNCTION OF DNA AND RNA IN PROTEIN SYNTHESIS
(16 min., 16mm, color, sound) 1965

This film opens with a view of a cell in the process of division. The daughter cells are observed to be half as big as the original cell and the question is raised as to how the process of cell growth takes place and how it is controlled. This film analyzes the chemical and physical properties of DNA and RNA and discusses the way in which these molecules act to control and bring about the synthesis of cell proteins at the ribosomes.

MGHT, cat. no. 603420, $190.

1000

CIRCULATION
(17 min., 16mm, B/W, color, sound)

Systematic and pulmonary circulation of the blood in animation; the route of the blood through the body, the heart cycle, and the exchange of oxygen and carbon dioxide in the lungs and body cells.

UEVA, B/W, $95.; color, $190.

CIRCULATION - THE FLOW OF BLOOD
Collaborator: Halas & Batchelor
(3 min., 8, S-8, color, silent)

Shows by means of animated diagrams the flow of oxygenated blood from the heart through arteries to the capillaries and the returning flow of deoxygenated blood through the veins to the heart.

EBF, cat. no. R80053, 8, $16.; S80053, S-8, $17.60

DIGESTION-CHEMICAL
(19 min., 16mm, B/W, color, sound)

The film depicts the secretion and action of saliva, gastric, pancreatic and intestinal juices; of bile on each type of food; how digested foods are distributed to be used and stored.

UEVA, B/W, $95.; color, $190.

THE DIVISION OF THE DNA MOLECULE
(2-5 min., 8, B/W, silent) 1966

See RIC, p. 225

DNA TRANSFORMATION EXPERIMENT
Collaborator: L. Riddiford, Harvard University
(3:40, S-8, color, silent)

In this film the classic biology experiment involving bacterial transformation is demonstrated. Two strains of Bacillus subtilis, one which cannot grow without trypotophan ($tryp^-$) and the other which can do so ($tryp^+$), are used in the film. DNA isolated from the $tryp^+$ strain is incorporated into the minus strain. When this has been achieved, the minus strain will henceforth be able to grow on a medium without tryptophan. All of the laboratory steps, involving incubation, controls, mixing, streaking and so on, are shown. The transformed bacteria will produce colonies, while the control bacteria will not.

EAL, cat. no. 81-6058/1, $22.95

DOWN ON THE FARM
(29 min., 16mm, B/W, sound) 1965

Cultivation of algae in heavy water to produce deuterated compounds; use of these compounds to study photosynthesis and plant growth.

AEC, free loan

EXTRACTION OF NUCLEIC ACIDS (DNA-RNA)
Collaborator: Joseph C. Daniel, Jr., University of Colorado
(10 min., 16mm, color, sound)

Deoxyribose nucleic acid, commonly known as DNA, is believed to be the chemical component of the hereditary material of living cells. This film demonstrates a process by which nucleic acids, DNA and RNA, may be extracted for study and experimentation.

THORNE, $120.

FROM ATOMS TO ORGANISMS
Collaborator: H. Burr Roney, University of Houston
(28 min., 16mm, B/W, color, sound; 8, color, sound)

Portrays current ideas concerning the organization of matter within organisms. Describes biology as a study of the place of atoms, molecules, cells, matter, and energy in the structure and function of organisms.

MGHT, cat. no. 613111, B/W, $150.; 613231, color, $300.; 8, $180.

GATEWAYS TO THE MIND
Collaborator: Bell Telephone Lab
(59 min., 16mm, color, sound)

What really happens when we see, hear, taste, smell and feel is presented through unusual pictures and animated sequences of physiological experiments and discoveries. Here is the colorful and absorbing story of the human senses.

STER, free loan

GENE ACTION
Collaborator: Ralph Buchsbaum, University of Pittsburgh; David M. Bonner, University of California; Martin Rachmeler, Northwestern University
(16 min., 16mm, B/W, color, sound) 1966

Proteins and amino acids; the DNA molecules; its relation to the action of the genes; genetic defects; the basis of inheritance.

EBF, cat. no. 2139, B/W, $102.50; 2138, color, $200.

GENETICS FUNCTIONS OF DNA AND RNA
(13½ min., 16mm, B/W, color, sound)

In all living things - simple or complex, one-celled or many-celled - heredity means transmission of characteristics from cell to cell. This film shows cellular mechanisms that make heredity possible: DNA in the nucleus, and messenger RNA and transfer RNA in the cytoplasm. Illustrates not only how specific DNA codes result in specific proteins, but how mutation and differentiation may occur.

CORF, B/W, $81.25; color, $162.50

1000

GIANT MOLECULES - PROTEINS
Collaborator: Nuffield Foundation
(2-5 min., 8, color, silent) 1966

See RIC, p. 225

GROWTH AND REPLACEMENT
Collaborator: H. Burr Roney, University o Houston
(28 min., 16mm, B/W, color, sound; 8, color, sound)

Explains cell growth from the molecular level to whole organisms. Indicates the roles of proteins and enzymes in growth and replacement, and describes how the nucleus directs cell growth and replacement.

MGHT, cat. no. 613107, B/W, $150.; 613227, color, $300.; 8, $180.

HORMONES
Collaborator: Donald Farner, Washington State University
(28 min., 16mm, B/W, color, sound; 8, color, sound)

Defines "hormone" and "target organs" and discusses experiments of Bayliss and Starling leading to discovery of hormones. Covers chemical constitution of hormones; demonstrates hormonal changes in rooster and caterpillar.

MGHT, cat. no. 613142, B/W, $150.; 613262, color, $300.; 8, $180.

HOW A VIRUS MULTIPLIES
(2-5 min., 8, B/W, silent) 1966

See RIC, p. 225

INGESTION AND DIGESTION
Collaborator: Beverly Reynolds, University of Maryland
(28 min., 16mm, B/W, color, sound; 8, color, sound)

Explains differences in feeding between one-celled animals and multicellular organisms. Illustrates use of teeth, mouth, stomach and digestive tract. Explains chemical reactions on carbohydrates, lipids, and proteins.

MGHT, cat. no. 613138, B/W, $150.; 613258, color, $300.; 8, $180.

AN INTRODUCTION TO NUTRITION
Collaborator: H. J. Heinz Co. Ltd.
(10 min., 16mm, color, sound) 1962

The first principles of nutrition; the five basic nutrients; the function of each in the body; simple dietary principles.

See RIC, p. 188

ISOLATION OF PHYTOCHROME
Collaborator: Iowa State University
(3:40, S-8, color, silent) 1967

This film demonstrates a procedure for isolating phytochrome from oat seedling. Maceration of dark-grown shoots is followed by filtration, centrifugation, and chromatographic fractionation.

EAL, cat. no. 81-5530/1, $21.50

LIFE IN A CELL
(14 min., 16mm, B/W, color, sound)

The life cycle and behavior of the Amoeba is studied in detail with the use of photomicrography. Time-lapse filming allows the viewer to see reproduction by cell division in just a few minutes which would normally take a long time to observe. The Amoeba is studied as a living organism with respect to filling these qualifications: locomotion, digestion, assimilation, respiration, excretion, irritability and reproduction.

JCA, cat. no. 501, B/W, $67.50; color, $135.

MEASURING OXYGEN CONSUMPTION
(4:55, 8, S-8, color, silent)

Shows the construction and use of a simple apparatus to measure the oxygen consumed by small mammals in demonstrating an important aspect of metabolic studies.

THORNE, cat. no. 41, $18.50

MEASURING TRANSPIRATION RATE
Collaborator: L. Riddiford, Harvard University
(3:40, S-8, color, silent)

The variations in the transpiration rates of plants are interestingly illustrated. The opening sequences show a tube being filled with a colored water solution which enables the water removal process to be discernible to the viewer. The leafy section of a potted plant is cut off at the stem base and the stem attached to the tube. The viewer can readily see that when a fan and then a hot lamp are directed onto the plant leaves, the rate of transpiration varies as reflected in the speed of water removal from the tube apparatus. If you have ever tried this experiment with poor results, here is your chance to see it done effectively!

EAL, cat. no. 81-6066/1, $22.95

MEDICINE IN FOCUS
Collaborator: Assn. of British Pharm. Ind.
(17 min., 16mm, color, sound) 1965

The research testing, clinical trials and quality control involved in the development and marketing of a new pharmaceutical product; the achievements of the past 25 years.

See RIC, p. 161

MILK AND NUTRITION
Collaborator: National Dairy Council
(20 min., 16mm, color, sound) 1964

Man's search for food through the ages; milk as a food; laboratory separation into its component parts; nutritional value of milk and milk products.

See RIC, p. 188

MITOSIS
Collaborator: A. Bajer, University of Oregon and R. and M. Allen, Princeton
(4:30, S-8, color, silent) 1967

Mitosis is one of life's most dramatic and basic processes. This color film presents a vivid portrayal of mitosis in endosperm cells of the African blood lily. The film follows the individual cells of Haemanthus katherinae from prophase to late telephase. One sees such details as the changes occurring in chromosome structure, the varied chromosomal movements, the breakdown and re-establishment of the nuclear membrane and nucleoli, the formation and dissolution of the spindle, the movements of mitochondria and other cytoplasmic elements, the appearance of the phragmoplast (or spindle remnant), and the detailed formation of the cell plate. A superior teaching tool, this splendid film is considered to be an outstanding cinematographic production.

EAL, cat. no. 81-5340/1, $21.50

MITOSIS-ANIMAL AND PLANT
(4 min., 8, S-8, color, silent)

Shows the dynamic, continuous process by which living cells reproduce during division and provides a means for comparing some features of cell division in plants and animals.

EBF, cat. no. R80073, 8, $20.; S80073, S-8, $22.

MUSCLES
Collaborator: Charles Brown, Howard University
(28 min., 16mm, B/W, color, sound; 8, color, sound)

Describes types of muscles and ways in which muscles are organized to do work. Establishes relationship between glycogen, pyruvic acid, lactic acid, and fatigue. Demonstrates the use of electron microscope.

MGHT, cat. no. 613143, B/W, $150.; 613263, color, $300., 8, $180.

NERVE ACTION-THE REFLEX ARC
Collaborator: Halas & Batchelor
(1:45, 8, S-8, color, silent)

Shows the pathway by which an impulse travels from a pain receptor in the thumb through the spinal cord to the muscles that effect the withdrawal of the hand.

EBF, cat. no. R80101, 8, $16.; S80101, S-8, $17.60

NEUROSPORA TECHNIQUES
Collaborator: BSCS
(8 min., 16mm, color, sound)

Presents methods used in culturing and handling of Neurospora (pink bread mold) for use in demonstrating genetic principles. Crossing of albino and arginine-deficient types with normal is shown, and the development of the resulting ascospores demonstrates the principle of genetic segregation.

THORNE, $96.

NICOTINIC ACID
(11 min., 16mm, color, sound) 1965

The synthesis of nicotinic acid from methane; purification; applications.

See RIC, p. 199

ORIGIN OF LIFE: FROM AMINO ACIDS TO PROTEINOIDS
Collaborator: Sidney Fox, Institute of Molecular Evolution, University of Miami
(3:40, S-8, color, silent)

Eighteen amino acids, basic constituents of all living things, are weighed out in proper proportions and placed in a flask with a vented stopper. The flask is then placed in a mineral oil bath at 90°C. for 15 minutes. During the heating, the amino acids will polmerize, forming proteinoids which are in almost every way similar to the proteins of living systems. The bubbling proteinoid has the appearance of lava boiling up under primitive earth conditions. The amino acid polymer, proteinoid, is then placed in a mortar for grinding. This film clearly demonstrates the significant transformation from the amino acids to the proteinoid stage.

EAL, cat. no. 81-6124/1, $22.95

ORIGIN OF LIFE: CELL-LIKE CHARACTERISTICS OF MICROSPHERES
Collaborator: Sidney Fox, Institute of Molecular Evolution, University of Miami
(3:40, S-8, color, silent)

Several dramatic demonstrations focusing on the similarity of microspheres and cells are performed. Microscopic views show microspheres doing a Brownian "dance". Several are seen to be moving independently. Comparison is then made between the microspheres and cocci. They are almost undistinguishable from one another. A further striking comparison is made between an electron micrograph and Bacillus cereus. Both exhibit granular interiors and have a well-defined membrane as the boundary. A tesia coil is placed at the bottom of a test tube containing suspended microspheres. A charge is applied and a sample of the suspension is taken and viewed under the microscope. Bud-like appendages are seen to form. Several other similarities to cells are clearly demonstrated.

EAL, cat. no. 81-6140/1, $22.95

ORIGIN OF LIFE: THE PRIMITIVE EARTH
Collaborator: Sidney Fox, Institute of Molecular Evolution, University of Miami
(3:40, S-8, color, silent)

The experiments performed are placed in the context of primitive earth conditions and each separate step is put together with a dramatic laboratory demonstration. The similarity between the hot primitive earth is brought forth with spectacular shots of lava flow. A volcanic rock is heated red hot and amino acids are sprinkled on it so as to duplicate the rain of amino acids that may have fallen on the primitive earth. Water is then sprinkled on the polymerized amino acids and a sample of the liquid run-off is examined under the microscope. Microspheres are produced as the results of this extremely simple demonstration. The film summarizes the hypothesized individual steps in the origin of life.

EAL, cat. no. 81-6512/1, $22.95

ORIGIN OF LIFE: FROM PRIMITIVE GASES TO AMINO ACIDS
Collaborator: Sidney Fox, Institute of Molecular Evolution, University of Miami
(3:40, S-8, color, silent)

The production of amino acids, basic constituents of all living things, from inorganic gases of the primitive atmosphere is one of the prime problems in research on the origin of life. Two of the principal syntheses are performed using heat and electricity as energy sources. An exact replica of Stanley Miller's apparatus is set up. The discharge chamber of the Miller apparatus is filled with CH_4NH_3 and H_2. A flask of water is boiled to provide the water vapor. A high voltage tesia coil is attached to the electrodes and turned on giving an eerie glow from the spark which repeatedly jumps across the gap. A sample of the reaction products is taken and submitted to chromatography. Four amino acids are obtained. The second part of the film deals with thermal polmerization as performed by Harada and Fox. By this method eighteen amino acids are isolated.

EAL, cat. no. 81-6116/1, $22.95

ORIGIN OF LIFE: FROM PROTEINOIDS TO MICROSPHERES
Collaborator: Sidney Fox, Institute of Molecular Evolution, University of Miami
(3:40, S-8, color, silent)

The formation of amino acids and proteinoids is a long step away from the origin of the first cell. The proteinoid prepared in "From Amino Acids to Proteinoids" (No. 81-6124) is ground up to a fine tan powder. Five ml. of distilled water is added to 0.5 g. of proteinoid. The contents are then boiled and a thick tar-like material separates out. The liquid portion is poured off and cooled until it too clears. As cooling occurs, a precipitate begins to form. The test tube is shaken to disperse the precipitate and a sample is placed on a microscope slide for analysis. Microspheres, which have striking similarity to living cells, are clearly seen.

EAL, cat. no. 81-6132/1, $22.95

OXYGEN LIBERATION BY ISOLATED CHLOROPLASTS - THE HILL REACTION
(9:45, 16mm, color, sound)

In this now classical experiment the evolution of oxygen by chloroplasts isolated from other cell components is demonstrated. The experiment is performed with specially designed apparatus and the results are given precisely as recorded. This film is particularly useful where students have had previous training in the interpretation of raw data.

MLA, cat. no. 6312, $75.

PATTERNS OF ENERGY TRANSFER
Collaborator: H. Burr Roney, University of Houston
(28 min., 16mm, B/W, color, sound; 8, color, sound)

Considers energy transfer from sunlight to utilization in cell metabolism. Illustrates heterotrophic and autotrophic processes; photosynthesis is used to illustrate autotrophic nutrition. Discussed the importance of energy transfer in biological phenomena.

MGHT, cat. no. 613105, B/W, $150.; 613225, color, $300.; 8, $180.

PHOTOSYNTHESIS AND MUSCULAR ENERGY
(15 min., 16mm, color, sound) 1964

The process of photosynthesis; conversion of starch and sugar into energy; inhalation of oxygen; exhalation of carbon dioxide.

See RIC, p. 212

THE PHOTOSYNTHESIS AND RESPIRATION CYCLE
($13\frac{1}{2}$ min., 16mm, color, sound)

By use of remarkable animation, the photosynthesis process is visualized both at the microscopic level and, more importantly, at the molecular level. An understanding is given of the complexity of forming a molecule of sugar, $C_{12}H_{22}O_{11}$, from water and carbon dioxide. The concept of releasing energy from food is explained. This process is visualized, again at the molecular level.

CHUR, $150.

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PHOTOSYNTHETIC FIXATION OF CARBON DIOXIDE-I AND II
Collaborator: Iowa State University
(3:40, S-8, color, silent) 1967
(6 min., 8, color, silent)

A method for measuring photosynthesis with radio-tracer techniques is demonstrated. Variegated Coleus leaves are place in a divided (light-dark) chamber containing $C^{14}O_2$. After suitable exposure, discs are cut from the green and white portions of both leaves and their radioactivity is determined. Results are given and a problem is suggested.

EAL, cat. no. 81-5118/1, Pt. I; 81-5126/1, Pt. II, $21.50
MLA, cat. no. 6106, Pt. I; 6107, Pt. II, $14.

ROLE OF ATP IN MUSCLE CONTRACTION
Collaborator: L. Riddiford, Harvard University
(3:40, S-8, color, silent)

The vital role of ATP as the molecule of energy transfer is clearly demonstrated. Muscle fibers are carefully teased from the psoas muscle (back muscle) of a rabbit. The muscle has been glycerinated to preserve it for experimental work. Four equal length fibers are placed in a specially designed experimental chamber having four compartments. Each of the four sections is then filled with a different solution; magnesium chloride and potassium chloride; 0.25% ATP; ATP, magnesium chloride and potassium chloride; and a water control. Cinephotomicroscopy, using high speed techniques, shows the actual movement of contraction which your students will be able to evaluate.

EAL, cat. no. 81-6082/1, $22.95

SAFARI FOR ENZYMES
Collaborator: Paul Lewis Lab
(20 min., 16mm, color, sound) 1960

Collection of the latex from tropical trees; drying and shipment to the U.S.; processing to extract three vegetable enzymes; purification and standardization.

See RIC, p. 199

SMALLER THAN LIFE
(39 min., 16mm, B/W, sound)

The medical science film is an indepth, college level study of viruses and the latest developments in the continuing search for a cure for virus diseases. The virus is considered one of biology's most baffling mysteries; "Smaller than Life" presents this important subject with remarkable clarity. Leading scientists, specialists in their fields, discuss different viruses and up-to-the-minute findings. They use specially constructed scale models, magnified three million times, to give the viewer an idea of the structure and shape of various strains of viruses. In addition, by the use of high resolution electron microscope, the only one of its kind - capable of magnifying a virus two million times - this film lets the viewer see and study several real viruses. This electron microscope has been an invaluable aid to scientists in studying the properties of viruses and in discovering ways of combatting them.

ROB, $250.

THE THREAD OF LIFE
Collaborator: Bell Telephone Lab
(59 min., 16mm, color, sound)

How such traits as left-handedness, red hair and other characteristics turn up in succeeding generations is explained in a way that is easy to understand in this interesting study of genetics, the science of heredity.

STER, free loan

TRANSFER OF MATERIALS
Collaborator: H. Burr Roney, University of Houston
(28 min., 16mm, B/W, color, sound; 8, color, sound)

Describes the chemical and physical aspects of movement of materials across cell boundaries. Explains the source of energy required for transfer of materials and indicates the importance of enzymes.

MGHT, cat. no. 613106, B/W, $150.; 613226, color, $300.; 8, $180.

UNDERSTANDING VITAMINS
Collaborator: John B. Youmans, United Health Foundation Inc.
(14 min., 16mm, color, sound) 1961

The discovery of vitamins; foods which provide them; their function in the body production by synthesis; vitamin research.

EBF, cat. no. 749, B/W, $86.; 575, color, $167.50

VIRUSES: THRESHOLD OF LIFE
Collaborator: John E. Kempf, University of Illinois
(13½ min., 16mm, B/W, color, sound)

What is a virus? How do viruses exist and reproduce? How can we use our knowledge of viruses to improve our health and well-being? Such questions are answered in a modern virology laboratory, where we see scientists using the ultra-centrifuge, the electron-microscope, tissue cultures, and experimental animals to explore the nature of viruses. In this film, students see a demonstration of gene mapping, a collection of electron micrographs and models which illustrate virus reproduction. Viruses have different shapes and may be simple or complex in structure. Outside a living host, they appear lifeless; inside cells, they re-

1000

produce and spread. Some viruses grow in animal tissues; others in plant tissues, still others in bacteria. Some viruses remain latent in the cells. Lysis, or cell destruction, is explained. The most exciting research thus far on viruses indicates that one day scientists may be able to create genes from chemicals, to create living cells, and perhaps to create and repair human tissues and organs. Students of biology will find this film a stimulating introduction to the fascinating and fast-growing science of virology.

CORF, B/W, $75.; color, $150.

VITAMIN A
Collaborator: Roche Products Ltd.
(30 min., 16mm, color, sound) 1960

The discovery of Vitamin A; chemical structure; sources; importance in animal nutrition.

See RIC, p. 163

WHAT IS A CELL?
Collaborator: Peter Rasmussen, Kansas University
(28 min., 16mm, B/W, color, sound; 8, color, sound)

Discusses research in understanding cells, and cell parts and their function in cell activities. Introduces techniques of investigation and describes applications of light microscopes and chemical techniques to cell research.

MGHT, cat. no. 613102, B/W, $150.; 613222, color, $300.; 8, $180.

WHICH CARBOHYDRATE:
Collaborator: Beecham Research Lab Ltd.
(30 min., 16mm, color, sound) 1966

Action of the various carbohydrates in metabolism; differences in action between them; experimental evidence; clincal aspects; dietary applications.

See RIC, p. 189

2001

ACIDS
Collaborator: Robert Disraeli Films
(5 min., 16mm, B/W, color, sound)

Emphasizes labels on acid reagent bottles. Correct way to hold stopper; pouring acid along stirring rod into solutions; using hand clamp when pouring acid into test tube. Important safety precautions.

AIM, cat. no. DC-108, B/W, $30.; color, $60.

THE BUNSEN BURNER
Collaborator: Robert Disraeli Films
(7 min., 16mm, B/W, color, sound)

Depicts and describes the parts of a bunsen burner; how to adjust mixtures of gas and air to produce a non-luminous to a luminous flame; shows flame cones and explains their use for heating materials; a "strike-back" and what to do.

AIM, cat. no. DC-102, B/W, $40.; color, $80.

THE BUNSEN BURNER
Collaborator: R. M. Whitney, Roxbury Latin School
(3:55, S-8, color, silent) 1967

This film describes the assembly, adjustment and operation of a Bunsen burner. In the first part of the film, the roles of the needle valve in controlling the gas flow rate and the chimney in adjusting the air intake are shown. A yellow flame is shown to be both cool and sooty. For the properly adjusted blue flame, the temperature variation in different regions of the visible flame is illustrated with scorch patterns; the highest temperature available is indicated by melting a piece of aluminum wire and forming a bead at the end of a copper wire. Additional scenes in the film show a fishtail for bending glass, a pinch clamp for controlling the gas flow rate in a burner without a needle valve, and the strike-back which occurs when the flow rate is too low. The correct operation of other common laboratory burners is also shown.

EAL, cat. no. 84-0025/1, $21.50

GLASS TUBING
Collaborator: Robert Disraeli Films
(9 min., 16mm, B/W, color, sound)

Shows how to cut and break glass tubing correctly using the triangular file; "fire polishing"; making a pipette and its uses. Details the use of the fishtail to make right angle glass tubing. Presents a bench with glass tubing apparatus.

AIM, cat. no. DC-103, B/W, $50.; color, $100.

HANDLING GASES
Collaborator: Yale Chem. Films
(3 min., 16mm, color, sound)

Shows the techniques of handling gases in high-pressure commercial cylinders and small lecture cylinders stressing precautions throughout. Correct use of oxygen with a blast burner is also shown.

AIM, cat. no. YF-206, $28.50

2001

HANDLING LIQUIDS
Collaborator: Yale Chem. Films
(4 min., 16mm, color, sound)

Demonstrates pouring techniques and uses and misuses of the eye-dropper and stirring rod. The film also emphasizes correct identification of chemicals and shows simple tests for several of the dangerous acids.

AIM, cat. no. YF-205, $38.

HANDLING SOLIDS
Collaborator: Yale Chem. Films
(3 min., 16mm, color, sound)

Demonstrates opening and pouring from bottles, using spatulas, and weighing granular material. It also stresses reading labels carefully, protecting stock containers against contamination, and safe disposal of waste materials.

AIM, cat. no. YF-204, $28.50

HANDLING SOLIDS AND LIQUIDS
Collaborator: R. N. Whitney, Roxbury Latin School
(3:40, S-8, color, silent) 1967

This film presents both correct and incorrect techniques for handling solid and liquid chemicals in the laboratory. In the section on solids, three techniques are shown: 1) pouring from the bottle with the flow controlled by careful rotation of the bottle; 2) using a hollow stopper to obtain and dispense small quantities, and 3) obtaining very small quantities with a spatula. In the section on liquids, methods are shown for obtaining liquids from a stoppered bottle and a bottle with a dropper. Liquid in the stoppered bottle is poured into a small graduate, using a glass rod to guide the liquid. When the rod is omitted, the liquid spills onto the table. An additional "wrong" technique illustrates the hazard of laying down bottle stoppers. When the stoppers for two reagents are crossed, a precipitate can be seen forming in the necks of the bottles. Finally, a dropper is used to remove a small quantity of liquid from a bottle. When the dropper is incorrectly inserted below the liquid level in the beaker, the resulting contamination is illustrated by the formation of a precipitate inside the dropper.

EAL, cat. no. 84-0017/1, $21.50

HEATING LIQUIDS
Collaborator: R. M. Whitney, Roxbury Latin School
(3:05, S-8, color, silent) 1967

Four techniques utilized in the heating of liquids are demonstrated: 1) heating a liquid in a test tube, 2) the use of a boiling chip, 3) evaporating a liquid, and 4) refluxing. In heating a liquid in a test tube, the correct method of applying heat near the surface of the liquid coupled with gentle agitation is shown. This is followed by a demonstration of the sudden boil over that results when the bottom of the tube is heated without agitation. The next sequence shows the use of a boiling chip to promote smooth boiling. The third part of the film presents the correct and incorrect methods of evaporating a solution to obtain a residue. In the correct, two-step procedure, the evaporating dish is transferred to a steam bath after the solution has become fairly concentrated. The advisability for this step is emphasized by showing the spattering which occurs when direct heat is used throughout the process. Finally, refluxing is presented as a method for heating a liquid without loss through evaporation. The construction of the refluxing column is shown, the water jacket is filled, and the system is examined in operation.

EAL, cat. no. 84-0041/1, $21.50

HEATING SOLIDS
Collaborator: R. M. Whitney, Roxburg Latin School
(3:55, 16mm, color, sound) 1967

In this film, which presents four different techniques associated with heating solids, emphasis is placed on selecting apparatus appropriate to the temperature to be encountered. The techniques shown are: 1) drying a filtered precipitate, 2) evaporating the water of crystallization, 3) collecting a gaseous product, and 4) obtaining a filtered precipitate by ignition. In the first section, a steam bath is used for heating a solid at a temperature which does not exceed 100°C. A filter paper containing a precipitate is removed from a funnel and placed on a watch glass. The watch glass, in turn, is placed over the steam bath for controlled, low temperature drying. When the temperature must be somewhat higher, as in dehydration, a porcelain evaporating dish is recommended for its good thermal properties and large open surface area. When the gaseous product must be collected, however, an ignition tube is selected. The potential danger of cracking the tube because of suck-back is illustrated by removing the burner before the apparatus is disassembled. For extremely high temperatures, as in the case of obtaining a filtered precipitate by ignition, a platinum crucible is used. The quantitative filter paper and its precipitate are folded up and placed in the crucible. The crucible is then heated until the paper has been entirely burned away, leaving only the precipitate.

EAL, cat. no. 84-0033/1, $21.50

HOW TO MAKE A WASHBOTTLE
Collaborator: Yale Chem. Films
(10 min., 16mm, B/W, sound)

Using the construction of a wash bottle as an example, the film demonstrates glassworking techniques required in making basic laboratory apparatus. A light and humorous approach is used to generate student interest.

AIM, cat. no. YF-211, $50.

2001

INTRODUCTION THE CHEMISTRY LABORATORY
Collaborator: Robert Disraeli Films
(7 min., 16mm, B/W, color, sound)

Introduces the laboratory bench and an outline of techniques; adjusting the flame of a bunsen burner; correct pouring from a reagent bottle; cutting glass tubing; using a blowpipe; preparing filter paper, etc. Emphasis is on neatness in laboratory work.

AIM, cat. no. DC-101, B/W, $40.; color, $80.

LABORATORY BURNERS
Collaborator: Yale Chem. Films
(9 min., 16mm, color, sound)

Demonstrates the use of various burners and accessories, including the Bunsen, Fisher, micro- and blast burners, gas lighter and fishtail or flame spreader, and indicates the different kinds of flames suited for specific laboratory tasks.

AIM, cat. no. YF-207, $85.50

PRECIPITIN ANALYSES - QUANTITATION BY TURBIDIMETRY
(14 min., 16mm, color, sound) 1959

Presents a research and development study on precipitin reactions in antigen bodies. Three approaches are used in making these tests: a) Measurement of turbidities using test tubes containing antigen with serum added, b) Photoelectric quantitation based on light scattering, c) Serum agar column quantitation.

DUART, cat. no. FR83, free loan

THE REAGENT BOTTLE
Collaborator: Robert Disraeli Films
(5 min., 16mm, B/W, color, sound)

Emphasizes the importance of reading the name and chemical symbols on bottles. Shows correct techniques to hold stopper and angle for flow control from bottle; how to avoid contamination of solutions in reagent. Shows errors to avoid.

AIM, cat. no. DC-105, B/W, $30.; color, $60.

SOLIDS
Collaborator: Robert Disraeli Films
(5 min., 16mm, B/W, color, sound)

Procedures in crushing solids with pestle and mortar. Correct method of pouring solids into a test tube. Shows method of blending two solids. Depicts errors to avoid.

AIM, cat. no. DC-106, B/W, $30.; color, $60.

THE TEST TUBE
Collaborator: Robert Disraeli Films
(7 min., 16mm, B/W, color, sound)

Shows a hard and a soft glass test tube and their correct usage; procedure for flow control from a beaker or a reagent bottle into a test tube. Correct heating of test tubes with a bunsen burner. Shows errors to avoid.

AIM, cat. no. DC-104, B/W, $40.; color, $80.

USING THE LABORATORY (CHEMISTRY AND PHYSICS)
(11 min., 16mm, B/W, color, sound)

Scientific techniques and attitudes, as well as safety practices, are developed in this film, as a student investigates and solves a problem. In performing a gas generating experiment, he puts together and demonstrates the use of common laboratory equipment.

CORF, B/W, $60.; color, $120.

VAPORS
Collaborator: Robert Disraeli Films
(3 min., 16mm, B/W, color, sound)

Shows the need for smelling acids, gases, fuming and boiling substances by waving vapors toward the nose.

AIM, cat. no. DC-109, B/W, $18.; color, $36.

WORKING GLASS
Collaborator: R. M. Whitney, Roxbury Latin School
(3:55, S-8, color, silent) 1967

This film is divided into three sections: 1) making a washbottle, 2) incorrect glass working techniques, and 3) salvaging broken tubing. In the making of a standard laboratory washbottle, a number of elementary glass working techniques are demonstrated. Glass tubing is measured, scratched with a file, snapped in two and fire polished. One piece of tubing is bent into an acute angle, a second into an obtuse angle, and a third is drawn to form a capillary which, when broken off and fire polished, serves as a nozzle. The next sequence shows the consequences of several common mistakes made in the laboratory when working with glass. The student is asked to identify the source of trouble in each instance. The final sequence shows the salvaging of a broken piece of tubing - in this case a burette. After the jagged edges have been stroked with wire mesh, the tubing is shown ready for fire polishing.

EAL, cat. no. 84-0108/1, $21.50

2002

CHEMICAL BOOBY TRAPS
(10 min., 16mm, color, sound)

Some potential dangers in laboratory work are

2002

depicted in this film, designed for training of new employees or students, or to remind experienced lab workers of hazards in everyday tasks. Safety procedures in handling and storing chemicals, danger of mixing chemicals which are harmless by themselves, and handling of laboratory equipment are among the subjects covered. Excellent for lab safety programs.

GE, $120.

FIRE SAFETY IN THE LABORATORY
Collaborator: Yale Chem. Films
(2 min., 16mm, B/W, sound)

A humorous approach is used in this safety film to capture the student's interest. Shows how to use a fire extinguisher, fire shower, fire blanket, and technique for washing eyes.

AIM, cat. no. YF-212, $7.

THE FIRST FEW SECONDS
Collaborator: Pyrene Co. Ltd.
(35 min., 16mm, color, sound) 1958

A demonstration of the various types of modern chemical fire extinguishers and the most effective methods of using them.

See RIC, p. 77

HANDLE WITH CARE: SAFE HANDLING OF RADIOISOTOPES
(21:36, 16mm, B/W, sound) 1963

The story of a radioactive contamination accident, to illustrate the need for the most meticulous observance of safe handling procedures in every detail. A situation is presented in which a man carries contamination out of the lab in which he is working even though he followed routine precautions. The film then shows the methods by which the contamination is traced to its source.

STER: AEC, free loan

SAFETY IN THE CHEMICAL LABORATORY
(20 min., 16mm, color, sound) 1963

Laboratory safety precautions; presenting step-by-step safety procedures in a typical laboratory experiment.

MCA, $100.

SAFETY IN THE LABORATORY
Collaborator: Robert Disraeli Films
(8 min., 16mm, B/W, color, sound)

Shows a neat and a cluttered laboratory bench. Reviews techniques: pouring solids into a test tube; pouring an acid; heating liquids in a test tube and a beaker; cutting glass tubing; smelling vapors, etc. Safety and correct techniques emphasized.

AIM, cat. no. DC-111, B/W, $45.; color, $90.

2003

AIR DAMPED ANALYTICAL BALANCE
Collaborator: Yale Chem. Films
(6 min., 16mm, color, sound)

Discusses the advantages of the balance, explains how to read the vernier scale, and shows step-by-step how to weigh a sample.

AIM, cat. no. YF-208, $57.

ANALYTICAL BALANCE-TARE WEIGHT DETERMINATION
Collaborator: Carl Clader, New Trier Township High School, Winnetka, Illinois and L. Carroll King, Northwestern University
(3 min., 8, S-8, color, silent) 1966

Points out the correct technique of weighing with the analytical balance. Close-up photography demonstrates the actual process of weighing to obtain the tare weight of a container, accurate to the nearest 1/1000th of a gram.

EBF, cat. no. R80453, 8, $16.; S80453, S-8, $17.60

ANALYTICAL BALANCE-WEIGHING SAMPLE AND CONTAINER
Collaborator: Carl Clader, New Trier Township High School, Winnetka, Illinois and L. Carroll King, Northwestern University
(3 min., 8, S-8, color, silent) 1966

Illustrates the technique of weighing a sample and container on the analytical balance. Concludes with the correct determination of final weight and the return of the weights to the weight case.

EBF, cat. no. R80454, 8, $16.; S80454, S-8, $17.60

THE BALANCE AND ITS USE
Collaborator: Imperial Chemical Industries
(18 min., 16mm, color, sound) 1960

The development and manufacture of the modern precision balance; calibration of weights; procedures for weighing a liquid and a powder; modern industrial balances.

See RIC, p. 13

FUNDAMENTAL TECHNIQUES OF CHEMISTRY· APPROXIMATE WEIGHING: TRIPLE-BEAM AND TOP-LOADING SUBSTITUTION BALANCES
Collaborator. Rod O'Connor, University of Arizona
(4 min., S-8, color, silent) 1968

Demonstrates weighing a predetermined amount of solid on a triple-beam balance and weighing an object on a top-loading substitution balance.

HR, $25.

2003

FUNDAMENTAL TECHNIQUES OF CHEMISTRY: PRECISION WEIGHING: THE SUBSTITUTION BALANCE
Collaborator: Rod O'Connor, University of Arizona
(4 min., S-8, color, silent) 1968

Shows procedures for precision weighing on a single-pan analytical balance.

HR, $25.

METTLER BALANCE
(4 min., 8, color, silent)

Instructions for operating the top loading Mettler Balance.

LBF, cat. no. 7, $15.

THE SARTORIUS BALANCE 2400
(4 min., 8, color, silent)

Instructions for operating the automatic analytical balance.

LBF, cat. no. 8, $15.

SETTING UP THE BALANCE
(2:08, 8, color, silent) 1965
(1:40, 8, S-8, color, silent) 1968

The adjustments necessary to prepare a balance for use are shown one by one in big close-ups. The aim is to assist the teacher in explaining detail that may not, on an actual balance, be visible to the whole class.

GAEF, cat. no. PM/461, $6.60
ICF, cat. no. 12510, 8, $12.; 12515, S-8, $15.

SINGLE PAN ANALYTICAL BALANCE
Collaborator: Yale Chem. Films
(6 min., 16mm, color, sound)

Using an Ainsworth model as an example, this film discusses the advantages of the single-pan balance and demonstrates the steps in weighing a sample.

AIM, cat. no. YF-209, $57.

TECHNIQUES OF OPERATING SINGLE PAN BALANCES
Collaborator: Yale Chem. Films
(20 min., 16mm, color, sound)

A demonstration of weighing by substitution on a simplified model provides a basic understanding of what happens within the balance at each step in the weighing operation, thus making it easy for the student to remember the fine points of technique needed to obtain precise measurements and to protect the knife edges from heedless damage. Weighing by difference, weighing out a desired quantity, taring, etc. are covered.

AIM, cat. no. YF-210, $190.

THE USE AND CARE OF THE ANALYTICAL BALANCE
Collaborator: T. D. Luckey, University of Missouri
(24 min., 16mm, B/W, color, sound)

This film provides an understanding of the proper use of the analytical balance and begins by showing the many places balances are used in everyday life. The film graphically illustrates that similar principles of operation are used in a variety of balances; acquaints the student with a brief history of the development of the balance; shows the parts of the balance and explains the function of each; and demonstrates the correct use of the balance through a complete weighing.

MGHT, cat. no. 698400, B/W, $100.; 698601, color, $195.

USING THE BALANCE
(3:38, 8, color, silent) 1965
(3:20, 8, S-8, color, silent) 1968

The complete sequence of weighing an object is shown, stage by stage, in big close-ups. The aim is to assist the teacher in illustrating detail that may not, in an actual weighing operation, be visible to the whole class.

GAEF, cat. no. PM/462, $8.28
ICF, cat. no. 12520, 8, $16.; 12525, S-8, $19.50

WEIGHING WITH THE ANALYTICAL BALANCE
(15 min., 16mm, B/W, sound)

Weighing with the Analytical Balance is a remarkably clear and easy-to-follow presentation of weighing techniques. The learner sees the balance from the operator's viewpoint. Close-up photographs are combined with narration emphasis to explain more difficult concepts. The result is quick, efficient learning of elementary weighing techniques for the student.

MINNU, $65.

WEIGHING PROCEDURE
Collaborator: Carl Clader, New Trier Township High School, Winnetka, Illinois and L. Carroll King, Northwestern University
(3½ min., 8, S-8, color, silent) 1966

Illustrates three types of balances used in the chemical laboratory: the platform balance, triple beam (centigram) balance, and the analytical balance. Defines a correct procedure for weighing, using a triple beam balance accurate to 1/1000th of a gram.

EBF, cat. no. R80451, 8, $16.; S80451, S-8, $17.60

2003

WEIGHING TECHNIQUES (2 Parts)
Collaborator: BSCS
(3-4 min., 8, S-8, color, silent) 1967

Techniques and principles of handling basic laboratory equipment used in weighing.

EAL, cat. no. 81-002; 81-003; $15.50

WEIGHING TECHNIQUES
(8 min., 16mm, color, sound) 1964

Techniques and principles of handling basic laboratory equipment used in weighing, starting with hand scale as the simplest type of balance, and progressing through the double pan single beam (Harvard trip) balance and triple beam balance, to the analytical balance.

MSC, cat. no. 65034, $96.

WEIGHING TECHNIQUES I
Collaborator: BSCS
(3:30, 8, S-8, color, silent)

Techniques and basic principles of handling laboratory equipment used in weighing, including the hand scale and double-pan, single beam balance.

THORNE, cat. no. 32-1, $18.50

WEIGHING TECHNIQUES II
Collaborator: BSCS
(4:45, 8, S-8, color, silent)

Techniques used in weighing materials with a triple-beam balance.

THORNE, cat. no. 32-2, $18.50

WEIGHING - TRIPLE BEAM BALANCE
(3½ min., 8, S-8, color, silent) 1966

Demonstrates the proper procedure for handling and weighing with the triple beam balance. Shows the actual weighing of a sample obtaining a weight, accurate to the nearest 1/1000th of a gram.

EBF, cat. no. R80452,8, $16.; S80452, S-8, $17.60

WEIGHING WITH TRIPLE BEAM BALANCE
Collaborator: R. M. Whitney, Roxbury Latin School
(4:05, S-8, color, silent) 1967

This film explains leveling, adjusting, and operating a triple beam balance and illustrates its use in determining the weight of an unknown quantity of liquid. In the opening scene, the three beams and riders are shown and the arrest/release mechanism demonstrated. The balance is then leveled and the zero adjustment made. The remainder of the film is devoted to showing that the weight of a quantity of an unknown liquid can be determined by subtracting the weight of an empty beaker from the weight of the same beaker and its contents. Once again, the observation of equal swings is utilized to determine when the mechanism is in balance.

EAL, cat. no. 84-0066/1, $21.50

WEIGHING WITH TWO PAN BALANCE
Collaborator: R. M. Whitney, Roxbury Latin School
(4 min., S-8, color, silent) 1967

This film explains the adjustment and operation of a two pan balance and demonstrates its use in obtaining a required quantity by weight of a solid. The first section examines the parallelogram construction and knife edges of the balance. The next section begins with the use of fixed weights and the gram rider to exert the required force on the right hand side of the balance. The film demonstrates the correct procedure for pouring out some of the solid onto a piece of filter paper on the left-hand balance pan. The succeeding scenes show the use of the unequal swings of the pointer in determining when slightly too much or slightly too little chemical has been placed on the pan and how equal swings of the balance indicate that the correct amount has been dispensed. Finally, the weights are removed with the gram rider left in position so that the mechanism remains off balance to preserve the knife edge.

EAL, cat. no. 84-0058/1, $21.50

2004

DECANTING AND WASHING A RESIDUE
Collaborator: Carl Clader, New Trier Township High School, Winnetka, Illinois and L. Carroll King, Northwestern University
(3 min., 8, S-8, color, silent) 1966

Shows the procedure for decanting a liquid, separating the liquid from a solid. The use of a wash bottle in purifying the residue is included in the technique.

EBF, cat. no. R80457, 8, $16.; S80457, S-8, $17.60

FUNDAMENTAL TECHNIQUES OF CHEMISTRY: GRAVIMETRIC TECHNIQUES
Collaborator: Rod O'Connor, University of Arizona
(4 min., S-8, color, silent) 1968

Shows procedures for precipitation, digestion, filtration, and ignition.

HR, $25.

2004

QUANTITATIVE TRANSFER
Collaborator: Yale Chem. Films
(17 min., 16mm, color, sound)

Demonstrates a basic analytical determination: preparing a precipitate, using a filter, igniting the precipitate, and weighing. The proper laboratory techniques are clearly pinpointed.

AIM, cat. no. YF-203, $161.50

2005

FILTERING
Collaborator: Carl Clader, New Trier Township High School, Winnetka, Illinois and L. Carroll King, Northwestern University
(3 min., 8, S-8, color, silent) 1966

The technique of preparing and using a filter, including the actual process of separating a solid residue from a liquid, is demonstrated.

EBF, cat. no. R80455, 8, $16.; S80455, S-8, $17.60

FILTRATION
Collaborator: Robert Disraeli Films
(7 min., 16mm, B/W, color, sound)

Correct preparation of filter paper for a funnel: adjusting bracket and beaker. How to pour mixture onto filter paper. How to remove clear filtered solution. Shows errors to avoid.

AIM, cat. no. DC-107, B/W, $40.; color, $80.

FILTRATION
Collaborator: R. M. Whitney, Roxbury Latin School
(4:05, S-8, color, silent) 1967

A precipitate resulting from a chemical reaction is allowed to settle while the simple method for folding a piece of filter paper is demonstrated. After the filter paper has been placed in a rack mounted funnel, the paper is wet thoroughly with a wash bottle, the bubbles of air are removed, and the full funnel stem is placed against the inside wall of a beaker. The reason for allowing the precipitate to settle becomes apparent as the clear liquid is decanted and flows readily through the filter. The precipitate is then transferred to the filter and washed with distilled water. At the end of filtration, the filter paper and its residue are placed on a watch glass which is transferred to a steam bath for drying. The film concludes with an alternate method of folding a filter paper as a fluted cone.

EAL, cat. no. 84-0074/1, $21.50

USING A FILTER
Collaborator: Yale Chem. Films
(2 min., 16mm, color, sound)

How to fold a filter paper, seat it in a funnel, seal it in place with water, and check on the efficiency of its operation.

AIM, cat. no. YF-202, $19.

2006

THE CARE OF LABORATORY GLASSWARE
Collaborator: James A. Jobling & Co. Ltd.
(7 min., 16mm, B/W, sound) 1951

Precautions in use and methods of ensuring thorough cleanliness of laboratory glassware.

See RIC, p. 13

FUNDAMENTAL TECHNIQUES OF CHEMISTRY: VOLUMETRIC TECHNIQUES
Collaborator: Rod O'Connor, University of Arizona
(4 min., S-8, color, silent) 1968

Demonstrates cleaning of volumetric glassware and procedure for quantitative dilution.

HR, $25.

MEASURING TECHNIQUES I
(4:20, 8, S-8, color, silent)

Shows techniques and principles of handling laboratory equipment, including the ocular and stage micrometers, hemacytometer, and volumetric flask.

THORNE, cat. no. 33-1, $18.50

MEASURING TECHNIQUES II
(5 min., 8, S-8, color, silent)

Demonstrates the use of buret and pipet in measuring volumes.

THORNE, cat. no. 33-2, $18.50

PRECISION IN VOLUME MEASUREMENT
(4 min., 8, color, silent)

The dependence of sensitivity, a factor in precision volume measurement, upon the cross-sectional area of the measuring vessel at the liquid level, is demonstrated.

UNESCO, cat. no. 1, $6.

2006

USE OF PIPETTE
Collaborator: R. M. Whitney, Roxbury Latin School
(3:55, S-8, color, silent) 1967

This film demonstrates the use of three types of pipettes: 1) transfer, 2) measuring, and 3) bulb. A 5 ml transfer pipette is used in conjunction with a 500 ml volumetric flask to produce a 0.01 M solution of a chemical by diluting a 1 M source. The correct technique for drawing the liquid into the pipette, allowing it to fall back to the calibration mark, transferring the pipette to the flask, and discharging the contents completely into the flask are shown. The flask is then filled nearly to its calibration mark with distilled water from a wash bottle and the operation completed using a squeeze bottle. The contents are then mixed thoroughly. The measuring pipette is used to dispense 4 ml of a liquid into one test tube and 6 ml into another. The bulb pipette is used to extract a known volume of a radioactive liquid from a bottle and transfer it to a flask.

EAL, cat. no. 84-0090/1, $21.50

USING A PIPETTE
Collaborator: Yale Chem. Films
(4 min., 16mm, color, sound) 1966

Emphasizes the proper cleaning of the glassware and correct technique for delivering reproducible samples while demonstrating how to calibrate a pipette.

AIM, cat. no. YF-201, $38.

VOLUMETRIC GLASSWARE
Collaborator: University of Leeds
(20 min., 16mm, B/W, sound) 1961

The cleaning, calibration and use of the graduated flask, burette and pipette.

See RIC, p. 15

2007

FUNDAMENTAL TECHNIQUES OF CHEMISTRY: TITRATION
Collaborator: Rod O'Connor, University of Arizona
(4 min., S-8, color, silent) 1968

Demonstrates simple titration using an indicator solution.

HR, $25.

TITRATING WITH PHENOLPHTHALEIN
Collaborator: Carl Clader, New Trier Township High School, Winnetka, Illinois and L. Carroll King, Northwestern University
(3 min., 8, S-8, color, silent) 1966

Illustrates and defines the range of phenolphthalein as an indicator. Demonstrates the correct technique of titrating and reaching an end point using phenolphthalein.

EBF, cat. no. R80458, 8, $16.; S80458, S-8, $17.60

TITRATION
(4 min., 8, color, silent)

Introduction to the techniques of acid-basic titration involving the buret with glass stopcock, pipet bulb, indicators. Sample calculations.

LBF, cat. no. 1, $15.

USE OF BURETTE: TITRATION
Collaborator: R. M. Whitney, Roxbury Latin School
(4 min., S-8, color, silent) 1967

This film demonstrates the use of a pair of burettes and an acid base indicator in determining the concentration of an acid by titrating with a base of known concentration. After the stopcock of the left burette has been greased and replaced in closed position the burette is filled with the acid, HCl. The burette tip is cleared of air, and the initial reading of the meniscus is noted. Then an arbitrary quantity of the acid is drawn off into a clean flask, and the final reading of the meniscus noted. An indicator, phenolphthalein solution, is added to the flask before it is transferred to the second burette. The initial reading of the base to be used, NaOH, is read, and a carefully controlled flow of the base is allowed to enter the flask. When the "pink clouds" begin to appear, a titration procedure is followed until the pink color generated by a single drop of the base can no longer be dissipated by swirling the flask. The final meniscus reading of the base is noted. Knowing the concentration of the NaOH used, the student can calculate the concentration of the HCl.

EAL, cat. no. 84-0082/1, $21.50

USING A BURETTE
Collaborator: Carl Clader, New Trier Township High School, Winnetka, Illinois and L. Carroll King, Northwestern University
(3 min., 8, S-8, color, silent) 1966

Demonstrates the correct handling and use of a burette in measuring liquid volume. Graphically illustrates the correct method of reading a burette.

EBF, cat. no. R80456, 8, $16.; S80456, S-8, $17.60

2008

DISTILLATION
Collaborator: Imperial Chemical Industries
(32 min., 16mm, color, sound) 1959

The principles of distillation; the separation of solutions and liquid mixtures by laboratory and industrial methods.

See RIC, p. 14

FUNDAMENTAL TECHNIQUES OF CHEMISTRY: DISTILLATION
Collaborator: Rod O'Connor, University of Arizona
(4 min., S-8, color, silent) 1968

Assembly and use of a simple ground-glass distillation set-up is demonstrated.

HR, $25.

2009

CHROMATOGRAPHY CHLOROPHYLL
Collaborator: L. Riddiford, Harvard University
(4 min., 8, color, silent) 1966

The successful extraction and separation of chlorophyll pigments requires careful attention to technique. This film is designed to show a simple, but effective, technique for the extraction and separation of chlorophyll pigments. Chlorophyll is extracted from spinach leaves with acetone using a Waring blender. This material is filtered through cheesecloth to remove particulates. The filtrate is poured into a separatory funnel and more acetone is added. Calcium chloride is added to dry the filtrate. The bottom layer is drawn off and the supernatant chlorophyll extract is ready for chromatographic separation. A dark line is spotted on the chromatography paper by repeated applications of the extract. The paper is placed in a mason jar, the chromatography chamber, to which a petroleum ether - acetone solvent - has been added. Time-lapse is used to show the separation of the individual pigments. The pigments chlorophyll b, chlorophyll a, xanthophyll, and the carotenoids are high-lighted. An unknown is then subject to a similar separation and compared with the known. The data for the computation of individual Rf values are provided. The film notes provide an explanation of the principles of chromatography.

EAL, cat. no. 81-5894/1, $21.50

FUNDAMENTAL TECHNIQUES OF CHEMISTRY: LIQUID-LIQUID EXTRACTION
Collaborator: Rod O'Connor, University of Arizona
(4 min., S-8, color, silent) 1968

Simple liquid-liquid extraction is used to separate an organic compound from a crude mixture.

HR, $25.

2009/2010

TECHNIQUES OF ORGANIC CHEMISTRY - Part 3
Collaborator: Louis Fieser, Harvard University
(12 min., 16mm, B/W, color, sound)

Deals with extraction, countercurrent distribution, and elution chromatography.

MGHT, cat. no. 402503, B/W, $65.; 402508, color, $130.

2010

CHROMATOGRAPHY TECHNIQUES: Amino Acids
Collaborator: L. Riddiford, Harvard University
(3:40, S-8, color, silent)

Chromatography is a means of separating compounds of mixtures which are only slightly different molecularly. This film demonstrates the techniques necessary to compare the rate of solubility of various known amino acids with an "unknown". First, the different amino acids are spot-applied to a sheet of filter paper, the paper rolled, and the edge dipped in a solvent of propanal, water, and formic acid. After the solvent has affected each amino acid spot and has moved near the top of the paper, the paper is dried. After a spray application of ninhydrin has caused the amino acid spot to be visible, a comparison can be made.

EAL, cat. no. 81-6025/1, $22.95

FUNDAMENTAL TECHNIQUES OF CHEMISTRY: ANALYTICAL CHROMATOGRAPHY
Collaborator: Rod O'Connor, University of Arizona
(4 min., S-8, color, silent) 1968

Uses "instant" thin-layer chromatography sheet to illustrate spotting, development, detection, and determination of R_f.

HR, $25.

IDENTIFYING LIQUIDS BY CHROMATOGRAPHY
Collaborator: Don Herbert, Prism Productions and M. H. Shamos, New York University
(4 min., S-8, color, silent)

By means of time-lapse photography, paper chromatography is demonstrated at 30 times the normal rate. Samples of a mixture of red and blue food color, black ink, and two unknown liquids labeled A and B, are dropped on four long strips of filter paper. The strips of paper are then hung in a tank containing alcohol water solvent. The time-lapse camera reduces the 30 minutes required for the development of the chromatograms into a few short seconds of viewing time. Since a chromatograph separation does not by itself identify an unknown mixture, the student is asked to identify the unknown chromatograms by comparing them to the knowns.

EAL, cat. no. 80-3338/1, $22.95

2010

PAPER CHROMATOGRAPHY
(4:18, 8, color, silent) 1961
(3:30, 8, S-8, color, silent)

The film demonstrates the complete sequence using first, typical ascending paper chromatography set-up and then a descending set-up. The apparatus used is the Unikit. Time-lapse photography is employed to condense a four hour operation into 15 seconds.

GAEF, cat. no. CP/435, $8.28
ICF, cat. no. 12560, 8, $16.; 12565, S-8, $19.50

PAPER CHROMATOGRAPHY
Collaborator: BSCS
(14 min., 16mm, color, sound) 1967

Basic principles and techniques for analyzing dissolved mixtures using paper-chromatographic separations. Starting with crude methods and materials (paper napkins, ink, water), refinements are introduced which increase the accuracy, reliability, and versatility of the procedure. The separation of chlorophyll extract and the separation and comparison of known to unknown amino acids are also illustrated.

THORNE, $150.

PAPER CHROMATOGRAPHY I
Collaborator: BSCS
(5 min., S-8, color, silent)

Illustrates basic principles and techniques for analyzing dissolved mixtures of substances by means of paper chromatographic separations.

THORNE, cat. no. 27-1, $18.50

PAPER CHROMATOGRAPHY II
Collaborator: BSCS
(3:45, S-8, color, silent)

Demonstrates the effects of varying the solvent mixture when making a chromatographic separation. Chlorophyll extract is used as an example.

THORNE, cat. no. 27-2, $18.50

PAPER CHROMATOGRAPHY III
Collaborator: BSCS
(4:45, S-8, color, silent)

Shows the chromatographic separation of three amino acids and their comparison with an "unknown" mixture.

THORNE, cat. no. 27-3, $18.50

PAPER CHROMATOGRAPHY WITH THE UNIKIT
Collaborator: Shandon Scientific Co. Ltd.
(2-5 min., 8, color, silent) 1965

See RIC, p. 226

THIN LAYER CHROMATOGRAPHY
(4:20, 8, color, silent) 1965

The complete sequence of the thin layer chromatography process is shown using the Unikit No. 2 equipment.

GAEF, cat. no. CP/437, $8.28

2011

FUNDAMENTAL TECHNIQUES OF CHEMISTRY: PURIFICATION OF SOLIDS BY RECRYSTALLIZATION
Collaborator: Rod O'Connor, University of Arizona
(4 min., S-8, color, silent) 1968

Illustrates purification by recrystallization, including gravity and vacuum filtration.

HR, $25.

TECHNIQUES OF ORGANIC CHEMISTRY Part 2
Collaborator: Louis Fieser, Harvard University
(20 min., 16mm, B/W, color, sound)

Deals with equipment, solubility tests, procedure for crystallization, clarification, cholesterol from gall stones, collection of precipitate, and supersaturation.

MGHT, cat. no. 402502, B/W, $125.; 402507, color, $250.

2012

COLORIMETRY Part I
(4 min., 8, color, silent)

Theory with Beer's law and Spectronic 20 colorimeter.

LBF, cat. no. 17, $15.

COLORIMETRY Part II
(4 min., 8, color, silent)

Directions for colorimetry and spectrophotometry with Spectronic 20. Suggested exercise.

LBF, cat. no. 18, $15.

FUNDAMENTAL TECHNIQUES OF CHEMISTRY: INFRARED SPECTROSCOPY
Collaborator: Rod O'Connor, University of Arizona
(4 min., S-8, color, silent) 1968

Shows use of simple student infrared spectrophotometer, including filling a liquid sample cell.

HR, $25.

2013

BACTERIOLOGICAL TECHNIQUES
Collaborator: BSCS
(5 min., 16mm, color, sound)

Illustrates making cotton plugs, flaming wire loop, transferring culture from tube to tube, and tube to flask, pipeting, preparing agar plates, spotting, streaking, picking up cover slip by hanging drop, and forming a micro-culture chamber.

THORNE, $65.

BACTERIOLOGICAL TECHNIQUES I
Collaborator: BSCS
(4:30, 8, S-8, color, silent)

Illustrates making cotton plus, flaming, transferring cultures from tube to tube and tube to flask, and pipetting.

THORNE, cat. no. 05-1, $18.50

BACTERIOLOGICAL TECHNIQUES II
Collaborator: BSCS
(3:15, 8, S-8, color, silent)

Demonstrates the preparation of agar plates, spotting, streaking, picking up cover slip by hanging drop, and forming a micro-culture chamber.

THORNE, cat. no. 05-2, $18.50

BACTERIOLOGICAL TECHNIQUES: INOCULATING
Collaborator: S. L. Weinberg, DeWitt Clinton High School, New York
(3:34, S-8, color, silent) 1967

The method for isolating single colonies on a Petri dish using clock-rotation technique is also presented. In each transfer the flaming of both the culture tube and the inoculation loop or needle is stressed as a safety precaution. The loop ends by showing in close-up each type of medium before and after growth. The student therefore sees exactly what each medium is used for.

EAL, cat. no. 81-0846/1, $21.50

BACTERIOLOGICAL TECHNIQUES: PREPARING AND DISPENSING
Collaborator: S. L. Weinberg, DeWitt Clinton High School, New York
(3:25, S-8, color, silent) 1967

The purpose of this film is to demonstrate how to make the most common bacteriological media and dispense them into various culturing containers. It shows first how to prepare broth and nutrient agar media from commercial stock-preparations, how to cook the media and dispense them cleanly and in the right amounts into test tubes and Petri dishes. The student prepares test tubes with broth, as well as with agar for stab and slant cultures. He also makes agar plates and sees how to insert a fermentation tube into a sugar medium for the identification of gas producers. The appropriate sterile technique is stressed at each stage.

EAL, cat. no. 0838/1, $21.50

BACTERIOLOGICAL TECHNIQUES: SERIAL DILUTION AND POUR PLATE
Collaborator: S. L. Weinberg, DeWitt Clinton High School, New York
(3:53, S-8, color, silent) 1967

Using a broth culture marked with a harmless dye (so that the results of serial dilution can be followed visually), the proper serial dilutions are carried out in five steps: undiluted, 9:1, 99:1, 999:1, control. Next, sterile, cool, but still liquid culture medium is dispensed into Petri dishes together with aliquots of the diluted broth culture, and the two are properly mixed. The film shows the plates after incubation and how to count colonies by using a simple ruled grid and a desk-lamp.

EAL, cat. no. 81-0853/1, $21.50

BACTERIOLOGICAL TECHNIQUES: STAINING
Collaborator: S. L. Weinberg, DeWitt Clinton High School, New York
(3:20, S-8, color, silent) 1967

This film examines two separate staining procedures. For gram-staining a small amount of broth culture is smeared onto a slide. The bacteria are heat-fixed over an alcohol flame. The slide is placed on a staining rack, and crystal violet is applied. The stain is rinsed off and replaced by iodine solution. Then the slide is carefully washed, until no more stain comes off. After drying, the slide is examined through the microscope and reveals a mixture of gram positive and gram negative microorganisms. Secondly, the technique for acid-fast bacteria is shown. Special attention is paid to applying heat correctly so that the slide steams but does not boil. After counter-staining, the slide is again examined under the microscope.

EAL, cat. no. 81-0861/1, $21.50

THE BLOWPIPE
Collaborator: Robert Disraeli Films
(6 min., 16mm, B/W, color, sound)

Preparing charcoal block for reduction; placing compound in cavity and clamping block to the stand. Explains the parts of a blowpipe. Adjusting Bunsen burner for non-luminous flame to sterilize mouthpiece, then to reduction flame. Shows process of blowpipe reduction of metallic compound.

AIM, cat. no. DC-110, B/W, $35.; color, $70.

2013

ELECTRON MICROSCOPY: The Microscope
Collaborator: Iowa State University
(3:40, S-8, color, silent)

This film shows the precision steps necessary for the actual use of the electron microscope and the specimen mount. It illustrates the pick up of the sectioned material on a coated or uncoated grid, the mounting of the grid in the specimen holder, and the insertion of the holder in an evacuated microscope column. The film also demonstrates the steps taken to insure a clear, visible image.

EAL, cat. no. 81-6702/1, $22.95

ELECTRON MICROSCOPY: Preparation of Specimen Supports
Collaborator: Iowa State University
(3:40, S-8, color, silent)

Because an electron beam cannot penetrate glass, it is not possible to use standard glass microscope slides in an electron microscope. The specimens are supported on a very thin plastic film which is in turn supported by a fine metal screen, the grid. This film illustrates the preparation of that support, the copper mesh screen, the plastic film, and finally, the carbon coating which is added to increase the stability of the plastic under thermal and electrostatic stresses.

EAL, cat. no. 81-6678/1, $22.95

ELECTRON MICROSCOPY: Specimen Fixation and Embedding
Collaborator: Iowa State University
(3:40, S-8, color, silent)

"Fixation" of biological specimens prior to sectioning involves killing the cells in such a way that the tissue is well-preserved and the cellular elements, as far as possible, are made insoluble in the reagents to be used. Demonstrations involving specimen fixation in buffered dilute gluteraldehyde are shown in the film. The final stages of the embedding procedure and the use of thermosetting epoxy plastics are then demonstrated.

EAL, cat. no. 81/6686/1, $22.95

ELECTRON MICROSCOPY: Ultramicrotomy
Collaborator: Iowa State University
(3:40, S-8, color, silent)

Metal knives used for preparing material for light microscopy are not sharp enough for ultramicroscopy. For durability and uniformity of the cutting edges, diamond knives are being used more often in today's laboratories. The film illustrates the mechanical advance of the specimen block in the ultramicrotome, followed by sectioning with a diamond knife. Sections from 40 to 60 millimicrons thick are optimum. The film ends as the frail, thin sections are floated from the knife edge onto a water surface from which they are transferable to a grid.

EAL, cat. no. 81-6694/1, $22.95

ELEMENTARY GLASSBLOWING
Collaborator: University of Leeds
(20 min., 16mm, color, sound) 1961

Cutting, drawing and bending glass tubing; making straight joints and T-pieces; construction of elementary apparatus for semimicro analysis.

See RIC, p. 15

HISTOLOGICAL TECHNIQUES
Collaborator: BSCS
(5 min., 8, S-8, color, silent)
(9 min., 16mm, color, sound)

The preparation of microscope slides is demonstrated, starting with the fixing of tissues and mounting in paraffin blocks. Cutting of sections on a microtome is followed by mounting and staining procedures. Several finished slides are illustrated through photomicrography.

THORNE, cat. no. 28, $18.50; $108.

HISTOLOGICAL TECHNIQUES: Counting Cells
Collaborator: S. L. Weinberg, DeWitt Clinton High School, New York
(3 min., S-8, color, silent)

This film illustrates the correct procedure for counting cells with a hemacytometer. Yeast cells are used as an example. Diluting is described and the all important method of mixing cell-suspension and dilutant is then demonstrated. Animation and live action photography show the chamber being charged and the hemacytometer placed on the stage of the microscope. Microscopic footage and highlighting is used to show an actual count. The film also demonstrates how to count cells properly. The difficult procedure in counting cells and the complex geometry of making the hemacytometer chamber are presented with unusual clarity.

EAL, cat. no. 81-0812/1, $22.95

HISTOLOGICAL TECHNIQUES: Hand Microtome
Collaborator: T. R. Marcus and G. P. Fulton, Boston University
(3:10, S-8, color, silent)

This film shows in detail the mechanism and operation of an inexpensive hand-held microtome. It explains the action of the drive mechanism and a method of calibrating the instrument against a millimeter ruler. A specimen is cut from a block of plant tissue, mounted in the microtome and sectioned with a straight razor. The microtome drive is then advanced and the next section is cut. The finished sections are lifted from the razor with a sharp needle and transferred to a drop of water on a slide.

EAL, cat. no. 81-0788/1, $22.95

2013

HISTOLOGICAL TECHNIQUES - Part I - Wet Mount
Collaborator: S. L. Weinberg, DeWitt Clinton High School, New York
(4 min., S-8, color, silent)

This film begins by showing the proper method of wiping a slide and cover slip with lens paper. The thin layer of epidermal cells is then stripped from an onion scale with forceps and fingers, cut into fragments, and floated on water. One fragment of epidermis is transferred by needle to a drop of water which has been placed on the clean slide. The cover slip is then placed gently on the preparation. The film then shows how to add fluids (including stains) to the preparation and how to remove excess fluid by means of paper toweling.

EAL, cat. no. 81-0796/1, $22.95

HISTOLOGICAL TECHNIQUES - Part II - Wet Mount
Collaborator: S. L. Weinberg, DeWitt Clinton High School, New York
(4 min., S-8, color, silent)

This film is designed to follow "Histological Techniques: Part I" 81-0796/1. This demonstrates a variety of other wet mount methods. First, it shows how to handle amoeba by placing a drop of culture medium on the cover slip, giving the amoeba time to settle, and then inverting the preparation onto a slide in such a way as to prevent crushing the amoeba. Next, shows how to make a semi-permanent wet mount by using vaseline to hold the cover slip and to seal in the moisture. Animation is used to clarify the underlying principles of the hanging drop. It shows the advantages of the hanging for viewing living materials. It also demonstrates how to "spot" an amoeba and set it approximately in the center of the field so as to reduce searching time. (For method of focusing the microscope see "Microscope Techniques: Using a Microscope" No. 81-0879/1.)

EAL, cat. no. 81-0804/1, $22.95

HOW TO TAKE A MELTING POINT
(10 min., 16mm, B/W, silent) 1950

A detailed demonstration of the technique of determining the melting point of an organic compound.

See RIC, p. 14

INORGANIC QUALITATIVE ANALYSIS BY SEMI-MICRO METHODS
(20 min., 16mm, B/W, silent) 1956

An introduction to the technique of semi-micro qualitative analysis; detailed instruction in the separation of the first three groups of metals by this method.

See RIC, p. 17

LIVING WITH A GLOVED BOX
Collaborator: Lawrence Radiation Laboratory, University of California
(15 min., 16mm, color, sound) 1964

Principles of the glove box; techniques of use; maintenance.

AEC, free loan

MEASURING OXYGEN CONSUMPTION
Collaborator: Joseph C. Daniel, Jr., University of Colorado
(4:55, 8, S-8, color, silent)
(6 min., 16mm, color, sound)

Construction from easily obtainable materials of a simple respirometer for measuring the oxygen consumed by small mammals.

THORNE, cat. no. 41, $18.50; $77.

MEASURING RATE OF RESPIRATION IN MITOCHONDRIA
Collaborator: L. Riddiford, Harvard University
(3:40, S-8, color, silent)

Mitochondria may be called the "power houses" of the cell, since it is responsible for the final food molecule being broken down and since ATP "trapping" occurs there. This highly interesting film traces the steps necessary to observe respiration of mitochondria. In adult bees, the flight muscles require so much energy that the mitochondria there are large and arranged in linear order. The film sequences show how mitochondria are extracted and how they continue to perform their respiration. This activity is demonstrated by use of a microrespirometer, indicating the oxygen consumption by the mitochondria.

EAL, cat. no. 81-6033/1, $22.95

THE MICROMETER
(15 min., 16mm, B/W, sound)

Various types of micrometers; how to use a micrometer, read the barrel and thimble scales, check the accuracy of readings, and take care of the instruments.

DUART, cat. no. OE2, $21.17

MICROSCOPE TECHNIQUES: USING A MICROSCOPE
Collaborator: S. L. Weinberg, DeWitt Clinton High School, New York
(3:03, S-8, color, silent) 1967

This film goes through the steps required to set up and view a microscope slide. It shows how to obtain the proper illumination, how to put the slide on the microscope stage, how to focus properly without damaging the slide, and how to place the desired object in the field. Emphasis is laid on those operations which students tend to find most difficult, for example, the inversion of the image on the eyepiece. The demonstrations here are applicable

2013

to most, commonly used, student microscopes.

EAL, cat. no. 81-0879/1, $21.50

OSCILLOGRAPHIC POLAROGRAPHY
(20 min., 16mm, color, sound) 1959

The apparatus and technique of oscillographic polarography.

See RIC, p. 18

PAPER ELECTROPHORESIS
(4:13, 8, color, silent) 1965

The complete process of paper electrophoresis, using the Unikit No. 1 equipment, is followed through.

GAEF, cat. no. CP/436, $8.28

PAPER ELECTROPHORESIS
(3:30, 8, S-8, color, silent) 1968

Three substances and a blend of them are seen migrating from an origin line by means of the application of an electric field. Aspartic acid leucine, lysine and a mixture of the three are shown migrating at their specific rates, whether alone or in a mixture. Electrophoresis is used in chemistry and biology as a method of separating mixtures of closely related substances through the application of an electric field.

ICF, cat. no. 12570, 8, $16.; 12575, S-8, $19.50

THE pH METER
(4 min., 8, color, silent)

Techniques of operation of Beckman 72 - calibration and measuring pH.

LBF, cat. no. 19, $15.

POLAROGRAPHY
(105 min., 16mm, B/W, sound) 1957

An introduction to the fundamental theory of classical polarography. The film is in three sections: a) introduction and charging currents; b) diffusion processes; c) special polarographic processes.

See RIC, p. 18

SMALL SCALE INORGANIC PREPARATIONS
Collaborator: Imperial Chemical Industries
(15 min., 16mm, B/W, sound) 1961

The apparatus and techniques needed to carry out the small-scale preparation of chromyl chloride, sulphur monochloride, potassium chromate, ferric chloride and hexammine cobaltic chloride.

See RIC, p. 15

SMALL SCALE ORGANIC PREPARATIONS
Collaborator: Imperial Chemical Industries
(17 min., 16mm, B/W, sound) 1960

The technique of carrying out small-scale organic preparations, using both corks and ground-glass joints, exemplified by the pre paration of ethyl bromide and the conversion of nitrobenzene to aniline and acetanilide.

See RIC, p. 15

SOLUTIONS OF ALKALI METALS IN LIQUID AMMONIA
Collaborator: Yale Chem. Films
(24 min., 16mm, color, sound)

Offers a glimpse of the techniques and craftsmanship of basic research. Using the preparation of a two-phase solution of sodium in ammonia as an example, it covers fundamentals of glass working and vacuum technique, including use of the McLeod gage, leak testing, and bake-out procedures.

AIM, cat. no. YF-231, $228.

SOLUTIONS OF ALKALI METALS IN LIQUID AMMONIA (Abridged)
Collaborator: Yale Chem. Films
(5 min., 16mm, color, sound)

This version of the longer film described in No. YF-231 summarizes the steps required to obtain a stable solution of sodium dissolved in liquid ammonia. The instructional footage is omitted.

AIM, cat. no. YF-232, $47.50

STERILIZATION TECHNIQUES
Collaborator: S. L. Weinberg, DeWitt Clinton High School, New York
(4 min., S-8, color, silent) 1967

This film demonstrates the use of the pressure cooker in lieu of an autoclave, to sterilize glassware and culture media. These include Petri dishes, broth-filled test tubes, Erlenmeyer flasks with broth, and plugged pipettes. The correct method is shown for bringing the cooker to pressure and cooling it. The film also demonstrates graphically what happens when certain incorrect techniques are used. It then shows how to wrap instruments and gloves so that they can be unfolded without contamination, and how to flame loops, instruments, and test tubes to maintain sterility.

EAL, cat. no. 81-0820/1, $21.50

TECHNIQUES OF ORGANIC CHEMISTRY Part I
Collaborator: Louis F. Fieser, Harvard University
(11 min., 16mm, B/W, color, sound)

Deals with equipment, fractional distillation, melting point determination, and Rast deter-

2013

mination of molecular weight.

MGHT, cat. no. 402501, B/W, $65.; 402506, color, $130.

TECHNIQUES OF ORGANIC CHEMISTRY Part IV
Collaborator: Louis Fieser, Harvard University
(19 min., 16mm, B/W, color, sound)

Deals with the preparation of Martius Yellow and six derived compounds.

MGHT, cat. no. 402504, B/W, $125.; 402509, color, $250.

UNDER GUARANTEE
(33 min., 16mm, color, sound) 1964

A survey of methods of chemical analysis, including titration, chromatography and spectroscopy, and their dependence upon high-purity reagents.

See RIC, p. 20

VACUUM PRACTICE
(16 min., 16mm, B/W, sound) 1958

A detailed explanation of the production and measurement of a vacuum. The latter part of the film illustrates the application of high vacuum techniques in industry and science.

MGHT, cat. no. 603508, $95.

WATER ASPIRATOR
Collaborator: Yale Chem. Films
(1 min., 16mm, color, sound)

Uses a transparent model and animated drawings to show how the Bernoulli effect functions in this device; the limitations of the pump are noted. The modern unit of vacuum measurements; the Torr, is defined.

AIM, cat. no. YF-257, $9.50

3000

THE ACCELERATION VECTOR
Collaborator: ESI
(3:15, S-8, B/W, silent)
(3:49, 8, B/W, silent)

Velocity vector is shown for spot moving in an irregular but repeated path. Acceleration is introduced by showing that head of velocity vector moves in a comparable but different path. Computer then determines speed and direction of head of velocity and displays this also as arrow - the acceleration of the original spot.

EAL, cat. no. 80-2538/1, $12.50
MLA, cat. no. 1743, $6.25

ANGULAR MOMENTUM, A VECTOR QUANTITY
Collaborator: Aaron Lemonick, Princeton
(27 min., 16mm, B/W, sound)

This film uses various demonstrations to show that angular momenta add vectorially. The phenomena of precession is used to indicate the presence of an angular momentum. The angular momenta of three wheels are added so that there is no precession, indicating a resultant angular momentum of zero. The film also demonstrates the results of torque applied to a spinning wheel.

MLA, cat. no. 0451, $150.
UEVA, $145.

ARCHIMEDES' PRINCIPLE
Collaborator: O. W. Eshbach, Northwestern University
(7 min., 16mm, B/W, sound)

Dramatizes the problem that led to Archimedes' famous experiments on buoyancy, and recreates the experiments under conditions that show the development of his principle. Demonstrates the use of the modern Archimedes Balance with the cup and cylinder apparatus. Demonstrates experimentally the measurement of the buoyant force of fluid upon an immersed solid.

EBF, cat. no. 740., $35.

BARRIER PENETRATION
(8 min., 8, B/W, silent)

A wide channel of deep water between two shallow regions in the ripple tank acts as a barrier to a wave incident from one of the shallow regions; the incident is totally reflected. As the channel is narrowed reflection diminishes and transmission across the channel increases.

MLA, cat. no. 0462, $50.

BASIC THEORY OF HEAT I
Collaborator: Robert G. Picard
(15 min., 16mm, B/W, color, sound)

Only a little over 150 years ago, heat was believed to be an invisible, weightless fluid called "caloric". Count Rumford and his cannon boring experiments were refined by Joule to relate heat to mechanical work. We now know heat is the motion (or kinetic energy) of all the atoms or molecules of a substance. If, in the case of a gas for example, the temperature of the molecules is increased by adding heat energy, their motion becomes more rapid, striking the sides of the containing vessel more frequently. If the volume of the container is kept constant, the moving molecules cause a definite increase in pressure. The relation of temperature, pressure and volume is always constant. When the temperature of a pure solid is raised sufficiently, it liquefies at a definite melting point while non-crystalline, impure solids soften gradually into a plastic state. When liquids become hot enough, they vaporize in a visible manner called boiling. Cold can be considered the absence of heat-energy. Two bodies can contain different amounts of heat-energy (measured in calories or B.T.U.) but be at the same temperature (measured in degrees centigrade or Fahrenheit).

EYE, cat. no. EG524, B/W, $75.; EG525, color, $150.

BASIC THEORY OF HEAT II
Collaborator: Robert G. Picard
(15 min., 16mm, B/W, color, sound)

Our day-to-day temperatures only range from plus 36 to minus 94 degrees Fahrenheit whereas we are aware of extremes of 100 million down to minus 273.1 degrees as measured on the centigrade scale. The familiar mercury filled thermometer freezes at only minus 39°C while the red alcohol thermometers begin to boil at 78.5°C. The optical pyrometer measures very high temperatures by comparing the color of visible light emitted to a standard color scale. Gas thermometers have been developed to measure in extremely low range temperature such as found in liquid nitrogen. The newer absolute or "Kelvin scale" begins at real zero where molecules cease all motion minus 273°C. Heat is transferred in one or a combination of three ways: conduction, convection and radiation. Dense materials such as most metals make good conductors while porous materials such as gases and liquids are poor ones, sometimes called insulators. Convection gives rise to currents of heated water or air. Radiation involves the transmission of heat in space as electromagnetic waves, traveling best through a vacuum. Temperature does not rise until the radiation hits an absorbing body.

EYE, cat. no. EG5[illegible], B/W, $75.; EG527, color, $150.

BRAGG REFLECTION
(10 min., [illegible], B/W, silent)

Waves are scattered from two-dimensional array (lattice) of small objects producing a strong reflection at the angle defined by 2D sin =) n. The strong reflection disappears as wavelength and angle of incidence are varied.

MLA, cat no. 0463, $50.

BUOYANCY IN A GAS
Collaborator: Carl Clader, New Trier Township High School, Winnetka, Illinois and L. Carroll King, Northwestern University
(2 min., 8, S-8, color, silent)

Live photography, illustrating a controlled vacuum assembly in the laboratory, demonstrates qualitatively the effect of the buoyant force of air upon the weight of a gas volume.

EBF, cat. no. R80605, 8, $16.; S80605, S-8, $17.60

BUOYANCY IN LIQUIDS
Collaborator: Carl Clader, New Trier Township High School, Winnetka, Illinois and L. Carroll King, Northwestern University
($2\frac{1}{2}$ min., 8, S-8, color, silent)

Utilizing a specially designed laboratory apparatus, this film visually relates the loss of weight of the solid to the volume and weight of displaced liquid, and further defines the buoyant force as the weight of water displaced.

EBF, cat. no. R80604, 8, $16.; S80604, S-8, $17.60

CAPACITORS AND DIELECTRICS
Collaborator: A. E. Walters, Rutgers
(3:55, S-8, color, silent)

Two large metal disks mounted on insulating stands, are connected respectively to the vane and frame of an electroscope. The electroscope is charged and the deflection noted. When the plates are brought close together, the vane of the electroscope collapses; when the plates are drawn apart, the vane deflects again to its initial value. The effects of plate separation, plate size and finally dielectric medium are illustrated.

EAL, cat. no. 80-2892/1, $21.50

THE CATHODE-RAY TUBE-WINDOW TO ELECTRONICS
(35 min., 16mm, color, sound) 1961

The heart of the oscilloscope is its cathode-ray tube, on whose screen the measurements appear in graph form. This film shows the steps in the manufacture of this complex component. Using animated sequences, it explains briefly and simply how a cathode-ray tube works.

TEK, cat. no. 067-0124-00, $203.

CHANGE OF FREQUENCY
(1 min., 8, S-8, B/W, silent)

Two sources vibrating at the same frequency are seen with the interference fringes occupying fixed positions. When the frequency of one source is slightly increased, the interference pattern becomes distorted and wheels steadily round. The effect of changing the frequency of source is studied further.

ICF, cat. no. 12040, 8, $6.; 12045, S-8, $9.50

CHANGE OF PHASE
(1 min., 8, S-8, B/W, silent)

When the two sources are vibrating in phase, they produce crests and troughs in step with one another, but the interference fringe shifts as one source is put out of step. The regions of maximum and minimum effect are interchanged: in phase, out of phase, in phase, out of phase.

ICF, cat. no. 12030, 8, $6.; 12035, S-8, $9.50

3000

CHARGE DISTRIBUTION: CONCENTRATION AND POINT DISCHARGE
Collaborator: A. E. Walters, Rutgers
(2:10, S-8, color, silent) 1967

Charge distributed on a metal surface tends to be more concentrated in areas where the radius of curvature is less than in areas where the radius of curvature is larger. When the radius of curvature becomes small enough, as in the case of a pointed conductor, the concentration can force charge to cross an air gap. The film begins with the charging of a large, metal, egg-shaped conductor. To demonstrate point discharge, a small sphere is mounted on the top of the electroscope and a charged rod brought near it. The vane of the electroscope deflects as the rod is brought near but collapses as soon as the rod is taken away. When an induction screen from a Van de Graaff generator is substituted for the sphere, the electroscope vane remains deflected even when the charged rod is withdrawn.

EAL, cat. no. 2868/1, $21.50

CHARGE DISTRIBUTION: THE FARADAY ICE PAIL EXPERIMENT
Collaborator: A. E. Walters, Rutgers
(2:25, S-8, color, silent)

A hollow conductor is charged. The charge collects on the outside of the conductor. This fundamental electrostatic phenomenon discovered by Faraday is demonstrated using two electroscopes. One electroscope has the metal "pail" mounted on it; the "pail" and electroscope are charged. A metal ball takes charge off the "pail" and tests for it on the second electroscope. No charge comes off the inside of the pail, but charge does come off the outside. This clear demonstration of a classic phenomena can be used by single students or entire classes.

EAL, cat. no. 80-2850/1, $21.50

CIRCULAR WAVE REFLECTION FROM VARIOUS BARRIERS
Collaborator: ESI
(3:45, 8, S-8, B/W, silent) 1967

Circular pulses are reflected by a straight barrier. Animated source behind barrier generates image pulse simultaneously with real pulse. Expanding image pulse coincides with real pulse. Circular pulses generated in center of circular barrier are reflected and converged back to origin. Pulses are generated at several positions along major axis of elliptical barrier. When source is at one focus, all parts of reflected pulse arrive simultaneously at the other focus.

EAL, cat. no. 80-2322/1, $12.50
EYE, cat. no. 8022, $12.50

CONSERVATION OF ENERGY
Collaborator: J. L. Stull, Alfred University
(2:50, S-8, color, silent)

Three examples of this principle are demonstrated. Work is transformed into kinetic energy by accelerating a glider with the constant force device used in Film No. 80-2736/1. Gravitational potential energy is converted to kinetic energy by accelerating a glider down an inclined track. Elastic potential energy is converted by projecting a glider with a compressed spring. In each case, the treatment is quantitative; the glider's velocity at a known distance is derived from a recorder-trace.

EAL, cat. no. 80-2769/1, $21.50

CONSERVATION OF ENERGY
Collaborator: Arthur LaCrosix, New England Electric and Jerrold R. Zacharias, MIT
(27 min., 16mm, B/W, sound)

Energy traced from coal to electrical output in a large power plant, quantitative data is taken in the plant; conservation law demonstrated for random and orderly motion.

MLA, cat. no. 0313, $150.

CONSTANT VELOCITY AND UNIFORM ACCELERATION
Collaborator: J. L. Stull, Alfred University
(4:25, S-8, color, silent) 1967

The glider's passage along the track is detected by photocells and recorded on a time-trace (viewed simultaneously in the lower half of the frame). Peak-separations measure the time taken to pass between adjacent photocells. Peak-widths yield approximate values for the glider's "instantaneous velocity". The film shows constant velocity along a level tract and uniform acceleration down a track at three different inclinations. The traces are reproduced in the film notes to provide a basis for calculating g.

EAL, cat. no. 80-2728/1, $21.50

COULOMB'S LAW
Collaborator: Eric Roger, Princeton; ESI; PSSC
(30 min., 16mm, B/W, sound)

Demonstrates the inverse square variation of electric force with distance, and also the fact that electric force is directly proportional to charge. Introduces the demonstration with a thorough discussion of the inverse square idea. Also tests inverse square law by looking for electrical effects inside a charged hollow sphere.

MLA, cat. no. 0403, $150.

3000

COUPLED OSCILLATORS: Energy Transfer
Collaborator: ESI
(3:35, S-8, color, silent) 1967
(4:01, 16mm, color, sound; 8, color, silent)

Two long, coupled pendulums, are started in synchronization and oscillate at uniform amplitude. The one pendulum is started while other is at rest; energy is transferred from one to the other and back again. Effect of altering coupling is shown. Finally, in an extremely elegant demonstration, coupled san-pendulums leave traces on a black, moving table and provide plot of amplitude variation with time.

EAL, cat. no. 80-2678/1, $15.50
MSC, cat. no. 12305, 16mm, $19.; 12304, 8, $8.75

COUPLED OSCILLATORS: Normal Modes
Collaborator: ESI
(3:40, S-8, color, silent) 1967
(4:11, 16mm, color, sound; 8, color, silent)

Two normal modes (symmetric and anti-symmetric) are shown for two coupled pendulums. Comparison is then made with two single pendulums, each having an effective length equal to that of one normal mode. The frequencies of the single pendulums are shown to equal those of the two normal modes of the coupled pendulums. It is also found that the single pendulums show beats and that the coupled pendulums exchange energy at this beat frequency.

EAL, cat. no. 80-2694/1, $15.50
MSC, cat. no. 12311, 16mm, $19.; 12310, 8, $8.75

COUPLED OSCILLATORS: Other Oscillators
Collaborator: ESI
(3:25, 16mm, color, sound; 8, color, silent)

This film shows a series of demonstrations of coupled mechanical oscillators exchanging energy. The frequency of the energy exchange is shown to depend on the coupling between a set of spring oscillators.

MLA, cat. no. 1902, 16mm, $18.75; 1702, 8, $8.50

CRYOGENIC PUMP
Collaborator: Yale Chem. Films
(1 min., 16mm, color, sound)

The use of liquid helium to obtain pumping action is shown together with radiation shielding features commonly included in this simple type of pump.

AIM, cat. no. YF-262, $9.50

DEFLECTING FORCES
Collaborator: Nathaniel Frank, MIT
(30 min., 16mm, B/W, sound)

Discusses nature of forces which produce curved paths, brings out concept of centripetal vector acceleration, shows how knowledge of path and mass of an object give information on the force involved.

MLA, cat. no. 0305, $150.

DIFFRACTION AT AN APERTURE (FIXED WAVELENGTH)
(1 min., 8, S-8, B/W, silent)

The effect caused by a light shining through a vertical slit opened to various degrees is shown. Waves in a ripple tank are shown as they encounter various sizes and combinations of apertures.

ICF, cat. no. 12110, 8, $6.; 12115, S-8, $9.50

DIFFRACTION AT AN APERTURE (RIPPLE TANK - DIFFRACTION
Collaborator: Halas and Batchelor
(3½ min., 8, S-8, color, silent)

Shows diffraction of plane waves at a small opening, diffraction by an aperture a few wave lengths wide, and diffraction at a large opening.

EBF, cat. no. R80202, 8, $20.; S80202, S-8, $22.

DIFFRACTION AT AN APERTURE (WAVELENGTH VARIED)
(1 min., 8, S-8, B/W, silent)

Waves are passed through an aperture which is kept at a constant width, while the wave length is doubled and trebled. The effects of the varied wavelength as opposed to the fixed wavelength are studied closely.

ICF, cat. no. 12120, 8, $6.; 12125, S-8, $9.50

DIFFRACTION AT A NARROW OBSTACLE
(1 min., 8, S-8, B/W, silent)

A vertical pin, lighted by a narrow vertical source, is moved into view and the diffraction is seen. Parallel waves are interrupted by a straight obstacle placed at the center of the tank. The interference fringes and the diffraction fringes are studied.

ICF, cat. no. 12140, 8, $6.; 12145, S-8, $9.50

DIFFRACTION AND SCATTERING AROUND OBSTACLES
Collaborator: ESI
(2:50, S-8, B/W, silent)

A wave is diffracted around the edge of a barrier. As λ decreases, disturbance behind barrier is confined to a region closer to edge of barrier. Diffraction of a wave around an obstacle is then shown. Here λ is increased until it approximately equals the obstacle's size and there is no apparent disturbance of wave front. Finally, scattering is shown from very small obstacles; scattered wave is circular.

EAL, cat. no. 80-2447/1, $12.50

DIFFRACTION AND SCATTERING OF WAVES AROUND OBSTACLES
(3:12, 16mm, B/W, sound; 8, B/W, silent)
(3:12, 8, B/W, silent)

The first sequence shows a wave diffracted around the edge of a barrier. As the wavelength decreases, the disturbance behind the barrier is confined to a region closer to the edge of the barrier. Then diffraction of a wave around an obstacle is shown. Here the wavelength increases until it is about the same dimension as the obstacle, and there is no apparent disturbance of the wave front. In the last sequence scattering from a very small obstacle is shown. The scattered wave is circular.

MSC, cat. no. 12354, 16mm, $10.75; 12353, 8, $6.50
MLA, cat. no. 1726, $6.25

DIFFRACTION AT A STRAIGHT EDGE
(1 min., 8, S-8, B/W, silent)

A slight diffraction effect is observed as a vertical straight edge is illuminated from behind by light from a narrow vertical source. The diffraction caused when a single barrier is moved sideways into the path of waves traveling across the ripple tank is observed.

ICF, cat. no. 12130, 8, $6.; 12135, S-8, $9.50

DIFFUSION PUMP - OIL VAPOR
Collaborator: Yale Chem. Films
(3 min., 16mm, color, sound)

The special design features of a multi-stage fractionating low vapor-pressure oil pump are illustrated. (Animation). The way in which pressures down to 10^{-7} Torr are obtained with it is explained in detail.

AIM, cat. no. YF-261, $28.50

DOPPLER EFFECT
Collaborator: ESI
(3:40, 16mm, B/W, sound; 8, B/W, silent)

A pulsed air jet producing a periodic circular wave moves over the water at 1/3 of the wave velocity clearly showing the Doppler effect. At one point the motion is frozen on the screen to permit close examination of the wavelength differences. Also shown is the source moving at twice the previous velocity.

MLA, cat. no. 1919, 16mm, $10.50; 1719, 8, $6.25

EFFECT OF PHASE DIFFERENCES BETWEEN SOURCES
Collaborator: ESI
(2:05, S-8, B/W, silent)
(2:24, 16mm, B/W, sound; 8, B/W, silent)

At a given wavelength and source separation, phase difference between two sources is altered so that positions of interference maxima and minima are exchanged. Then, right hand source is continuously retarded, and interference pattern sweeps continuously about origin. Superposed reference mark identifies effect of beats.

EAL, cat. no. 80-2413/1, $12.50
MSC, cat. no. 12345, 16mm, $10.75; 12344, 8, $6.50

ELECTRIC CURRENT AND ITS MAGNETIC FIELD
(3 min., 8, S-8, color, silent) 1964

A piece of wire connected to a battery is held above and below a compass. A series of demonstrations reveals some basic principles concerning the magnetic field surrounding every electric current.

ICF, cat. no. 10070, 8, $16.; 10075, S-8, $19.50

ELECTRIC FIELDS
Collaborator: Francis Bitter, MIT and John Waymouth, Sylvania Electric
(25 min., 16mm, B/W, sound)

An electric field discussed as a mathematical aid and a physical entity; experiments demonstrate 1) vector addition of fields, 2) shielding effect by closed metallic surfaces, 3) the electric force which drives an electric current in a conductor for both straight and curved conductors. Physical reality of fields discussed briefly in terms of radiation.

MLA, cat. no. 0406, $120.

ELECTRIC LINES OF FORCE
Collaborator: Alexander Joseph, Bronx Comm. Col.
(7 min., 16mm, B/W, sound)

How to produce electric field patterns with a neon sign transformer as high voltage source. Safety precautions. How electric field patterns are set up.

MLA, cat. no. 0407, $40.

ELECTRICITY AND DIFFERENT MATERIALS
(4 min., 8, S-8, color, silent)

The extent to which different materials conduct electricity may be observed by viewing the rate of discharge when an electrometer is touched by various materials. The effects of humidity, temperature, and the shape of objects may be studied.

ICF, cat. no. 10020, 8, $16.; 10025, S-8, $19.50

ELECTRICITY AND MAGNETISM
(2 min., 8, S-8, color, silent)

Recreates Michael Faraday's experiment and shows how electricity is produced when a coil of wire is moved through a magnetic field. Notes that an electric meter moves in one direction when the magnet is pushed into a coil of wire and in the opposite direction when pulled out, indicating that it makes no difference which is moved, the coil or the magnet as long as the magnetic lines of force are cut by the wire. It also shows how the first electrical generator, a simple copper disk, passing through the poles of a magnet, has developed into a modern plant.

UEVA, $16.

ELECTRICITY (STATIC) BY INDUCTION AND CONDUCTION
(3 min., 8, S-8, color, silent)

A metal electrophorus plate, a plastic sheet, a charged ebonite rod, an aluminum plate are all used to demonstrate static electricity. The film illustrates the fact that objects charged by conduction acquire the same charge as bodies used to charge them, and that objects charged by induction acquire a charge opposite in polarity to the bodies used to charge them.

ICF, cat. no. 10030, 8, $14.; 10035, S-8, $17.50

ELECTRODYNAMICS
Collaborator: Harvey B. Lemon, University of Chicago
(11 min., 16mm, B/W, sound)

Introduces basic principles of electrodynamics by illustrating that electricity and magnetism are related phenomena. Animated drawings and a series of laboratory experiments are used to demonstrate that electric charges in motion are associated with magnetic fields, and that moving magnets produce electric fields. Also shows the construction and use of the electromagnet, and the process of electromagnetic induction.

EBF, cat. no. 212, $70.

ELECTROMAGNETS
(4 min., S-8, color, silent)

Demonstrates the production and properties of an electromagnet and recreates some of Hans Oerstead's original experiments. Shows how the magnetic field produced by electric current passing through a wire, is detected by a compass and dry cells. Notes that a solenoid, or coil of wire with a piece of wire in the center, becomes an electromagnet when a direct current passes through the wire. Many uses of electromagnets are shown.

EYE, cat. no. 8001, $20.

THE ELECTROSCOPE
Collaborator: A. E. Walters, Rutgers
(3:55, S-8, color, silent) 1967

A graphite coated ball is suspended beneath the top of a "T" shaped piece of metal mounted on an insulating stand. When a charge is transferred to the top of the instrument by contact, the ball is repelled from the metal upright. Two methods are used to charge a large laboratory electroscope with the same type of charge as that on the glass rod. When the glass rod itself is used to charge the electroscope by contact, the vane deflection is not very large. When, however, the plastic rod is used and the electroscope charged by induction, a much larger deflection results. When a connection to ground is placed in the path of the electroscope vane near its point of maximum deflection, a pulsed electroscope results. As a charged rod is drawn across the terminal, the vane alternately swings out and collapses at a rate determined by the rate at which charge is applied.

EAL, cat. no. 80-2843/1, $21.50

ELECTROSTATIC CHARGES AND FORCES
Collaborator: Lester I. Bockstahler, Northwestern University
($13\frac{1}{2}$ min., 16mm, B/W, color, sound)

This film shows how positive and negative charges are created; defines such basic concepts as insulator, conductor, and electric field; and introduces Coulomb's Law, used to measure electrostatic charges. A demonstration of Faraday's ice-pail experiment is presented.

CORF, B/W, $75.; color, $150.

ELECTROSTATIC INDUCTION
Collaborator: A. E. Walters, Rutgers
(4:05, S-8, color, silent) 1967

Objects charged by contact have the same type of charge as the objects with which they were contacted, but objects charged by electrostatic induction have the opposite charge. Two metal spheres mounted on insulating stands, are brought into contact with each other and a charged rod brought near one of them. With the rod still close by, the two spheres are separated. When each in turn is brought near a charged ball, the sphere which was originally further way from the charged rod repels the ball; the sphere close to the charged rod attracts the ball. When the spheres are brought in contact, neither sphere exhibits any attraction for the ball.

EAL, cat. no. 80-2835/1, $21.50

ELECTROSTATICS (2nd Edition)
Collaborator: Members of the Physical Sciences Staff, University of Chicago
(11 min., 16mm, B/W, sound)

Demonstrates some of the basic phenomena of static electricity and shows ways in which it can be produced and measured. Laboratory experiments and film animation are used to illustrate attraction and repulsion, to show the effects of positive and negative electric changes, and to explain the significance of electrostatic experimentation.

EBF, cat. no. 464, $70.

3000

ELLIPTIC ORBITS
Collaborator: Albert Baez, PSSC; ESI
(19 min., 16mm, B/W, sound)

Starting with an elliptic orbit (as of a satellite) and using Kepler's law of areas, this film shows that the gravitational force on the satellite obeys an inverse square relation. The derivation is almost entirely geometric in nature.

MLA, cat. no. 0310, $90.

ENERGY AND WORK
Collaborator: Dorothy Montgomery, Hollins College; ESI
(28 min., 16mm, B/W, sound)

Shows that work, measured as the area under the force-distance curve, does measure the transfer of kinetic energy to a body, calculated from its mass and speed. A large-scale falling ball experiment, a non-linear spring arrangement and a "Rube Goldberg" graphically establish work as a useful measure of energy transfer in various interactions.

MLA, cat. no. 0311, $150.

FIELD EMISSION OF ELECTRONS
Collaborator: A. P. French, MIT
(4 min., 16mm, B/W, sound)

Shows how electrons can be dragged out of an unheated wire by strong electric fields.

MLA, cat. no. 0471, $25.

FORCES
Collaborator: Jerrold R. Zacharias, MIT
(23 min., 16mm, B/W, sound)

Introductory to mechanics in general, provides background for later study of forces. Qualitative Cavendish experiment shows gravitational forces, compare this type of force with electrical force.

MLA, cat. no. 0301, $120.

FORMATION OF SHOCK WAVES
(3:51, 8, B/W, silent)

A pulsed air jet producing a periodic circular wave moves over the water surface at 1/3 (and then 2/3) of the wave velocity; the leading wave fronts are compressed. Then when the source velocity exceeds the wave velocity a shock wave builds up and moves along with the source. When the ratio of source to wave velocity is 1.6 the cone of the shock wave is quite sharp. Then motion is frozen and animation is superposed showing the relationship of the angle of the shock wave to wave and source velocities.

MLA, cat. no. 1720, $6.25

FRICTION (Advanced)
(20 min., 16mm, B/W, sound) 1954

A film demonstration through diagrams, models and photomicrography, of the basic laws of friction; first, that friction is independent of surface area, and second, that it is proportional to load. The effect of molecular surface layers in reducing friction and the increase in temperature of sliding contacts are both shown. The principles of fluid and of boundary lubrication are also demonstrated and the chemical action of long-chain fatty acids as boundary lubricants is explained.

MGHT, cat. no. 603504, $120.

GENESIS OF THE TRANSISTOR
Collaborator: Bell Telephone Lab
(15 min., 16mm, color, sound)

The story of the discovery of the "transistor effect" and the subsequent invention of the transistor is told in a direct, documentary style by Dr. Walter Brattain, Nobel Prize-winning inventor of the device. This film emphasizes experimental processes rather than the details of particular experiments. Two books are available for use with the film: "Conductors and Semi-conductors" by Alan Holden, and "Experiments with Conductors and Semiconductors" by S. S. Meyers. A conductivity demonstration device is also included.

STER, free loan

GRAVITATIONAL DISTRIBUTION
Collaborator: Harold A. Daw, New Mexico State University
(4 min., S-8, color, silent) 1967

When one side of the air table is raised, the pucks fall "down-hill" and congregate along the lower wall. When the "temperature" is increased by vibrating the walls, this solid mass of pucks sublimates until all the pucks are in motion. The equilibrium puck density, however, is obviously greater along the lower edge. This density distribution is studied by turning off the air to freeze the motion of the pucks and then counting the number of pucks in each of nine equal strips running parallel to the lower edge. Repeated runs of this type provide data for a histogram which can be compared with a superimposed theoretical distribution. Further data are collected for a mixed population containing pucks of two different masses.

EAL, cat. no. 80-2942/1, $21.50

HEAT-ITS NATURE AND TRANSFER (2nd Edition)
Collaborator: O. W. Eshbach, Northwestern University
(11 min., 16mm, B/W, sound)

Explains in animated drawings the nature of heat and some of the principle ways in which heat is transferred. Illustrates practical applications of heat in home and industry.

EBF, cat. no. 1608, $70.

HEAT IS PRODUCED IN DIFFERENT WAYS
(4 min., 8, S-8, color, silent) 1964

Several of the most common ways in which heat is produced are shown. Electric heat is shown by a spark device and friction by a grinding wheel and lighter. Chemical heat and spontaneous combustion are also shown.

ICF, cat. no. 13130, 8, $16.; 13135, S-8, $19.50

HEAT IS REFLECTED AND ABSORBED
($3\frac{1}{2}$ min., 8, S-8, color, silent) 1964

In this film, the temperatures of a black can and a silver colored can exposed to a heat lamp are recorded. A radiometer is shown in action.

ICF, cat. no. 13110, 8, $14.; 13115, S-8, $17.50

HEAT TRAVELS BY CONDUCTION, CONVECTION AND RADIATION
(3:45, 8, S-8, color, silent) 1964

This film explores the means by which heat is transmitted from one place to another. Conduction, convection and radiation are each illustrated with experiments, several of which may be duplicated in the classroom. The sequence may be effectively used to introduce or to summarize a unit of heat.

ICF, cat. no. 13100, 8, $16.; 13105, S-8, $19.50

INERTIA
Collaborator: E. M. Purcell, Harvard University
(26 min., 16mm, B/W, sound)

Galileo principle of inertia shown with dry ice pucks and multiple flash photography, also the relation that acceleration is proportional to force when mass is constant.

MLA, cat. no. 0302, $150.

INERTIAL FORCES - TRANSLATIONAL ACCELERATION
Collaborator: F. Miller, Jr., Ohio State University
(1:50, S-8, color, silent)

The concepts of force, acceleration and constant velocity are illustrated in this film. A 156 lb. student riding in an elevator is seen to experience a measurable increase in weight when the elevator starts up, and a decrease when it accelerates downward. When moving at constant speed between floors his weight is normal. The camera displays the dial of a sensitive balance on which the student stands during the experiment. Explanatory notes accompany the film.

EAL, cat. no. 80-2132/1, $15.50

INERTIAL MASS
Collaborator: E. M. Purcell, Harvard University
(19 min., 16mm, B/W, sound)

The relation that acceleration is inversely proportional to mass with constant force. Shows different objects may have the same inertial mass. Compares inertial and gravitational masses, their proportionality.

MLA, cat. no. 0303, $120.

INSULATORS AND CONDUCTORS
Collaborator: A. E. Walters, Rutgers
(2:44, S-8, color, silent)

Some materials, called conductors, transfer charge readily while other materials, called insulators, do not. A piece of newspaper and a piece of metal foil are suspended by threads from an overhead support. When a charged rod is brought near these objects, they are attracted to, and then stick to, the rod. A metal disk at the end of a plastic rod (one which gives up charge fairly readily). When the proof plane is brought near the strip of paper, the paper is attracted to, and sticks to, the proof plane, but when brought near the strip of metal foil, the foil is attracted to, touches, and then flies away from the proof plane.

EAL, cat. no. 80-2827/1, $21.50

INTERFERENCE AND DIFFRACTION
Collaborator: James Strickland, ESI
(19 min., 16mm, B/W, sound)

Starting from single pulses from two sources an interference pattern is built up. Various interference patterns produced by two point sources are demonstrated to show the effects of wavelength, separation of the source and phase. Diffraction is presented as a form of interference. Waves are diffracted around obstacles, and through slits to illustrate the effect of varying wavelength, obstacle size and slit width. Multiple slit diffraction is also demonstrated.

MLA, cat. no. 0461, $90.

INTERFERENCE (RIPPLE TANK-INTERFERENCE)
Collaborator: Halas and Batchelor
(2 min., 8, S-8, color, silent)

Demonstrates interference and shows (through the use of diagrams) the pattern produced by combining the waves from two similar generators.

EBF, cat. no. R80205, 8, $16.; S80205, S-8, $17.60

INTERFERENCE OF WAVES
Collaborator: ESI
(3:40, S-8, B/W, silent) 1967
(4:08, 16mm, B/W, sound; 8, B/W, silent)

Interference pattern is produced by two sources vibrating in phase. Motion is frozen, and source separation (d) and wavelength (λ) of periodic waves are defined. Superposed reference mark identifies a first order maximum. Keeping d constant, λ is doubled, and mark returns to first order maximum. Finally, interference pattern is slowly changed by continuously decreasing λ.

EAL, cat. no. 80-2405/1, $12.50
MLA, cat. no. 1922, 16mm, $10.50; 1722, 8, $6.25

INTRODUCTION TO ELECTROSTATICS
Collaborator: A. E. Walters, Rutgers
(3:30, S-8, color, silent) 1967

A large sheet of plastic is rubbed with a piece of cloth and lowered slowly over a pile of light neutral particles. Photographed in slow-motion, the particles jump up and attach themselves to the underside of the plastic. From two experiments, the student is able to conclude that like-charged objects repel each other and unlike attract. Rods of plastic and of glass are charged to help the student refine his previous conclusion. Charged bodies with identical histories do repel each other; those with unlike histories may attract or repel, but always do one or the other.

EAL, cat. no. 80-2819/1, $21.50

LAWS OF CONSERVATION OF ENERGY AND MATTER
Collaborator: Marvin Camras, Illinois Inst. Tech.
(8 min., 16mm, B/W, color, sound)

A background for understanding these laws and their importance as basic principles of science is clearly developed. Simple laboratory experiments and special photographic effects illustrate the important principle that matter and energy may not be created or destroyed, but, as explained by Einstein's equation, they can be converted into one another.

CORF, B/W, $45.; color, $90.

LEARNING ABOUT HEAT
Collaborator: Wilbur L. Beauchamp, University of Chicago
(8 min., 16mm, B/W, sound)

Demonstrates the effects of heat on different kinds of materials; explains the principles of expansion and contraction; and illustrates how heat travels by conduction, convection, and radiation.

EBF, cat. no. 889, $52.50

LIGHT: REFRACTION
Collaborator: Paul L. Copeland and Edward Piotrowski, Illinois Inst. Tech.
($13\frac{1}{2}$ min., 16mm, B/W, color, sound)

A graphic illustration of how light changes direction or is refracted when it passes from one substance into another; Snell's law; and how the laws of refraction are applied in the use of lenses.

CORF, B/W, $75.; color, $150.

LIGHT WAVES AND THEIR USES
Collaborator: H. Horton Sheldon, New York University
(11 min., 16mm, B/W, sound)

Illustrates principles of reflection and refraction of light. Illustrates refraction through lenses, and reflection from plane, concave, and convex mirrors. Explains the human eye as a lens, depicts use of light waves in making minute measurements, calls attention to interference, electromagnetic spectrum, and principles and uses of polar screens.

EBF, cat. no. 261, $70.

THE LINEAR ACCELERATOR
(12 min., 16mm, B/W, sound) 1954

This film introduces the theory of nuclear transmutations and the production of hard x-rays with laboratory accelerated particles. It shows the development of equipment and techniques from the original Cockcroft and Walton experiments up to the most recent traveling wave linear accelerator, the design and underlying theory of which are described in detail.

MGHT, cat. no. 603505, $75.

LONG TIME INTERVALS
Collaborator: Harrison Brown, Cal. Tech.; ESI
(25 min., 16mm, B/W, sound) 1959

A discussion of the significance of long time intervals with a detailed description of radioactive dating arriving at an estimate for the age of the earth.

MLA, cat. no. 0102, $120.

MAGNETIC FIELDS PART I AND II
(4 min., 8, S-8, color, silent) 1964

Part I - Compass needles and magnets are used in this film to illustrate the principle that similar poles repel and opposite poles attract each other. The direction of the field at various points around the magnets is observed. Part II - Iron filings and two types of magnets are used to illustrate the magnetic field. The fields around the poles of a bar magnet and a "U" shaped magnet are studied with iron filings. Filings are also used to show the field around a rectangular iron core in a coil connected to a battery.

ICF, cat. no. 10050, 10060, 8, I, II, $16. ea.
10055, 10065, S-8, I, II, $19.50 ea.

MAGNETISM PRODUCES ELECTRICITY
(4 min., 8, S-8, color, silent) 1964

The fact that voltage is induced in a conductor whenever there is relative motion between the conductor and the magnetic field, is illustrated. It is seen that the amount of meter deflection increases with the number of magnets, number of turns and speed of motion.

ICF, cat. no. 10150, 8, $16.; 10155, S-8, $19.50

MATERIALS CONDUCT HEAT AT DIFFERENT RATES
(3½ min., 8, S-8, color, silent) 1964

A copper wire and glass rod with match heads placed at the ends are used to show differences in heat conduction. The copper conducts heat from a flame and the match head ignites. The match head in the glass rod does not ignite although the glass melts.

ICF, cat. no. 13120, 8, $14.; 13125, S-8, $17.50

MEASUREMENT OF ELECTRICITY
Collaborator: Ira C. Davis, University of Wisconsin
(11 min., 16mm, B/W, color, sound)

Presents the fundamental definitions and the physical concepts involved in the Volt, Ampere, Ohm, and Watt.

CORF, B/W, $60.; color, $120.

MICHELSON INTERFEROMETER
Collaborator: F. Miller, Jr., Ohio State University
(4:15, S-8, color, silent)

The Michelson interferometer is shown in detail. Then clear image fringes are obtained from a sodium arc. A moving fringe pattern is produced by advancing the rear mirror and thus changing the path difference for the light. When the arc is replaced by a tungsten bulb, white light fringes appear. Insertion of a thin "Mylar" film (7.8 microns thick) causes a shift of the fringe system from which the refractive index for Mylar can be calculated. A modification of the interferometer, the Mach-Zehnder interferometer, makes visible small changes in the index of refraction of heated air above a candle flame.

EAL, cat. no. 80-2090/1, $15.50

MOVING WITH THE CENTER OF MASS
Collaborator: Hermon Branson, Howard University
(26 min., 16mm, B/W, sound)

Demonstrates the validity of the conservation of energy and momentum of several magnetic dry ice puck interactions as viewed in two different frames of references. A discussion and demonstration of the partition of energy into a part associated only with the motion of the center of mass of the system and a part called the internal energy, the latter is associated with the motion of the parts of the system with respect to the center of mass.

MLA, cat. no. 0320, $150.

MULTIPLE SLIT DIFFRACTION
Collaborator: ESI
(3 min., S-8, B/W, silent)

The interference pattern from two narrow slit sources is shown to be similar to that produced by two point sources. In both cases, the same wavelength is used and the source separation equals the slit separation. Using two, three, four and eight narrow slits, interference maxima are shown to become directional beams with very low divergence. Zero and first order beams are identified by superposed guides.

EAL, cat. no. 80-2439/1, $12.50

MULTIPLE SLIT DIFFRACTION OF WAVES
Collaborator: ESI
(3:24, 16mm, B/W, sound; 8, B/W, silent)

The interference pattern of two narrow slits is shown to be similar to that produced by two point sources; the wavelengths as well as the source and slit separations are the same. Then using 2, 3, 4 and finally 8 narrow slits, the interference maxima are shown to become stronger directional beams; i.e., the wavefronts become straight. The zero and first order beams are emphasized by superposed guides.

MLA, cat. no. 1925, 16mm, $10.50; 1725, 8, $6.25

THE NATURE OF ENERGY
(11 min., 16mm, B/W, color, sound)

Clarifies the scientific concept of energy and relates atomic energy to other forms of energy.

CORF, B/W, $60.; color, $120.

THE NATURE OF HEAT
Collaborator: James H. Kraakevik, Wheaton College, Illinois
(11 min., 16mm, B/W, color, sound)

Shows the molecular nature of heat and how it is transferred, and demonstrates the applications of these principles to everyday use.

CORF, B/W, $60.; color, $120.

NEWTON'S FIRST AND SECOND LAWS
Collaborator: J. L. Stull, Alfred University
(4:20, S-8, color, silent) 1967

A special three-section, ten-meter track is level in the center and inclined at each end. A glider traversing the level section is subject to practically zero retarding force. The inclined end sections reverse the glider's direction without introducing any additional source of energy loss. A clock records the glider's transit time between two markers on the level section. Another records total elapsed time. The glider's motion is filmed over a period of about five minutes. Another glider is attached by a spring and a long thread to a device which produces a constant force. The extension of the spring measures the tension in the thread. The glider, initially at rest, is accelerated for a known distance, and the time is measured. Readings are taken for various masses and accelerating forces.

EAL, cat. no. 80-2736/1, $21.50

NEWTON'S THIRD LAW
Collaborator: J. L. Stull, Alfred University
(3 min., S-8, color, silent) 1967

This film demonstrates the famous reaction-car experiment proposed by Ernst Mach. Two gliders which are initially at rest on an air track are forced apart by a compressed spring. Their motions are subsequently "frozen" and the distances they have travelled are measured. The experiment is performed using gliders of various mass ratios. Finally, we observe the oscillation of pairs of gliders (of equal and unequal masses) joined by a spring.

EAL, cat. no. 80-2744/1, $21.50

NON-RECURRENT WAVEFRONTS
Collaborator: F. Miller, Jr., Ohio State University
(3:25, S-8, B/W, silent) 1967

Five spectacular effects in this film illustrate the nature of non-recurrent waves. The slow motion build-up and breaking of a water wave crest in a test basin; a tidal wave in the river Seine; a shock wave in a crowd of people, where the movement of the disturbance is analogous to molecular motions in the sound wave of a gas; the hydrogen bomb test and its associate atmospheric shock wave. Finally, on an interstellar scale, the movement of an electromagnetic pulse of radiation from the Nova Persei explosion is shown by photographs taken at monthly intervals after the event, and different parts of an irregular nebulosity lying between the star and the earth are shown to be successively illuminated by the non-recurrent wave.

EAL, cat. no. 80-2173/1, $12.50

NUCLEAR POWER REACTORS
Collaborator: Greenpark Productions Ltd.
(36 min., 16mm, color, sound) 1961

The film covers a number of power reactor systems, largely by means of animation. It traces the development of reactors from Enrico Fermi's first self-sustaining nuclear chain reaction in Chicago, to the development of Calder Hall. After explaining briefly the principles of nuclear fission and the need for a moderator, it then discusses the suitability of graphite, heavy water and ordinary water as moderators. The following reactor systems are then illustrated: Pressurized Water Reactor, Boiling Water Reactor. A survey map of the world's reactors leads to a description of the present nuclear power program in GB and the need for high 'on-load' use. In the experimental systems which are next discussed, the illustrations cover: Homogeneous Aqueous Reactor, Sodium Graphite Reactor, Organic Liquid Moderated Reactor, Heavy Water Moderated Reactor; the film then deals with the fast Breeder Reactor, the Advanced Gas-cooled Reactor and High-Temperature Gas-cooled Reactor (Dragon) and ends with a summing-up of the achievements of Calder Hall.

UKAEA, free loan

OHM'S LAW
Collaborator: Marvin Camras, Illinois Inst. Tech.
($5\frac{1}{2}$ min., 16mm, B/W, color, sound)
(4 min., 8, S-8, color, silent) 1964

Graphically demonstrates Ohm's Law to help students understand voltage, current, resistance and their interrelationships.

CORF, B/W, $30.; color, $60.
ICF, cat. no. 10130, 8, $16.; 10135, S-8, $19.50

ONE DIMENSIONAL MOTION
Collaborator: H. F. Meiners, Rensselaer Poly. Inst.
(3:10, S-8, color, silent)

Real-time plots of displacement, velocity and acceleration versus time are shown for a small cart being pulled back and forth along a track. First, the student sees the cart on a 10-foot track being pulled back and forth by a chain while a small X-Y recorder, mounted on an overhead projector, plots the displacement of the cart as a function of time. Then, in three successive scenes, the cart is seen in the lower half of the picture, traveling the full length of the track and back again. The upper half of the picture is occupied by the X-Y recorder which plots displacement, velocity and acceleration as the cart traverses the track. A potentiometer on the drive motor provides the displacement data, a tachometer the velocity, and a computer differentiation of the tachometer output supplies the acceleration.

EAL, cat. no. 80-3007/1, $21.50

THE OSCILLOSCOPE-DRAWS A GRAPH
(20 min., 16mm, color, sound) 1962

How an oscilloscope works is described simply in words and pictures, in this non-technical film. The importance of an oscilloscope to science and industry is emphasized. The film tells how to read information that is graphed on the oscilloscope's cathode-ray screen.

TEK, cat. no. 067-0132-00, $78.

3000

THE OSCILLOSCOPE-WHAT IT IS, WHAT IT DOES
(9 min., 16mm, color, sound) 1961

This non-technical explanation of the oscilloscope and its uses stresses the instrument's importance as a basic measuring tool for electronics in particular, and science and industry in general.

TEK, cat. no. 067-0125-00, $53.

PLANE AND SPHERICAL WAVES: DIFFRACTION AT OBSTACALES (RIPPLE TANK-PLANE AND SPHERICAL WAVES)
Collaborator: Halas and Batchelor
(2 min., 8, S-8, color, silent)

Shows sperical progressive waves from a generator, plane progressive waves, and diffraction of plane waves around obstacles small and large with respect to the wave length.

EBF, cat. no. R80201, 8, $16.; S80201, S-8, $17.60

POSITRON-ELECTRON ANNIHILATION
Collaborator: Stephan Berko, Brandeis University
(28 min., 16mm, B/W, sound)

The annihilation of positron-electron pairs is demonstrated. This and several other brief demonstrations emphasize the conservation of energy and the transformation of matter into radiation. A coincidence experiment also shows the conservation of momentum in the process.

MLA, cat. no. 0454, $150.

PRINCIPLES OF ELECTRICITY
(20 min., 16mm, color, sound)

"Principles of Electricity", a basic film for teaching fundamental concepts of electricity for twenty years, is offered in revised form by General Electric Educational Films. The updated version continues the useful function the original version has performed in classes in high school, college, adult education, trade school and industrial education classes for many years. Using animation the film describes the basic concepts of electrons and electron flow, positive and negative charges, current, voltage, resistance, and fundamental methods of generating electricity.

GE, $150.

PRINCIPLES OF NUCLEAR FISSION
(10 min., 16mm, color, sound) 1957

After considering the historic and the modern conceptions of the structure of the atom, the film shows diagrammatically the relation of its basic particles, electrons, protons, and neutrons. It describes in detail how bombarding neutrons cause fission in Uranium-235 atoms and the production of chain reactions. The film then deals with the graphite nuclear reactor, showing methods of controlling action in a nuclear reactor and relating this to the production of electricity.

MGHT, cat. no. 603511, $125.

PROBLEMS IN ELECTROSTATICS
Collaborator: A. E. Walters, Rutgers
(4:05, S-8, color, silent) 1967

This film presents four interesting electrostatic phenomena to be explained by a student who has learned the material presented in the other films in this set. The first device presented is an electrophorus - a metal plate with an insulating handle. The second device is a "hand chime" made from a small ball supported at the end of a thread which alternately strikes the author's hand and the electrophorus. The third device involves the use of a Leyden jar which is charged by point discharge from a Van de Graaff generator. Finally, a metal ball suspended by a thread is attached to the upper sphere of a Van de Graaff generator. When the generator is turned on, the ball flies out and remains suspended.

EAL, cat. no. 80-2900/1, $21.50

REFLECTION OF CIRCULAR WAVES FROM VARIOUS BARRIERS
Collaborator: ESI
(3:50, 16mm, B/W, sound; 8, B/W, silent)

Circular pulses reflected by a straight barrier. Superposed animation behind the barrier generates an image pulse simultaneously with a real pulse. Circular pulses from center of a circular barrier reflect and converge back to origin. Then a series of pulses generated at several positions along the major axis of an elliptical barrier. Source at one focus, all parts of the reflected pulse arrive simultaneously at the other focus.

MLA, cat. no. 1912, 16mm, $10.50; 1712, 8, $6.25
MSC, cat. no. 12318, 16mm, $10.75; 12317, 8, $6.50

REFLECTION AND REFRACTION
Collaborator: James Strickland, ESI
(17 min., 16mm, B/W, sound)

Circular and straight pulses are reflected from various shaped barriers. Periodic straight waves are refracted at various angles. Mention is made of Snell's law and spherical and chromatic aberrations. Various focusing effects and total internal reflection are demonstrated.

MLA, cat. no. 0460, $90.

REFLECTION OF STRAIGHT WAVES FROM STRAIGHT BARRIERS
(2:52, 16mm, B/W, sound; 8, B/W, silent)

Single straight pulses are first reflected from a straight barrier placed parallel to the wave front, the pulse is reflected straight back. The barrier is then placed at 35° and then 45° to the wave front and the pulse is reflected at the same angle; the action is stopped and angles superimposed to emphasize $\theta_r = \theta_i$. Pulses reflected at 55° are also shown. Then a continuous periodic wave is reflected from the barrier placed at 45° to the wave fronts; the reflected wave moves off at 90° from the direction of the incident wave.

MSC, cat. no. 12315, 16mm, $10.75; 12314, 8, $6.50
MLA, cat. no. 1911, 16mm, $10.50; 1711, 8, $6.25

REFLECTION OF WAVES FROM CONCAVE BARRIERS
(4 min., 8, B/W, silent)

Circular pulses generated along the axis of a parabolic barrier. Pulse generated at the parabolic focus, a straight pulse is reflected. Circular pulse reflected from a semi-circular barrier. Spherical aberration demonstrated. Superposition of a parabola on this barrier shows difference. A straight pulse and then a burst of straight pulses are reflected from this parabola; all parts of the reflected pulses converge at the focus.

MLA, cat. no. 1713, $6.25

REFRACTION
(8 min., 16mm, B/W, sound)

The law of refraction and its applications are explained and demonstrated by means of the submarine periscope and binoculars. The refraction of light by water and prisms are shown.

UEVA, $45.

REFRACTION (RIPPLE TANK-REFRACTION)
Collaborator: Halas and Batchelor
(3:45, 8, S-8, color, silent)

After a shot of plane progressive waves, refraction at a plane interface, refraction by a triangular prism, and refraction by a lens are seen.

EBF, cat. no. R80204, 8, $20.; S80204, S-8, $22.

REFRACTION OF WAVES
Collaborator: ESI
(2:20, S-8, B/W, silent) 1967
(2:41, 16mm, B/W, sound; 8, B/W, silent)

Wave velocity and wavelength, (λ) are shown to decrease as wave crosses boundary from deep to shallow water. When periodic wave is incident at an angle to the boundary, wave fronts are seen to bend, thereby changing direction of propagation. Situation is reversed when wave crosses boundary from shallow to deep water. When angle of incidence, (θ_i) is increased to critical angle, refracted wave runs parallel to boundary. With further slight increase in θ_i, wave is totally reflected.

EAL, cat. no. 80-2348/1, $12.50
MLA, cat. no. 1914, 16mm, $10.50; 1714, 8, $6.25

RESISTANCE
(4 min., 8, S-8, color, silent) 1964

The resistance of different lengths and diameters of copper and nichrome wire are compared by using a series-circuit and a galvanometer. The extreme differences that are clearly registered on the galvanometer provide for extensive discussions relating electrons and atoms to the conductors and resistance.

ICF, cat. no. 10120, 8, $16.; 10125, 8, $19.50

RIPPLE TANK WAVE PHENOMENA DEMONSTRATIONS
(series of 14)
Collaborator: James Strickland and E. Carini, ESI
(2-4 min., 16mm, sound; 8, silent; color and B/W)

This series contains 14 demonstrations or various wave phenomena. Light projected from below a glass bottom ripple tank, through the water, and was focused by the curvature of the water waves onto a screen above the tanks, producing a pattern that is the same as the wave pattern in the tank. The pattern on the screen was then photographed. The tank had a useful working area of about 30" on a side. The screen was placed about 30" above the tank and a small bright light source was about 6" away, reflected by a 45° mirror, up through the water. In order to prevent strobing effects in the projected picture the sequences were photographed with a high speed camera (48 frames per second). Unless otherwise noted the projected phenomena you see in this series will be slowed down by a factor of 3.

MSC, cat. no. 12379, 16mm, $150.50, 12378, 8, $91.

SIMILARITIES IN WAVE BEHAVIOR
Collaborator: Bell Telephone Lab
(27 min., 16mm, B/W, sound)

Dr. J. N. Shive of Bell Telephone demonstrates, with the aid of specially-built torsion wave machines, many aspects of wave behavior in mechanical, electrical, acoustical and optical wave systems.

STER, free loan

SIMPLE HARMONIC MOTION - THE STRINGLESS PENDULUM
Collaborator: J. L. Stull, Alfred University
(3:20, S-8, color, silent)

A five meter track is curved to produce a gravitational potential energy well. The glider oscillates in simple harmonic motion. Riser blocks are inserted to include the track, and the new equilibrium position of the glider is measured by the method of swings. Thus, the radius of curvature of the track can be calculated. The period of the glider's oscillation is also measured, allowing g to be calculated. Finally, a small sphere and a test tube containing liquid are placed on top of the moving glider to illustrate non-inertial frames of reference.

EAL, cat. no. 80-2785/1, $21.50

SIMPLE WAVES
Collaborator: John Shive, Bell Telephone Lab
(27 min., 16mm, B/W, sound)

Pulse propagation on ropes and slinkies show elementary wave characteristics. A torsion bar wave-machine gives reflection and other phenomena.

MLA, cat. no. 0204, $150.

SINGLE SLIT DIFFRACTION
Collaborator: ESI
(3:20, S-8, B/W, silent)
(3:42, 16mm, B/W, sound, 8, B/W, silent)

Initially, wavelength is approximately equal to slit width. Holding slit width constant, is decreased to 1/4 its initial value and then restored. Next, holding λ constant, slit width is increased. Positions of nodes and maxima in diffraction pattern are seen to depend on both variables.

EAL, cat. no. 80-2421/1, $12.50
MLA, cat. no. 1824, 16mm, $10.50; 1724, 8, $6.25

SOUND WAVES IN AIR
Collaborator: Richard H. Bolt, MIT
(35 min., 16mm, B/W, sound)

The wave characteristics of sound transmission with frequencies up to 5000 cycles. Experiments in reflection, diffraction, interference and refraction supplemented with ripple tank analogies.

MLA, cat. no. 0207, $150.

SPECIFIC GRAVITY AND ARCHIMEDES' PRINCIPLE
Collaborator: Robert H. Carleton, National Science Teachers Assn.
(11 min., 16mm, B/W, sound)

This film introduced the concept of specific gravity and procedures for finding specific gravity of a substance. Moving from the simple comparison method to the displacement method, Archimedes' Principle of Buoyancy is then presented as a more direct method to find specific gravity. The construction and use of a hydrometer is shown.

CORF, B/W, $60.; color, $120.

STATIC ELECTRICITY
Collaborator: Edward Victor, Northwestern University; Cenco Films
(11 min., 16mm, B/W, color, sound)

Sometimes we notice that plastic bags cling to cloth or that we get a shock when we shuffle across a room and touch something metallic. this is due to electricity; not flowing electricity as in a wire, but static electricity - a charge that is not flowing. Static electricity is made when two objects (usually nonmetals) are rubbed together. The type of charge, negative or positive, that we generate depends on the materials we rub together. Some, such as glass and silk produce positive charges; others, like rubber and wood produce negative charges. We find that objects with the same type of charge repel each other, while objects with different charges attract each other. Why does rubbing or friction cause the charge? If we could peer inside an atom we would see how an electron can be stripped from one atom to make it positively charged and added to another atom to make it negatively charged. We find too, that objects with no charges can be attracted and then repelled by the induction of either a positive or negative electrical charge. Lightning is nature's awesome example of static electricity. What is its cause?

EYE, cat. no. EG886, B/W, $60.; EG887, color, $120.

STATIC ELECTRICITY, INDUCTION
Collaborator: Yale Chem. Films
(9 min., 16mm, color, sound)

Separations of charges is demonstrated with a simple experiment and animated sequences. This information is then used to explain how charges are identified and measured with an electroscope.

AIM, cat. no. YF-254, $85.50

SUPERPOSITION OF PULSES
Collaborator: ESI
(3:50, 16mm, B/W, sound; 8, B/W, silent)

Single pulses from two sources are generated; first simultaneously, then the pulse from the right hand source is delayed more and more. The paths taken by the intersection of the two pulses are superposed over the film: the more the right pulse lags the other, the farther the path is bent to the right. Then multiple pulses from two sources are shown (again the intersection paths are superposed): these multiple pulses build up to periodic waves from the two sources, and the interference pattern is seen.

MLA, cat. no. 1921, 16mm, $10.50; 1721, 8, $6.25

3000

TEMPERATURE WAVES
Collaborator: F. Miller, Jr., Ohio State University
(3:35, S-8, color, silent) 1967
(4 min., 16mm, color, sound; 8, color, silent)

A temperature gradient along a solid brass rod is demonstrated by a row of alcohol in glass thermometers, inserted in holes at half-inch intervals along it. The rod can be heated or cooled at one end, as required, by circulating hot water or cold anti-freeze solution, respectively. First, a steady state change produces an exponential temperature distribution. When the end temperature is then cycled between -5°C and 45°C in square wave pulses, a temperature wave is obtained which shows dispersion and the damping of the Fourier components of the square pulse with distance. A full analysis of the effects can be made.

EAL, cat. no. 80-2165/1, $15.50
MSC, cat. no. 12184, 16mm, $20.; 12182, 8, $9.85

THERMIONIC EMISSION OF ELECTRONS
Collaborator: A. P. French, MIT
(6 min., 16mm, color, sound)

Current is observed in a diode when the filament is heated with a positive plate potential - the plate also gets red hot. No current is detected with potential reversed. The apparatus is explained.

MLA, cat. no. 0472, $45.

TIME DILATION: An Experiment with mu-Mesons
Collaborator: David H. Frisch, MIT and James H. Smith, University of Illinois
(36 min., 16mm, B/W, sound)

Using the radioactive decay of cosmic ray mu-mesons the dilation of time is shown in a filmed experiment which takes place on top of Mt. Washington, N. H., and at MIT in Cambridge, Mass. Data are taken to determine the time distribution of the decays of mu-mesons at rest. The counting rate for mu-mesons with speed of about .99 the speed of light which arrive on top of Mt. Washington is determined, and the number that survive to reach sea level is measured. From the experimental results the conclusion is drawn that the mesons, moving at .99c, keep time at about 1/9th the rate they do when they are at rest. A detailed report and critical analysis of this experiment has been published: Am. J. Phys. 31, 342 (1963). A reprint is sent with the film.

MLA, cat. no. 0453, $150.

TWO SOURCES IN PHASE
Collaborator: Gateway Educational Films
(1 min., 8, S-8, B/W, silent)

Two sources are vibrating in phase, producing crests and troughs in step with one another. The result is an interference pattern. At each interference fringe the waves always arrive out of step, and neutralize each other, producing interference fringes of minimum wave motion.

ICF, cat. no. 12010, 8, $6.; 12015, S-8, $9.50

UNIVERSAL GRAVITATION
Collaborator: Patterson Hume and Donald Ivey, University of Toronto
(31 min., 16mm, B/W, sound)

The law of universal gravitation derived by imagining a solar system of one star and one planet. Models show kinematics and dynamics of planetary motion. Satellite orbits displayed with digital computer.

MLA, cat. no. 0309, $150.

ULTIMATE SPEED
Collaborator: William Bertozzi, MIT
(38 min., 16mm, B/W, sound)

Using a Van de Graaff electrostatic generator and a linear accelerator, the speeds of electrons with kinematic energies in the range 0.5-15 mev are determined by time-of-flight techniques, and the kinetic energy of the electrons is measured by calorimetric means. The results indicate a limiting speed equal to that of light, in agreement with the theory of special relativity.

MLA, cat. no. 0452, $150.

VECTOR KINEMATICS
Collaborator: Francis Friedman, MIT; ESI; PSSC
(16 min., 16mm, B/W sound)

Velocity and acceleration vectors are introduced and shown simultaneously for 2-dimensional motions including circular and simple harmonic. The vectors are computed and displayed as arrows on a cathode ray tube screen by a digital computer, and their relationships are discussed.

MLA, cat. no. 0109, $90.

VELOCITY AND ACCELERATION IN CIRCULAR MOTION
Collaborator: ESI
(3:05, S-8, B/W, silent) 1967
(3:27, 8, B/W, silent)

Displacement, velocity, and acceleration, are examined simultaneously for spot moving in circular motion. Acceleration vector is seen to lead velocity vector by 90°. Likewise velocity vector leads displacement vector by 90°. Velocity is shown to depend not on size of displacement but on how displacement changes.

EAL, cat. no. 80-2546/1, $12.50
MLA, cat. no. 1744, $6.25

VELOCITY AND ACCELERATION IN FREE FALL
(2:13, 8, B/W, silent)

A spot moves vertically up and down in a motion similar to that of an object being repeatedly thrown upwards. The velocity and then the acceleration vectors are displayed along with the displacement of the spot. The acceleration vector does not change during the motion.

MLA, cat. no. 1746, $6.25

VELOCITY AND ACCELERATION IN SIMPLE HARMONIC MOTION
Collaborator: ESI
(1:15, S-8, B/W, silent) 1967
(2 min., 8, B/W, silent)

Displacement, velocity, and acceleration are examined simultaneously for spot moving in simple harmonic motion. Compare 80-2546/1.

EAL, cat. no. 80-2553/1, $12.50
MLA, cat. no. 1745, $6.25

VELOCITY IN CIRCULAR AND SIMPLE HARMONIC MOTION
(2:40, S-8, B/W, silent)
(2:40, 8, B/W, silent)

A spot moving clockwise and then counter-clockwise in a circle at several different speeds is shown with its velocity vector; then the spot moving in simple harmonic motion is seen with its velocity vector.

EYE, cat. no. 8042, $12.50
MLA, cat. no. 1742, $6.25

THE VELOCITY VECTOR
Collaborator: ESI
(2:40, S-8, B/W, silent) 1967
(2:57, 8, B/W, silent)

This film should always be shown before the other films in this Vector series since it introduces the procedures and methods used throughout the series. Movable spot is established on oscilloscope screen. Computer measures speed and direction of motion and displays this additional information on screen in form of an arrow-the velocity vector. Linear motion in several directions and at several speeds is examined.

EAL, cat. no. 80-2512/1, $12.50
MLA, cat. no. 1741, $6.25

WAVES AND ENERGY
Collaborator: Albert V. Baez, Harvey Mudd College
(11 min., 16mm, B/W, color, sound)

Film demonstrates that sound, light, and radio waves have common characteristics; they take time to travel, they can be reflected, they can carry energy, and therefore can transmit information.

EBF, cat. no. 1875, B/W, $70.; 1874, color, $135.

WHAT IS ELECTRICITY (STATIC)?
(4 min., 8, S-8, color, silent) 1964

This film illustrates the principle that similar electrical charges repel each other and opposite charges attract each other. A pith ball and various objects are utilized to clearly illustrate this principle.

ICF, cat. no. 10010, 8, $14.; 10015, S-8, $17.50

WHAT IS MAGNETISM?
(4 min., 8, S-8, color, silent) 1964

A bar magnet attracts iron and steel objects but not others; such as glass, aluminum or wood. Other demonstrations show that only some metals are magnetic, and how metals are magnetized and lose magnetism.

ICF, cat. no. 10040, 8, $16.; 10045, S-8, $19.50

THE WILBERFORCE PENDULUM
Collaborator: F. Miller, Jr., Ohio State University
(4:25, S-8, color, silent) 1967

Several features of simple harmonic motion, potential and kinetic energy, translational and torsional motion are all shown by this simple pendulum. It consists of a weight of variable moment of inertia and mass suspended at the base of a helical spring. At first, translational vibration and then, rotational vibration are demonstrated separately with frequencies determined by the mass and moment of inertia, respectively. The system is altered so that resonance occurs when the oscillations have a common frequency. Energy exchange between the two degrees of freedom is then apparent as the system adjust itself to vibrate in one mode and then in the other.

EAL, cat. no. 80-2157/1, $15.50

WORK, ENERGY AND POWER
Collaborator: Harvey E. White, University of California and Earl S. Herald, California Academy of Sciences
(22½ min., 16mm, B/W, sound)

Dr. Harvey E. White, Professor of Physics at the University of California and Dr. Earl S. Herald of the California Academy of Sciences demonstrate forms of work, energy and power, relating the principles to everyday experiences and illustrating with a variety of models, pictures and scientific apparatus applications of these concepts. The conservation of energy

3000

law is emphasized and the new era of atomic and nuclear energy is introduced in non-technical terms.

ALFI, $125.

4001

ATOM SMASHING
(22 min., 16mm, B/W, sound)

The work of the Curies and James Chadwick in discovery of the neutron is projected; splitting of the lithium atom by Cockcroft and Walton is discussed; Einstein explains his theory of mass and energy. The cyclotron and its use is illustrated.

UEVA, $120.

*THE BUILDING OF THE BOMB
(72 min., 16mm, B/W, sound)

"The Building of the Bomb" is made up of contemporary newsreel material, classified footage never before seen, and actual statements from the men who made the bomb. Oppenheimer, Teller, Segre, Fermi, Von Heisenberg tell their own deeply moving interpretation of the events that led to Hiroshima. Special filming in New York, Chicago, Los Alamos, Princeton, Washington, London, Oxford, Cambridge, Munich, Hamburg, Gottingen and Berne contributes to the total story. The only movies in existence of the dropping of the first atomic bomb shakily taken by scientist Harold Agnew are shown for the first time. "The Building of the Bomb" begins in Germany in the early 30's when physicists first realized that vast amounts of energy could be harnessed from the atom. Since many leading European physicists were Jews as Hilter rose to power they fled to the U.S. and England bringing with them their knowledge of nuclear physics. The start of World War II triggered a suspenseful race between Germany and the Allies as to who would be first. Einstein's intervention with Roosevelt, just how close Germany did come, all events leading to eventual success and the climax at Hiroshima are all part of this compelling scientific and historical document.

ROB, $400.

DISCOVERY OF THE INERT GASES
(19 min., 16mm, color, sound) 1965

This survey begins in 1868, when the French astronomer Janssen analyzed the light emitted by the very hot gases surrounding the sun, and discovered helium. In 1892 Lord Rayleigh and Professor Ramsey discovered argon. After several years of work and experimenting, Professor Ramsey and his collaborator Travers found that the gases helium, argon, neon, krypton and xenon could all be produced by the process of liquifying air and collecting its constituents separately. The film shows the gigantic installations of today, which produce inert gases in precisely the same way which Ramsey and Travers did. These gases are used in scientific research and industry and in all kinds of lighting.

IFB, cat. no. 2 IFB 400, $195.

THE GOD WITHIN
Collaborator: June Goodfield and Stephen Toulmin, Nuffield Foundation
(21 min., 16mm, color, sound) 1962

The God Within is a film about the origins of modern science. Examination of the social and geographic environment of the pre-Socratic philosophers it suggests the intellectual influences that inspired these people to seek the very first rational explanations of the world around them. The film begins with a quotation from Aristotle which tells how men turned to philosophy out of perplexity and how, at first, they puzzled about the things near at hand. The sequences illustrating the environment of these early philosophers were shot in Greece and Ionia which is present day Turkey, Samos and the Dodecanese. Although clothes have changed, the pattern of life is still very much the same in this area and the people still retain the same regard for the natural materials around them. The film recreates the attitudes of the first scientists to their world - both the questions they asked and the answers they gave. The visual symbols - a wet, unbaked clay vase standing for the world, and the stages in making the vase corresponding to the various theories about its nature were chosen not only for their visual simplicity but also for a sound intellectual reason. In constructing their first theories the Greeks turned to everyday experiences for their analogies. The methods used by their potters were one such experience and these methods have not changed to this day, as the pottery sequences, shot on the island of Sifnos, show. Finally, the film deals with questions and theories introduced by Plato's pupil Aristotle. These suggest that for complete understanding it is also necessary to ask questions about function and destination. It is necessary to ask how things grow, what will be their final form and function, what agents guide their growth. And these questions, too, are asked in the atmosphere of the world as the Greek philosophers knew it.

CONTEMPF, $175.

HUNT FOR A CANCER KILLER
(26 min., 16mm, B/W, sound)

A graphic account of science's determined search for a chemical cure for cancer, outlining the promising work being done in the field of antibiotics, and showing several of the many scientists whose lives are devoted to conquering this disease.

MGHT, cat. no. 628011, $135.

4001

LIFE OF ALBERT EINSTEIN
(4 min., 8, S-8, B/W, silent)

AFL, cat. no. S-5, 8, $12.50; S-8, $14.50

THE LIFE AND TIMES OF JOHN DALTON
Collaborator: Imperial Chemical Industries
(30 min., 16mm, B/W, sound) 1966

A pictorial account of the life of Dalton and his relationships with his contemporaries.

See RIC, p. 21

LOOKING BACK ON THE BOMB
(29 min., 16mm, B/W, sound)

Dr. Vannevar Bush discusses some of the great events of his life, the development of the atomic bomb and its effect upon the world, scientific acceleration, and C. P. Snow's views on the "two cultures".

INDU, cat. no. CS-1611, $125.

THE MODERN CHEMIST-DIAMOND SYNTHESIS
Collaborator: H. Tracy Hall, Brigham Young University
(13 min., 16mm, color, sound)

This film is designed to motivate students' interest in the study of chemistry by dramatizing a recent discovery-diamond synthesis. The film documents the work of Dr. H. Tracy Hall, showing how he was able to use his understanding of the atomic structure of carbon, graphite and diamond to achieve a goal which had eluded chemists for centuries. The film dramatized man's search for knowledge throughout the ages in highly stylized and colorful art work. It points out the chemists' creative thinking and experimental method. It explains modern chemistry, its place in the world of science and how it contributes to the welfare of man.

SUTH, $130.

STRANGENESS MINUS THREE
(45 min., 16mm, B/W, sound) 1967

Once in a great while, a physics film comes along which is so superior that we find ourselves making unspoken comparison. "Strangeness Minus Three" tells persuasively why physicists are addicted to their profession. It does this by weaving together interviews with Murray Gellman, Yuval Ne'eman, Nicholas Samios and Richard Feynmen. Gellmann and Ne'eman, working independently of each other, developed the theory which predicted the properties of Omega-minus, but the exhilaration of being the first ones to know it really existed fell to Samois at Brookhaven. The point is not made explicitly, but the viewer is sure to make the connection between the experimentalist's preoccupation with the patterns seen in the transient flash of the bubble chamber and the theorist's obsession with mathematical patterns of nature. This relationship is amplified at the end by Feynman who, in the quiet of a garden, talks about the partial symmetry of a flower as reflecting some deeper, underlying symmetry in the laws of nature. Since most of us are Feynman buffs and know something about the importance of symmetry in physics, it is to be expected that we would enjoy a film like this and rate it highly. "Strangeness Minus Three" is a masterpiece of a film which deserves the widest possible circulation.

ROB, $275.

THE YUKAWA STORY
(40 min., 16mm, B/W, sound) 1955

The life and work of Dr. Hideki Yukawa, the atomic physicist and Nobel laureate.

See RIC, p. 22

4002

MINERALS AND ORES
(4 min., 8, color, silent)

Approximately 25 common minerals and ores along with their chemical compositions are individually exhibited.

LBF, cat. no. 4, $15.

4003

AMMONIA MANUFACTURE
Collaborator: Nuffield Foundation
(2-5 min., 8, color, silent) 1966

See RIC, p. 229

BROMINE MANUFACTURE
Collaborator: Nuffield Foundation
(2-5 min., 8, color, silent) 1966

See RIC, p. 228

COMMERCIAL PRODUCTION OF CAUSTIC SODA
(7½ min., 16mm, color, sound)

Electrolytic decomposition of brine, shipment of caustic soda to customers, and precautions taken in loading and handling in shipment by rail, truck, barge.

PPG, free loan

COMMERCIAL PRODUCTION OF CHLORINE
(9½ min., 16mm, color, sound)

Laboratory demonstration shows electrolyzation of brine; then shifts to commercial plant to show commercial manufacture of chlorine form extraction of brine from the earth to shipment by rail or barge.

PPG, free loan

COPPER MINING
(14 min., 16mm, color, sound)

At a huge open-pit mine, ore is mined by the use of heavy equipment and transported to a mill. The processes of milling smelting are shown until blister bars containing 99% pure copper are obtained. The film emphasizes the vast amount of raw material that must be mined to extract the valuable remaining metal.

BFI, $135.

COPPER REFINING
Collaborator: Nuffield Foundation
(2-5 min., 8, color, silent) 1966

See RIC, p. 228

FLUORINE MANUFACTURE
Collaborator: Nuffield Foundation
(2-5 min., 8, color, silent) 1966

See RIC, p. 228

HERITAGE OF METALS
Collaborator: Carborundum Co. Ltd.
(38 min., 16mm, color, sound) 1965

Mining and refining of copper, lead, tin, aluminum and gold.

See RIC, p. 95

IODINE MANUFACTURE
Collaborator: Nuffield Foundation
(2-5 min., 8, color, silent) 1966

See RIC, p. 229

IRON MAKING
Collaborator: British Iron and Steel Foundation
(13 min., 16mm, B/W, sound) 1956

Photography and animated drawings are used to show the chemical processes of smelting iron from its ore and to state the functions of each of the raw materials. Explanation of the construction of the blast furnace stresses the hollow fire-brick-lined steel shaft, the bustle main, and the tuyere pipes. The system of "bells" keeps the gases from escaping into the open while the correct amount of "burden" is added to the furnace. The changes which occur are illustrated by the use of chemical formulas.

IFB, cat. no. 2 IFB 94, $65.

MAGIC MOLECULE
(9 min., 16mm, color, sound) 1963

A film showing the new world created by the techniques and processes of the plastics industry. Transmuted from coal, oil or wood, plastics can be anything, do anything. Simply rearrange some molecules and you have materials never found in natural form. From these new synthetic substances industry can make thousands of products - from silk threads to furniture. In light and lively treatment this film explores the colorful, versatile world of these man-made materials.

NFBC, cat. no. 0164004, $100.

OIL
(10 min., 16mm, B/W, sound)

The origin of oil is an interesting story and in this film it is graphically explained by animated diagrams of the subsurface of the earth - its layers and structure. Modern methods of determining oil deposits are highly scientific and the tools and machines which do the job, employ sound waves and dynamite. Oil makes the wheels of our modern civilization turn, and how and why we get it, is important.

ALFI, $60.

PRECIOUS METALS IN INDUSTRY
Collaborator: Engelhard Industries Ltd.
(37 min., 16mm, color, sound) 1965

Mining and refining of silver, gold and the platinum group metals; their distinctive properties; uses in modern industrial processes.

See RIC, p. 107

SALT PRODUCTION
Collaborator: Nuffield Foundation
(2-5 min., 8, color, silent) 1966

See RIC, p. 228

SAND AND IMAGINATION
(29 min., 16mm, B/W, sound)

Scientists exhibit new developments in glass technology and discuss the types and uses of glass, its structure, and its properties. Glass ceramics, photochromatic glass, thin-walled glass, and strengthened glass are shown.

INDU, cat. no. FS-1157, $125.

SODIUM CARBONATE
Collaborator: Imperial Chemical Ind.
(20 min., 16mm, color, sound) 1961

Manufacture of sodium carbonate by the ammonia-soda process; use in the paper and glass industries.

See RIC, p. 104

4003

SODIUM HYDROXIDE
Collaborator: Imperial Chemical Ind.
(20 min., 16mm, color, sound) 1961

Manufacture of sodium hydroxide by the lime-soda process and by the electrolysis of brine; use in the rayon, soap and paper industries.

See RIC, p. 104

SOUNDS OF PROGRESS
(34 min., 16mm, color, sound) 1963

Several Tektronix manufacturing activities are shown in this film, including metal, plastics, tooling, electrochemical and front panel production.

TEK, cat. no. 067-0133-00, $230.

THE TYRANNY OF LARGE NUMBERS
Collaborator: Western Electric
($15\frac{1}{2}$ min., 16mm, color, sound)

Presented with the problem of manufacturing carbon deposited resistors in hugh quantities to rigid electrical specifications, Western Electric engineers developed a mechanized process that was the first of its kind. The film shows how the engineers synthesized knowledge from many sciences and skills to solve this manufacturing problem. The result was an amazing block-long computer controlled production line.

STER, free loan

WATER
(10 min., 16mm, B/W, sound)

Every living creature needs water and this film explains that need and goes on to present the variety of forms in which water is used in industrial processes.

ALFI, $60.

WHAT COMES OUT OF THE BLAST FURNACE?
Collaborator: British Iron and Steel Foundation
(8 min., 16mm, B/W, sound) 1956

How molten iron is removed from the furnace, cooled into billets called pigs or poured into castings; and how slag and gases are handled, processed and used is discussed. The by-products of the furnace, slag and hot gases, contribute importantly to the operations of the iron works. The slag, cooled and mixed with tar, becomes good road surfacing material. The heated air, when cleaned of dust and smoke, is re-used in the furnace. Emphasis is placed on the effective uses of the by-products from smelting process as well as the primary product - iron.

IFB, cat. no. 1 IFB 95, $45.

WHAT GOES INTO THE BLAST FURNACE?
Collaborator: British Iron and Steel Foundation
(15 min., 16mm, B/W, sound) 1956

Enormous quantities of materials are used in separating iron from iron ore. Photography and animated drawings here illustrate the securing of raw materials. Iron ore is quarried, crushed, sintered, and blended. Coal is used for making coke, as well as for preheating the air used in the furnace. Limestone is quarried, crushed, and fed to the blast furnace in the proper amount.

IFB, cat. no. 2 IFB 93, $70.

4004

ABSOLUTE FILTRATION
(22 min., 16mm, color, sound) 1961

The manufacture, testing and use of very fine filters for the removal of dust and radioactive particles from gases; installation and servicing.

See RIC, p. 23

AIR AND GAS CLEANING FOR NUCLEAR ENERGY
(30 min., 16mm, color, sound) 1964

Development, manufacture and testing of high-efficiency filters for the American nuclear energy industry; research into highly efficient methods of air cleaning.

AEC, free loan

CONTROL OF AIR POLLUTION
(5 min., 16mm, color, sound)

Acquaints the viewer with the relationship between our modern, technological way of life and air pollution. It stresses the need for expanded research and for increased control effort.

DUART, cat. no. MIS676, $17.23

EFFECTS OF AIR POLLUTION
(5 min., 16mm, color, sound)

Acquaints the viewer with the relationship between our modern technological way of life and air pollution. It gives examples of adverse effects on health, agriculture, and our total economy.

DUART, cat. no. MIS678, $17.40

POISONS, PESTS AND PEOPLE (2 Parts)
Collaborator: National Film Board of Canada
(30 min., 16mm, B/W, sound) 1960

It is one thing to use a fly swatter or spray gun but quite another to blanket whole forests, whole fields with insect-killing fog. In two half-hour films Poisons, Pests and People examine the effects of widespread use of chemical insecticides both on the insect population at large and on warm-blooded creatures, including humans. Part I examines the ravages of insects and man's centuries-old struggle to keep them under control. Part II shows experiments being conducted to find means of controlling specific insects, leaving harmless ones unmolested. All aspects of the problem are discussed by entomologists, agriculturists, and manufacturers of chemicals.

CONTEMPF, $130. each or $250.

RADIOACTIVE WASTE DISPOSAL
(24 min., 16mm, color, sound)

Shows extreme precautions used at the National Institute of Health in handling radioactive waste and the care used in its ultimate disposal in the ocean.

DUART, cat. no. M-443, $74.55

THE SAFE TRANSPORT OF RADIOACTIVE MATERIALS
(20 min., 16mm, color, sound) 1964

This film is designed to be shown throughout the world to all those whose work is involved in any way in the transport of radioactive materials, particularly radioisotopes. It starts with a brief description of radioactivity. It then shows the comparatively simple transport of unused fuel elements, which is compared with the special means needed for transporting fuel elements under special supervision after they have been used in a reactor. The film then concentrates on the transport of radioisotopes, starting with their preparation and showing some of the many ways in which they are used. The film ends with a reminder of the importance of maintaining the standards laid down in the Regulations of the International Atomic Energy Agency.

UKAEA, free loan

*SCIENCE AND FORESIGHT
(25 min., 16mm, B/W, sound)

This provocative film examines a serious problem of our times - how to cope with the advances of modern science and technology. We live in an era when scientific discoveries are thrilling... and chilling. They can bring heaven, or hell, on earth. All too often our finest scientific advances are barbed with dire consequences. For example, biological and chemical research has produced sprays which destroy pests and plant diseases. In turn, this has led to increased crops - so vital in a world faced with feeding an expanding population. Yet the sprays are, simultaneously, destroying useful insects and are also harmful to animals and humans. Many similar examples are graphically depicted in this film. They emphasize the need to cope with the problem. Our technological "revolution" is, after all, just beginning; it will certainly increase. When scientific discoveries are likely to affect the whole of society, there must be better lines of communication among scientists, technologists and government. We must foresee the consequences - good or bad - of new discoveries. Only by using foresight can we avoid or minimize the harmful effects of a new discovery. All concerned must learn to foresee tomorrow and to plan for it.

ROB, $200.

THE SILENT SPRING OF RACHEL CARSON
(54 min., 16mm, B/W, sound) 1963

Is man unknowingly killing himself? Is the balance of nature being permanently upset? Can the increase in cancer and lukemia be linked to pesticide poisoning? To examine these questions brought up by Rachel Carson in her book, "The Silent Spring", the film's producer spent eight months in extensive research for the presentation. Miss Carson, appearing in the film, claims that "we have put poisonous and biologically potent chemicals into the hands of persons largely or wholly ignorant of their potentialities for harm". She contends that these chemicals are used with little or no advance investigation of their effect on soil, water, wildlife and man himself. Critics of this charge state that Miss Carson's allegations are exaggerated in that she does not sufficiently credit benefits to humanity created by pesticides. While they agree that a problem does exist, they disagree with her view of its seriousness. Some of the other participants, voicing a broad spectrum of opinion concerning pesticides, are Dr. Luther Terry, U.S. Surgeon General; Orville Freeman, U.S. Secretary of Agriculture; and Dr. Robert White-Stevens, Asst. to the Director of Research, American Cyanamid Company.

CONTEMPF, $250.

SOURCES OF AIR POLLUTION
(5 min., 16mm, color, sound)

Acquaints the viewer with the relationship between our modern technological way of life and air pollution. It shows the principal sources of air pollution.

DUART, cat. no. MIS677, $15.27

WATER FOR A THIRSTY WORLD
(30 min., 16mm, B/W, sound)

In a new desalination process called ultrafiltration being developed at MIT, synthetic membranes modeled after those existing in nature are used as a filter. Existing methods of desalination are discussed.

INDU, cat. no. FS-1154, $125.

SPECIAL INTEREST

ADVANCE INTO THE UNKNOWN
Collaborator: Esso Petroleum Co. Ltd.
(24 min., 16mm, color, sound) 1966

Launching of a Saturn rocket; research into space flight; the search for more powerful rocket fuels.

See RIC, p. 74

ATOMIC ENERGY FOR SPACE
(17 min., 16mm, color, sound) 1966

Advantages of atomic power for exploration of deep space; isotopic power plant; construction and operation of the nuclear rocket; comparison with chemical rocket; nuclear engines.

AEC, free loan

ATOMIC WEATHERMAN
($18\frac{1}{2}$ min., 16mm, color, sound) 1961

The recovery of strontium-90 from radioactive waste; its conversion to titanate; use for the direct conversion of its heat of decay into electricity for the world's first radioisotope-powered weather station, located in the Canadian Arctic.

AEC, free loan

ATOMS FOR PEACE
Collaborator: Moscow Popular Science Studios
(70 min., 16mm, B/W, color, sound) 1960

Recent Russian work on the peaceful uses of atomic energy, including a description of several types of atomic reactor in use in the Soviet Union.

See RIC, p. 39

BALANCE IN NATURE
Collaborator: R. C. Dickson, UCLA; William C. Stehr, Ohio University and Fred S. Truxal, L. A. County Museum
(17 min., 16mm, color, sound)

The tiny aphid, with its amazing capacity for ovoviviparous reproduction, has the potential for complete destruction of the earth through its consumption of vital plant life. Its relentless enemy, the ladybird beetle, however, holds the aphid population in check. Both the aphid and the ladybird beetle are found all over the world, and both have thousands of different species. Although the aphid is able to produce various defense secretions, according to the particular species, to protect them from other predators, nothing seems to deter the ladybird beetle. The aphid is capable of growing wings when there is a need to travel to other feeding places - but the ladybird beetle has wings, as well. Sometimes the ladybird beetle performs its function as a balance almost too well. When they have consumed all the aphids in one place, they must seek out yet another untouched area, or face starvation. The female ladybird's ability to reproduce depends on her intake of food - the average beetle requires scores of aphids per day. Thus, the system of biological control is carried on in nature without fanfare, upon which man's existence depends. "Balance in Nature" was designed to provide the general science student with one of the true insights found in nature - the relationship between the destructive aphid and the ladybird beetle, or ladybug. The producer, Robert H. Crandall, used specially designed electronic and optical equipment, along with a "pinch of humor" to provide the viewer with a never-to-be-forgotten visual experience via the medium of motion pictures.

CCA, $190.

CHALLENGING CAREERS IN CHEMISTRY
($23\frac{1}{2}$ min., 16mm, color, sound)

Through a series of research projects, shows the type of challenging research conducted by USDA to create new products for industry from agricultural commodities.

DUART, cat. no. 1407-1, $73.70

COMPUTER PROGRAMMING
(26 min., 16mm, B/W, sound)

A film on basic programming; what it is about, what the programmer does, how and why he does it. A good film to show to logically- minded prospective programmers or those interested in knowing what a programmer does.

SDC, cat. no. XF-8, free loan

A DISCUSSION AMONG TEACHERS AND THE CHEM STUDY STAFF
(29 min., 16mm, B/W, sound)

Topics discussed in this panel session include the ability range of students for whom the CHEM Study materials are designed; problems some students have with quantitative concepts and minipulation of numbers; performance of CHEM Study student in freshman college courses; the rationale for presenting atomic theory and bonding late in the course; the possible effects of a detailed teacher's guide on teachers' creativity and initiative; the minimum content of the course that should be taught in a year's time; security of the testing materials; ideas for central distribution of the laboratory material; and the desirability of teachers getting together several times during the year to compare problems and share ideas.

MLA, cat. no. 4082, $150.

SPECIAL INTEREST

AN ESSAY ON SCIENCE
(19:33, 16mm, color, sound) 1963

A film to show what happens at Canada's National Research Council, a complex of off-shaped buildings on the outskirts of the city of Ottawa. Here scientists work on the frontiers of knowledge and involved through most of the work is some aspects which have a fascinating visual effect, such as the pattern of flow from a jet engine and a stop-motion study of northern lights. Areas of re search examined by the film include applied science, medicine, chemistry, biology, to which the federal government's research center has contributed a variety of knowledge.

NFBC, cat. no. 0164022, $180.

EXPLORING CHEMISTRY
Collaborator: Nuffield Foundation
(35 min., 16mm, B/W, sound) 1966

Demonstration of the teaching of chemistry by a method based upon individual enquiry and imaginative thinking.

See RIC, p. 23

EXPLORING BY SATELLITE
Collaborator: Cenco Educational Films
(28 min., 16mm, B/W, color, sound)

The year 1958 will be remembered in history as the International Geophysical Year....a year devoted to the most vast and intensive scientific research program ever undertaken by man. For the first time in history, the major phenomena of the earth and its immediate environs were studied simultaneously by more than 5,000 scientists in cooperation with the governments of 64 nations. By far the most astounding and far-reaching achievement of the I.G.Y. was the launching of the first earth satellites. By the end of that historic year, Russia and the U.S. had launched a number of these artificial moons with cargoes ranging from instruments that were marvels of miniaturization, to dogs whose life processes could be studied in flight. Circling the earth in a great ellipse, these explorers probed where man had never ventured. These were man's first outposts in space, stepping stones to his exploration of the universe. Names like Sputnik, Explorer, Vanguard, Pioneer have left the headlines to take their places in history books. They mark only the beginning of a new age of exploration...an age that would overshadow the age of Columbus, but for its immediacy.

EYE, cat. no. EB500, B/W, $120.; color, $240.

FOUNDATIONS FOR THE FUTURE
(30 min., 16mm, B/W, sound)

Discusses what the future may hold in each of the areas in which Argonne scientists are working and the problems yet to be solved concerning radiation effects and their peaceful uses and dangers.

INDU, cat. no. FS-983, $125.

FUEL FOR THE FUTURE
Collaborator: Mullard Ltd.
(35 min., 16mm, color, sound) 1961

The limitations of conventional sources of power; production of power from nuclear fission and nuclear fusion; possible future developments.

See RIC, p. 40

FUSION RESEARCH
(22 min., 16mm, color, sound) 1964

The nature of thermonuclear research; investigations into plasma production and confinement; difficulties encountered; methods of plasma measurement.

AEC, free loan

THE HIGH ENERGY PEOPLE
(5:15, 16mm, color, sound) 1963

An account of the Zero Gradient Synchrotron and its ancillary equipment.

AEC, free loan

INDUSTRIAL MEDICINE IN ACTION-TOXIC CHEMICAL AGENTS
(29 min., 16mm, color, sound) 1960

Emphasizes need to evaluate working conditions in shops and on flight lines and stresses importance of protecting workers from toxic chemical agents. Shows parts of hazardous environment affecting respiratory tract, gastrointestinal tract, skin and lung irritations, exposure to strong solvents, acids, gases, radiation, noise, burns, etc.

DUART, free loan

INTERLUDIUM ELECTRONICUM
Collaborator: Philips Electrical Ltd.
(28 min., 16mm, color, sound) 1965

A survey of modern methods for extending the senses, including radiography, electron microscopy, closed-circuit television, sound recording and the use of computers.

See RIC, p. 27

LOOKING INTO GLASS
Collaborator: James M. Jobling and Co. Ltd.
(25 min., 16mm, color, sound) 1962

The manufacture, properties and applications of "Pyrex" laboratory and industrial glassware.

See RIC, p. 124

SPECIAL INTEREST

LSD
(37 min., 16mm, color, sound)

Discusses dangerous effects of LSD on the brain and body. Explains dosage, buildup period, the trip, tapering off and post depression. Emphasizes chances of insanity, homicide, self-destruction, mutation, and recurrences of a trip in later months or years. Also points out how LSD was discovered in 1938.

DUART, cat. no. SFP 1826, free loan

THE MAGNETIC BOTTLE
(10 min., 16mm, color, sound) 1958

Research into controlled nuclear fusion with the aim of generating heat from the fusion of hydrogen derived from sea-water.

AEC, free loan

MAN AND THE ATOM
(59 min., 16mm, color, sound) 1965

The United States atomic energy program; mining of uranium, production of fissionable materials; the role of the USAEC; responsibility for safety; processing and storage of radioactive waste; production and uses of radioisotopes; future prospects.

AEC, free loan

MAN-MADE DIAMOND
(11 min., 16mm, color, sound)

How scientists first made diamond in the laboratory. Pressure and temperature needs and techniques to achieve the transition of carbon crystals to diamond are covered. Tests applied to Man-Made diamond to assure that the successful process had, in fact, duplicated nature's hardest material and assured adequate supplies of industrial diamonds.

GE, $120.

MICROSCOPE FOR THE UNKNOWN
(29 min., 16mm, B/W, sound) 1965

Some examples of experimental apparatus used in high energy research, including zero gradient proton synchrotron, bubble chamber and spark chamber.

AEC, free loan

A PANEL FEEDBACK SESSION (Midway in Course)
Collaborator: CHEM Study Teacher Training Films - Lesson 9
(29 min., 16mm, B/W, sound)

A panel of CHEM Study staff members and high school teachers discuss questions raised by teachers who were using the CHEM Study materials and participating in the in-service training program. The topics include difficulties in teaching the concepts of uncertainty and measurement, teacher preparation and institutes, further applications of the concept of randomness, the use of models, some specific laboratory techniques, an evaluation of student achievement, the use and grading of laboratory reports and standardized texts.

MLA, cat. no. 4050, $150.

PLASTICS
(10 min., 16mm, B/W, sound)

Our time may well be called the Plastic Age. Science has made tremendous strides in the production and use of a wide variety of plastics from such common materials as air and water, rags, coal, glass - and even fish from the sea. We see produced many amazing things we use such as dinnerware, auto bodies, and parts, ornaments and textiles, from things we believed could never be used.

ALFI, $60.

POWER FROM FUSION Part I - The Principles
Collaborator: Greenpark Productions Ltd.
(29 min., 16mm, color, sound) 1964

The principles of fusion and the problems to be solved before power from fusion can be mastered. The film starts with a description of the nature of plasma and its familiar uses in neon lighting and in mercury rectifiers. The properties of the lighter elements are then shown, leading on to the loss of rest mass which is transformed into energy when nucleons are fused. The problems of producing fusion reactions are then defined in terms of the temperature and the density/time product for the containment of the plasma which are required. The behavior of charged particles in a magnetic field is illustrated and the possible uses of magnetic fields as a means of containing the plasma are briefly mentioned.

UKAEA, free loan

POWER FROM FUSION Part II - The Problem of Containment
(40 min., 16mm, color, sound) 1965

Recommended to see part one of this film first. After recapitulating the theory of the fusion process and the nature of a plasma, the required conditions are defined in terms of the temperature and the density X time product for the containment of the plasma. The film then illustrates a number of experiments, starting with the pinch effect and considering in detail the instabilities which arise. After Zeta and the stabilizing effect of shear, Hard Core or Inverse Pinch is examined. The Thetraton system is then considered, followed by magnetic gages and in particular the Phoenix experiment. Cusp-shaped fields are then illustrated in detail. This leads to the combination of mirror and cusp geometries to produce a humbug-shaped field, which led to the Magnetic Trap Stability Experiment. The film ends with the warning that although the major instabilities appear to have been overcome, other less violent instabilities may now be revealed.

UKAEA, free loan

POWER FROM PLUTONIUM
(25 min., 16mm, color, sound) 1963

This film describes the problems in using plutonium fuel in both thermal and fast reactors, and the development work being carried out to solve them.

UKAEA, free loan

A PROBING MIND
(29 min., 16mm, B/W, sound)

Illustrates the uses of new educational media-films, television, recordings, teaching machines and well-equipped laboratories in the teaching of high school science.

DUART, cat. no. OE505, $40.96

PUTTING THE ATOM TO WORK
(25 min., 16mm, color, sound) 1966

A comprehensive film which is designed specially for non-technical audiences. It includes basic information on nuclear fission; how this is applied to generate power; the present nuclear generating stations now operating or under construction for Britain's power program; the Advanced Gas-cooler Reactor; the Dounreay Fast Breeder Reactor; radioisotopes, what they are and how they are used.

UKAEA, free loan

THE SENSES
Collaborator: Vincent Detheir, University of Pennsylvania
(28 min., 16mm, B/W, color, sound; 8, color, sound)

Discusses optical process, nervous impulses which stimulate optic nerves, and chemical reactions involved in vision. Illustrates ear structure in bullfrogs, man, and grasshoppers. Demonstrates experiments in investigating taste using flies.

MGHT, cat. no. 614145, B/W, $150.; 613265, color, $300.; 8, $180.

TEACHER-DIRECTED TELEVISION INSTRUCTION
(28 min., 16mm, B/W, sound)

A demonstration for university and school faculties of a television facility which frees the instructor from some of the restrictions inherent in traditional television presentations and enables him to control by push buttons the use of the medium to best serve his purposes.

DUART, cat. no. OE513, $38.81

TEACHING MACHINES AND PROGRAMMED LEARNING
(29 min., 16mm, B/W, sound)

Presents B. F. Skinner explaining the theory of programmed learning, Arthur Lumsdaine describing a variety of teaching machines and programmed materials and Robert Glaser discussing the implication of such machines and materials for education.

DUART, cat. no. OE496, $40.96

TELEVISION, A TEACHING ASSISTANT, PRESENTING PATTERNS OF INTER-INSTITUTIONAL AND INTER-REGIONAL COLLEGE TEACHING BY TV
(28 min., 16mm, B/W, sound)

A documentary in which concrete examples are shown of patterns of inter-institutional and inter-regional teaching on television in selected areas of the U.S. including the educational advantages to both staff and students of cooperative uses of television in college teaching.

DUART, cat. no. OE511, $41.58

TIME-LAPSE PHOTOGRAPHY EXPLAINED
(4 min., S-8, color, silent) 1967

The special equipment needed to take a time-lapse picture is seen. The steps in photographing the opening of a flower are shown. Also included are scenes of a treetop studio being built to film the growth and development of an apple.

EAL, cat. no. 81-9896/1, $20.50

THE WORLDS WITHIN
Collaborator: Stanford University
(29 min., 16mm, color, sound) 1963

The development of the linear accelerator; design, construction and operation of a new accelerator at Stanford.

AEC, free loan

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