DOCUMENT RESUME

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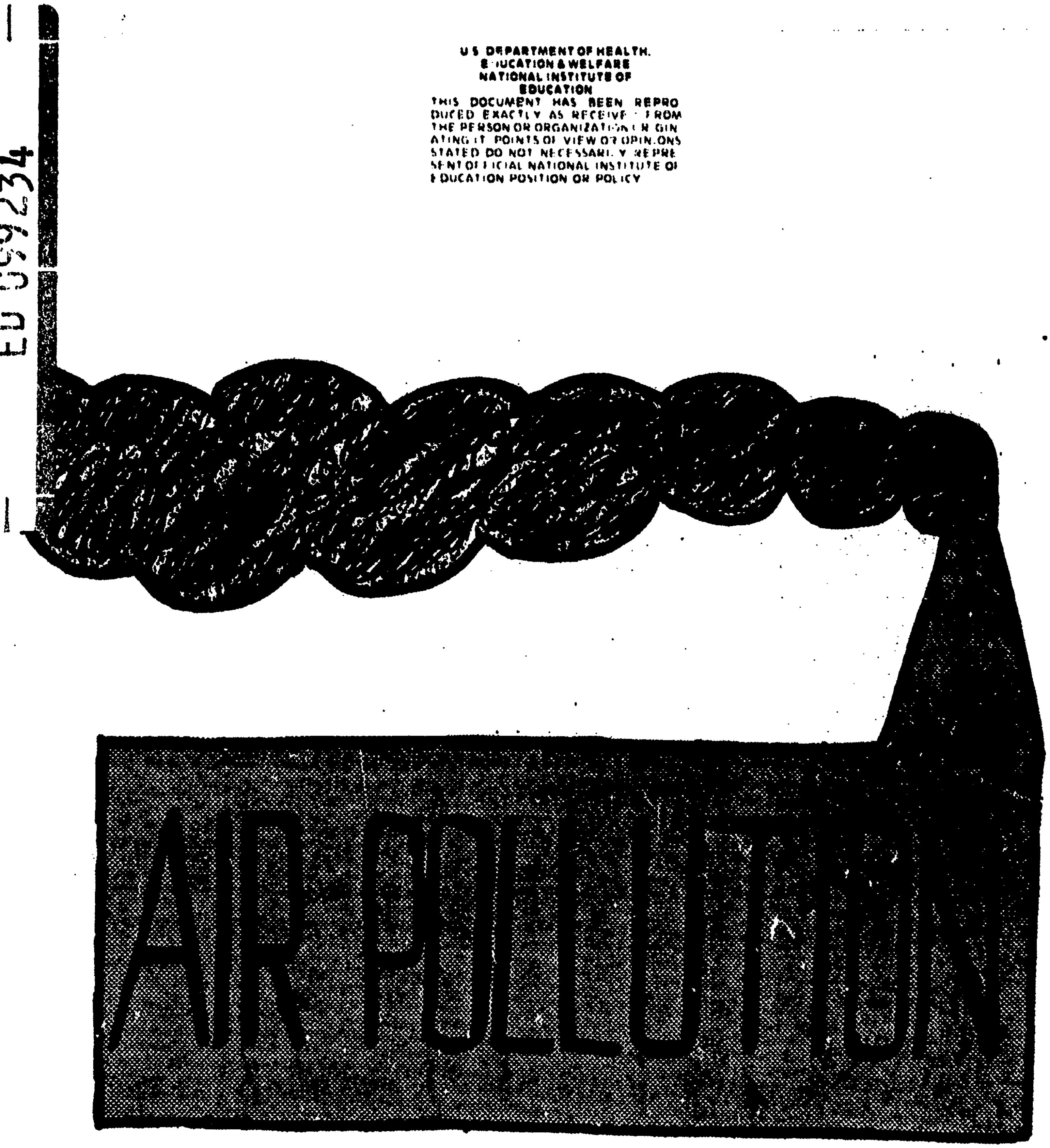
ABSTRACT

This interdisciplinary program, developed for secondary students, contains 16 air pollution activities that can either be used directly in, or as a supplement to, curriculum in Science, Photography, Mathematics, English, Social Studies, Industrial Arts and Home Economics. The topics to be investigated include: pollutants from automobiles, exhaust collection, lead in lichens, sources of air pollution, the effect of air pollution on synthetics, solid particles, lead, sulfur dioxide and carbon monoxide analysis. Each learning activity includes: subject area and grade level for which it can be used, level VI objectives, time schedule for prelab and performance of the activity, background information for the teacher and a listing of materials needed. Where applicable, a listing of audio-visual aids included and an air pollution bibliography is attached. (BT)



CONTENTS

AIR POLLUTION UNIT

LEVEL VI OBJECTIVES

The student will know the amount of pollutants such as carbon monoxide, hydrocarbons, and nitrogen oxide caused by automobiles in a specified area.

The student will know a legal process used to solve an environmental issue such as air pollution.

The student will know that two different air pollutants such as smoke from a match and smoke from a cigarette lighter have harmful effects on the growth of plants.

The student will know major sources of air pollution within his community.

The student will know the ratio of oxygen produced to the consumption of oxygen in the United States.

The student will understand the role of CO_2 in the carbon cycle.

The student will be able to determine the levels of CO_2 in auto emission samples and cigarette smoke samples.

The student will be able to determine the levels of sulfur dioxide in the air we breathe.

The student will determine the difference of lead levels between four, six and eight cylinder engine exhaust emissions.

The student will determine the total amount of auto emission such as hydrocarbons, CO_2, oxides of nitrogen from 45 cars as compared to 1 diesel bus.

The student will know that the air we breathe contains many particles such as soot, dust, pollen, spores, etc.

The student will be able to determine the amount of water and hydrocarbons from auto emissions.

The student will be able to identify environmental problems in his local community.

The student will be able to determine the lead content in lichens located near a freeway.

The student will know that certain chemical pollutants have an adverse effect on dyed fabrics, nylon and rubber.

A-1

SUBJECT AREAS Math and Social Studies

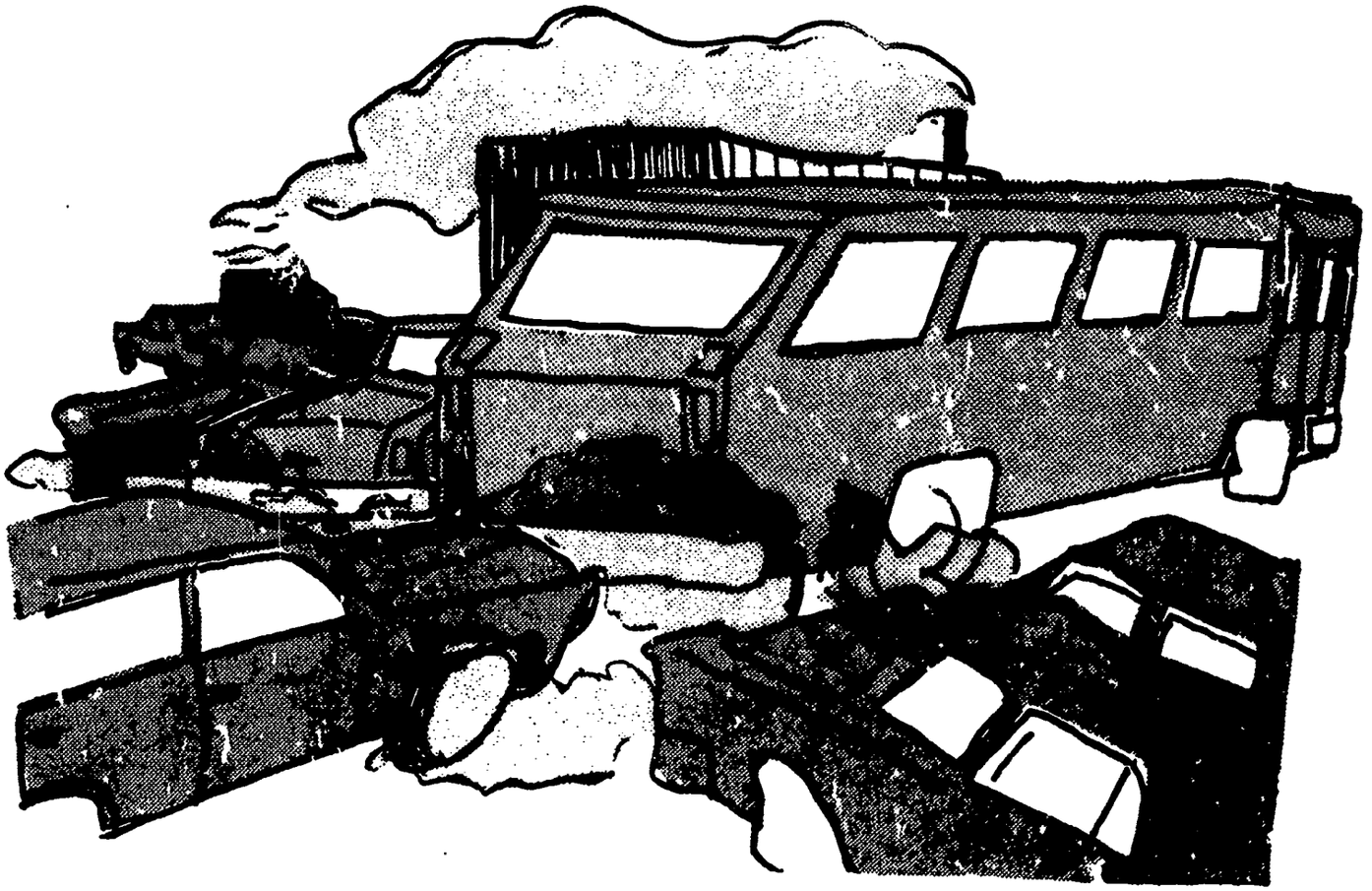
LEVEL (7 - 12)

ESTIMATED TIME 20 min.

Amount of Carbon Monoxide, Hydrocarbons and Nitrogen Oxide produced per day by one automobile.

PROBLEM SOLVING

Automobiles emit air pollutants.



LEVEL VI OBJECTIVE

The student will know the amount of pollutants such as carbon monoxide, hydrocarbons, and nitrogen oxide caused by automobiles in a specified area.

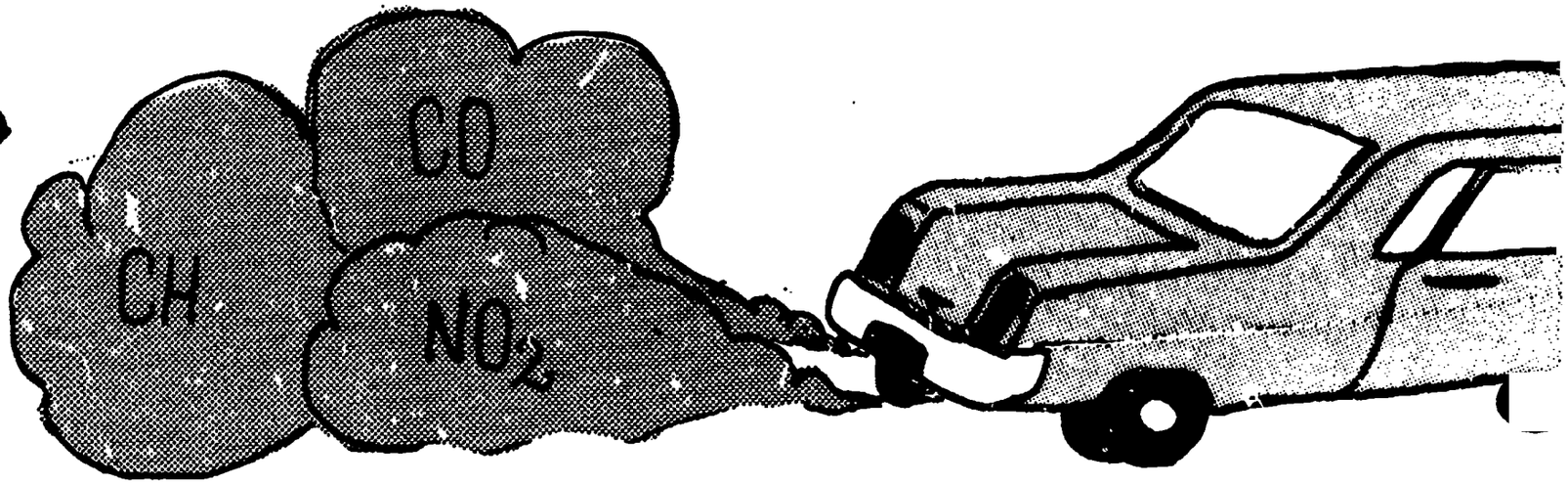
TEACHER BACKGROUND

Determine the amount of carbon monoxide, hydrocarbons, and nitrogen oxide produced per day by one automobile. Give the answer in pound weight to the nearest hundreth.

GIVEN: 90,000,000 cars produce on the average
180,000 tons of carbon monoxide,
33,000 tons of hydrocarbons and
17,000 tons of nitrogen oxide per day.

Discuss problem, noting that information given is a national average and is not broken down into the number of cylinders or horsepower of car engines.

Discuss the type of math procedures needed to solve the problem.



MATERIALS NEEDED

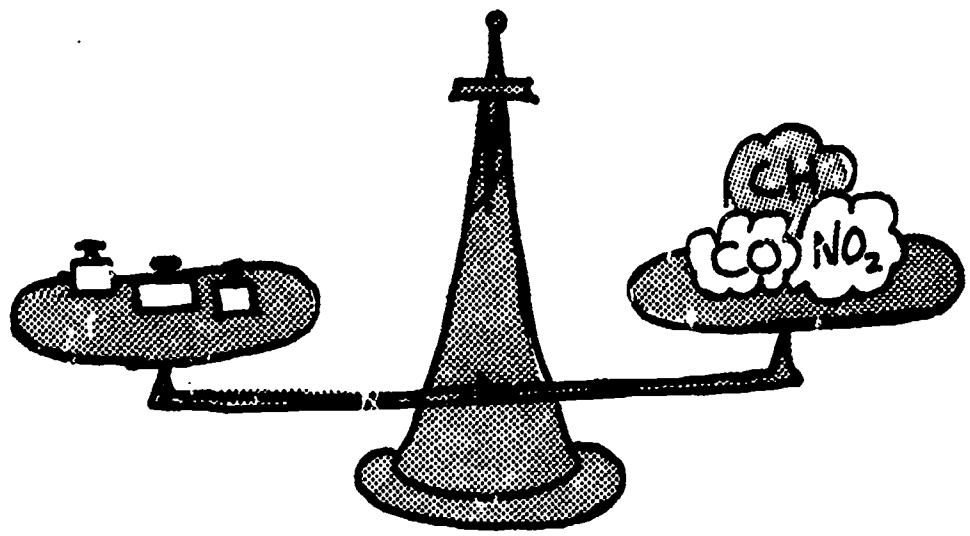
Pencil and paper, blackboard or ditto w/problem

Problem Solving:
If 90,000,000 cars account for 180,000 tons of carbon monoxide, 33,000 tons of hydrocarbon, and 17,000 tons of nitrogen oxide per day, what is the production of one car per day in pound weight to the nearest 100th? Per year (365)?

Project the daily average per car to yearly average.

Obtaining the daily average of number of automobiles in local area, project the amount of pollutants into the air daily.

Some discussion questions might be: "What ways might be used to cut down on automobile pollution?" "Is the rapid transit idea a means for cutting back on the use of so many cars?"



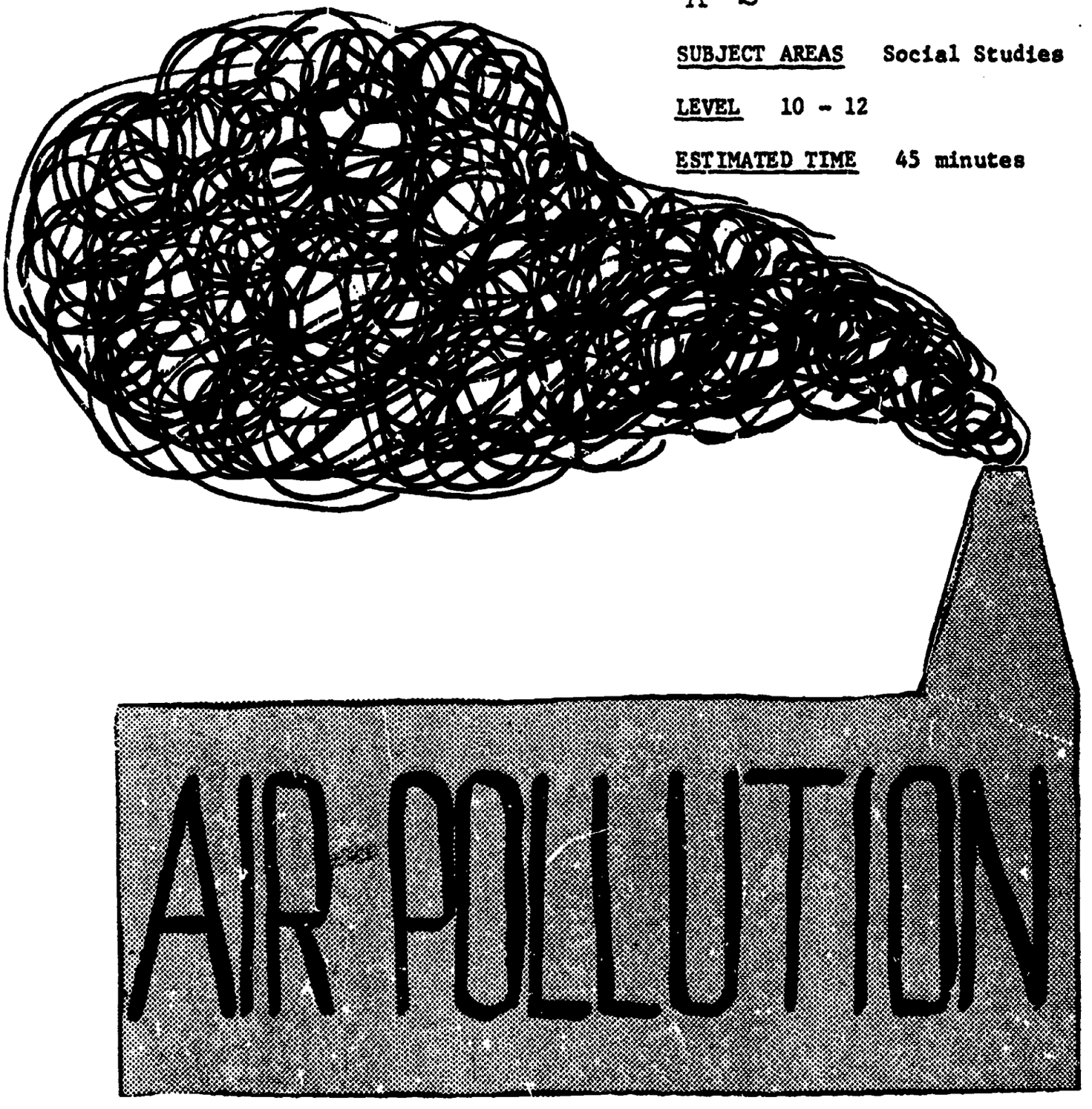
ACTIVITY

A-2

SUBJECT AREAS Social Studies

LEVEL 10 - 12

ESTIMATED TIME 45 minutes



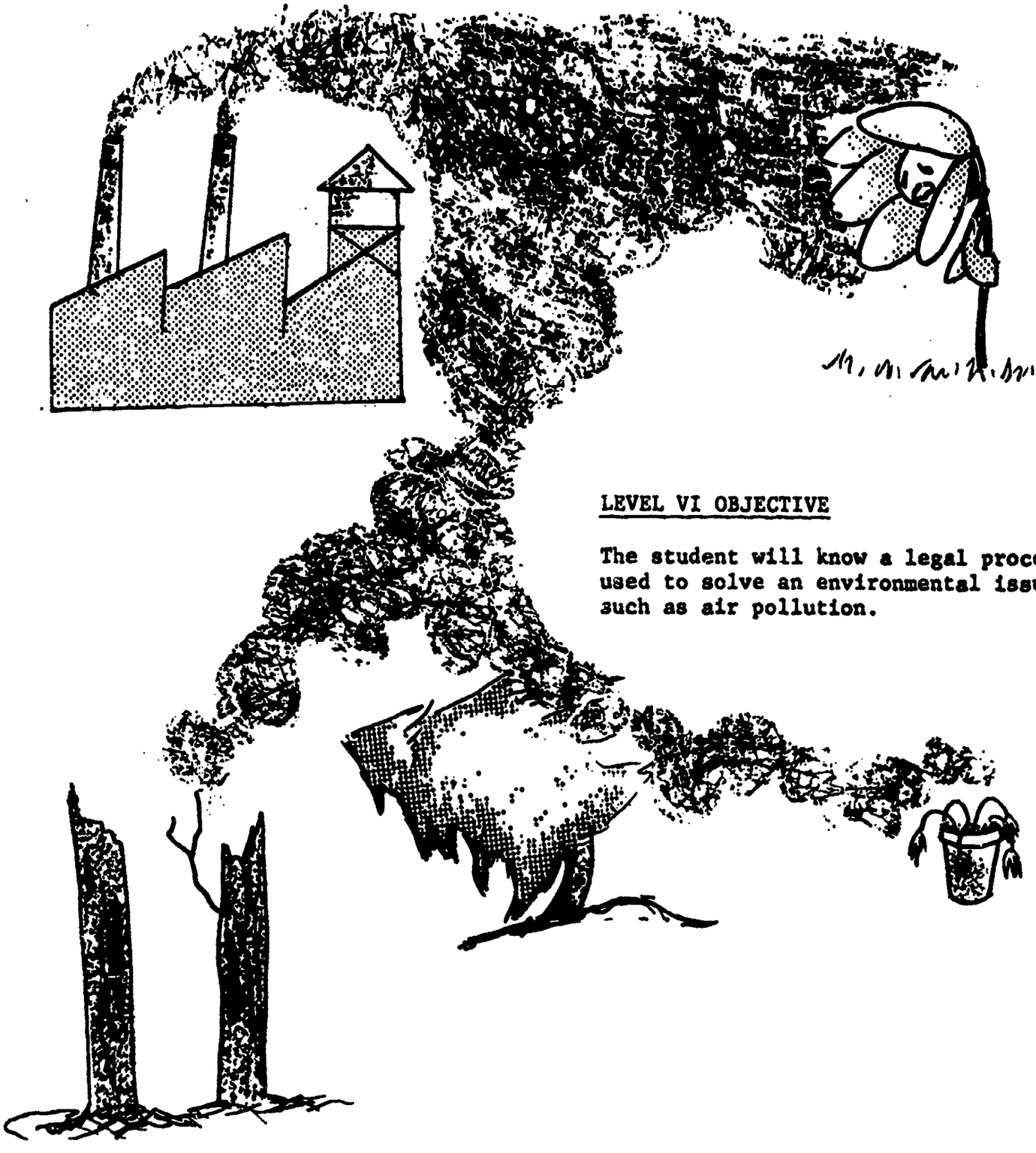
Hearing by Air Pollution Board

Concerning Industrial Emissions of

Air Pollution

SIMULATION GAME

Air pollution is harmful to plants.



LEVEL VI OBJECTIVE

The student will know a legal process used to solve an environmental issue such as air pollution.

OBJECTIVES

TEACHER BACKGROUND

Some introductory questions might be: "What courses of action might a citizen or group of citizens take against an industry which is emitting air pollution?" "What governmental agency might handle the hearing?"

Introduce the hypothetical problem to be solved by the hearing board. Example: Company X is emitting air pollutants which has an adverse effect upon vegetation within a 2 mile radius. Included within that radius is a park site and private homes. The teacher can make a decision on the amount, if any, of discussion necessary prior to the beginning of the simulation game.

Example for Teacher use:

> Role Card - Hardware store owner of Group A--special interest in Industry
>
> 1. What affect would closure of the industry have on the community?
> 2. What affect . . . . . .
> 3.
> 4.

MATERIALS NEEDED

Role cards, white butcher paper and marking pens, Washington State air pollution laws, biological information concerning the effect of air pollution upon plant life, and other materials considered important by teacher (i.e., a map indicating the hypothetical area affected by the industrial plant.)

REFERENCES

Environmental Pollution. Andrews, William A. et al. Prentice-Hall -- 1972 Contours Series

Washington Air Pollution Laws and local laws

PRE-ACTIVITY

Students should be given role cards indicating the role to be played by each student and some of the effect that might occur (i.e., Hearing Board members will have to reach a decision whether or not controls will be placed upon the industry as a result of the hearings.) Each student should be clear as to the role he has assumed and the teacher should check to make sure the role is clear to the student.

ACTIVITY

The roles are as follows:

GROUP A: Business Owners - Grocer, Hardware Store Owner, Apartment Owner and Department Store Owner

These players represent the business interests within the city. The businessmen might have some of the following interests:

1. What affect would the closure of the industry have upon the community?
2. What affect will limiting production capacity have on local tax revenue?
3. Will the adding of pollution control devices raise the possibility of work force reduction?
4. Is the saving of a few plants worth the possibility of any of the above actions?

GROUP B: Citizen Action Committee - Garden Club member, representative from Park Board, Biologist, Environmentalist.

These people might have some of the following interests:

1. What affect does the air pollution have upon plant life within the park site?

2. What yearly expenses might be expected through replacement of plants and trees in the park if the air pollution was allowed to continue?

3. Would the use of the park be less because of the air pollution?

4. What mechanical devices might be used to control smokestack emissions of the industry?

(Some research will be necessary to have factual information available for student use.)

GROUP C: Local Homeowners - Homeowner A, Homeowner B, Homeowner C and Homeowner D.

These people may exhibit some of the following interests:

1. What is the effect of the air pollution upon the surrounding land value?

2. What is the effect of the air pollution upon the landscape efforts of local homeowners?

3. What is the effect of the air pollution upon human health?

GROUP D: Representatives of the Industry - Financial Advisor, Plant Engineer, Personnel Director and an Industrial Health Biologist

These players may exhibit the following interests:

1. What effect may the addition of pollution control devices have on total cost of running the company?

2. What means may be employed to cut down on costs to equalize the cost factor of implementation of pollution control devices?

3. What laws govern the control of air quality?

4. What types of plants might be used that would have a resistance to the air pollution?

5. If controls are levied, how long would the company have to implement the corrective measures?

The class will be divided into groups, each representing the special interest Groups A through D and an air pollution hearing board of 3 to 5 members. Each group will have 10 minutes to come up with arguments to convince the air quality board why or why not controls should be levied upon the industry. When the time is up, the groups will have 3 minutes each to state their case to the board. They may use comparison charts or any other visual aid to help them with their case.

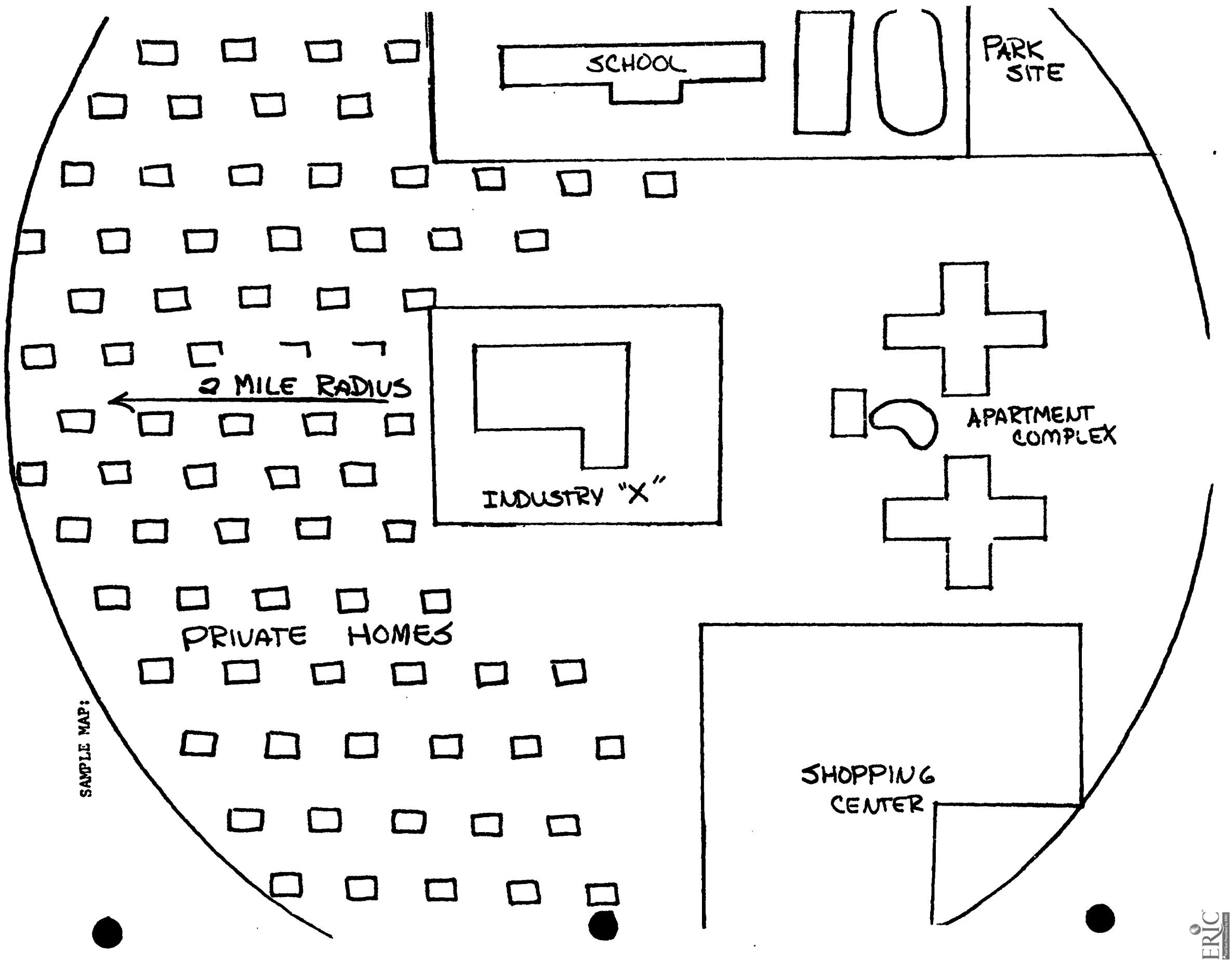
After the presentations, the board will recess for 5 minutes and come up with their solution to the problem.

Time for this Activity: 45 minutes

POST-ACTIVITY

A classroom discussion as to the trend of public offices towards decisions involving industry should be the logical follow-up.

Some questions for discussion might be: "How realistic was the decision made by the quality board in relation to what happens in real life?"


SCHOOL
PARK SITE
2 MILE RADIUS
INDUSTRY "X"
APARTMENT COMPLEX
PRIVATE HOMES
SHOPPING CENTER
SAMPLE MAP:

OTHER SIMULATION GAME ACTIVITIES RELATED TO AIR POLLUTION

1. Application by a company to the County Planning Board to build a pulp mill three miles from the city limits.

2. Federal Court case to close down an offensive smelter.

3. Application to the County Planning Board to build a flouride producing aluminum plant in dairy country.

4. Federal Court case: State vs. Large Coal Burning Power Plant.

5. Presentation by the city council in an open hearing to the voters of a plan to ban cars from the city center within a 5 mile radius.

6. Airborne soil erosion: County Agriculture Agent meeting with farmers over wind erosion on unprotected soil.

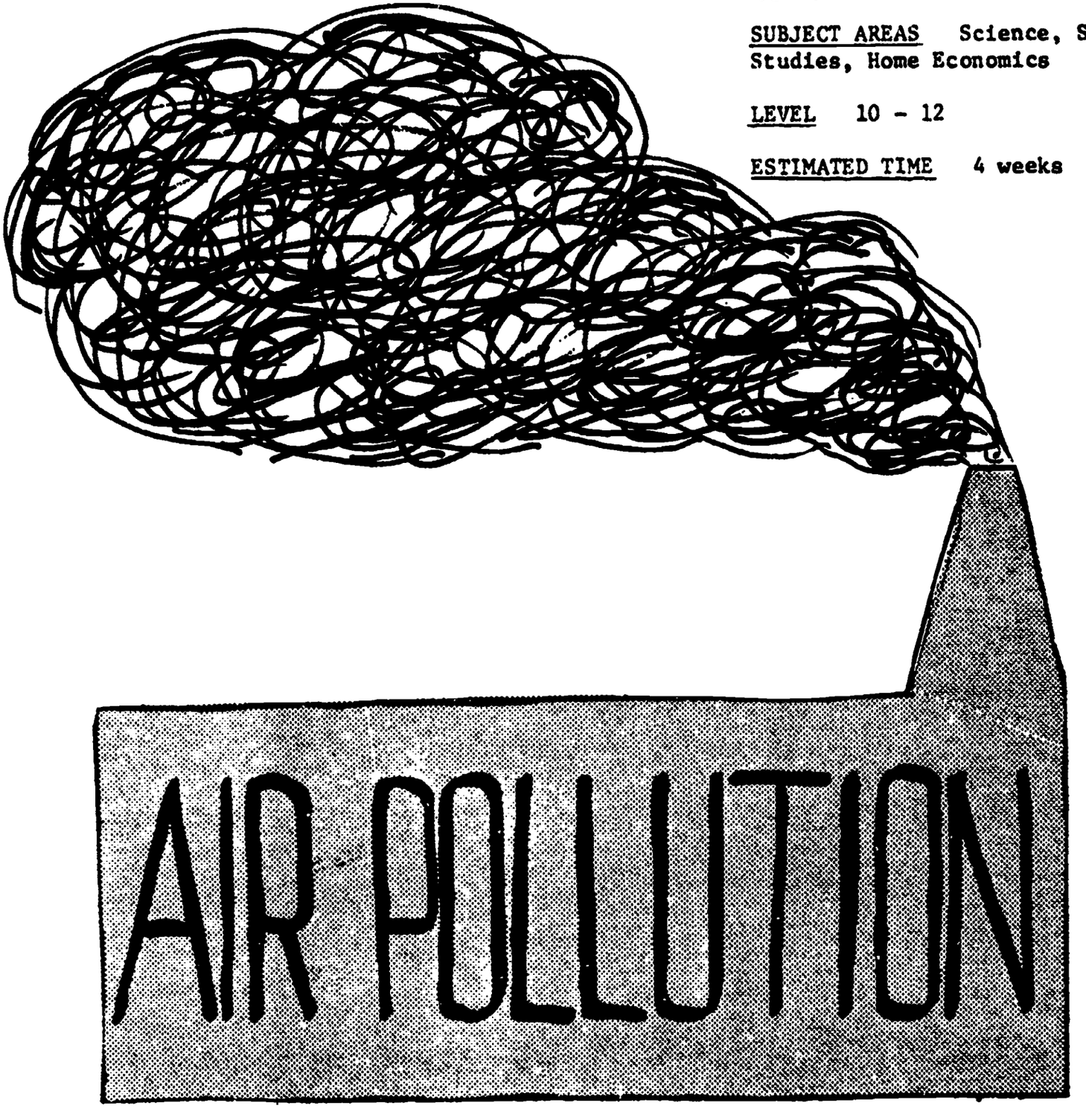
7. Spraying pesticides: Corn Growers vs. Department of Ecology.

A-3

SUBJECT AREAS Science, Social Studies, Home Economics

LEVEL 10 - 12

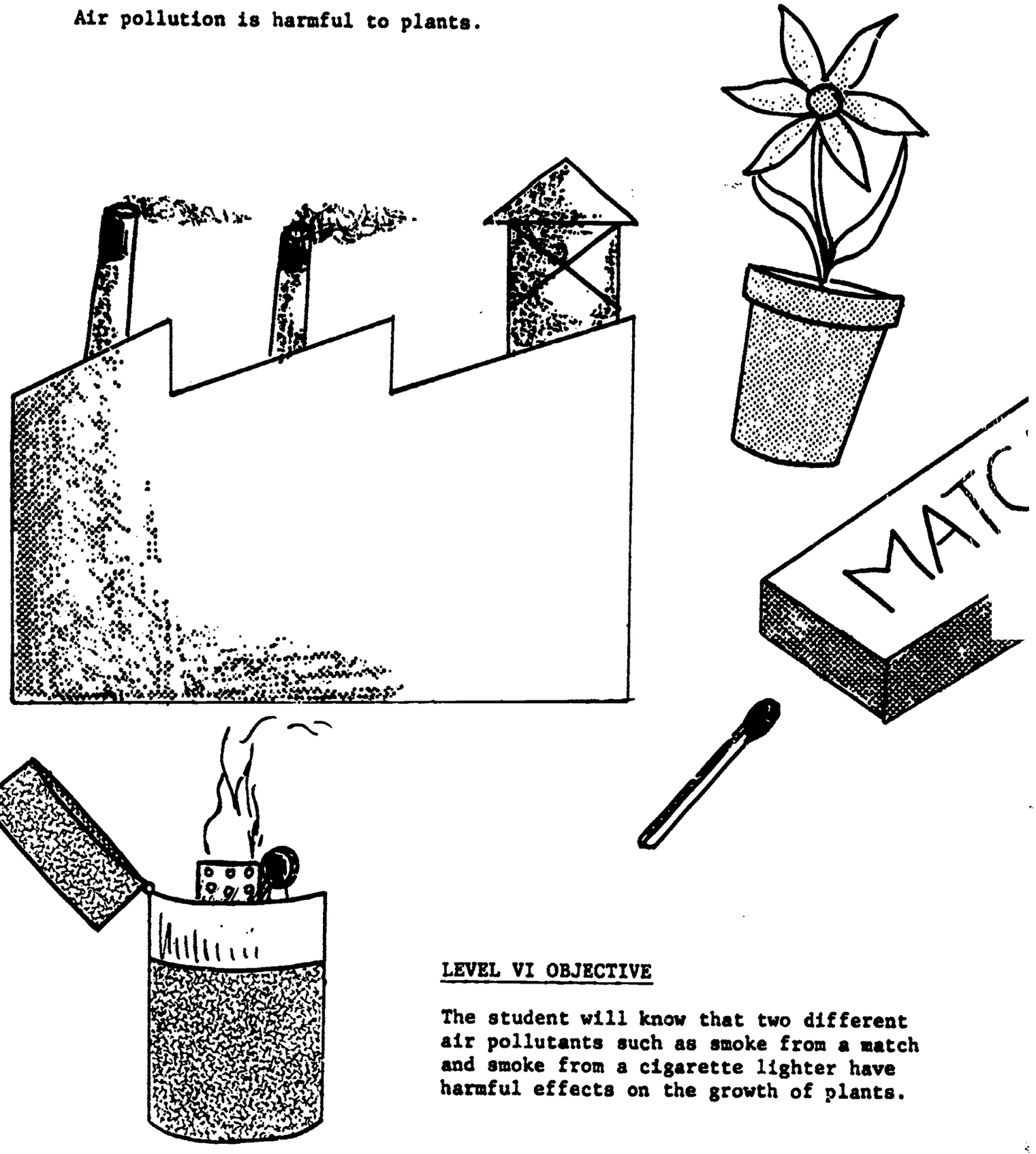
ESTIMATED TIME 4 weeks



Effects of Two Air Pollutants upon White Petunias.

LAB EXPERIMENT

Air pollution is harmful to plants.

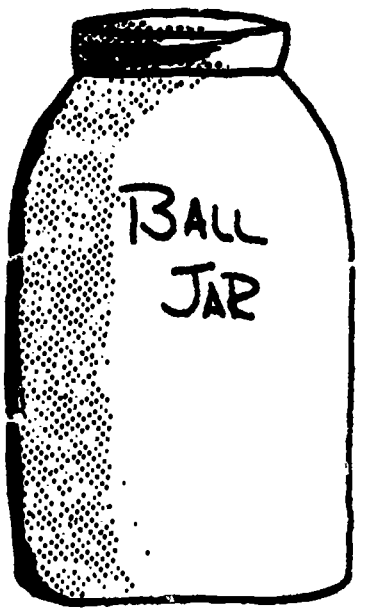


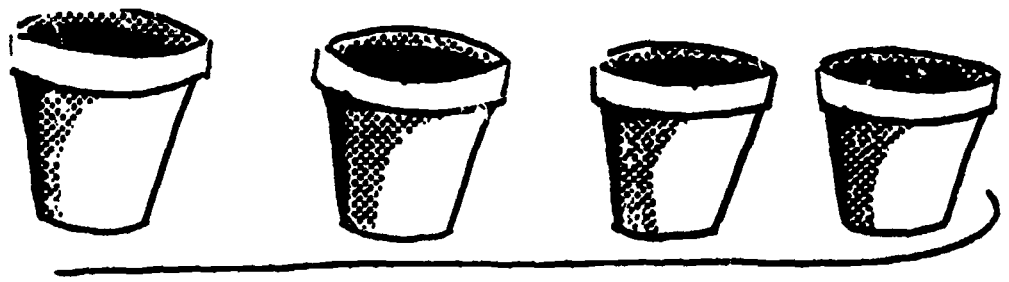
LEVEL VI OBJECTIVE

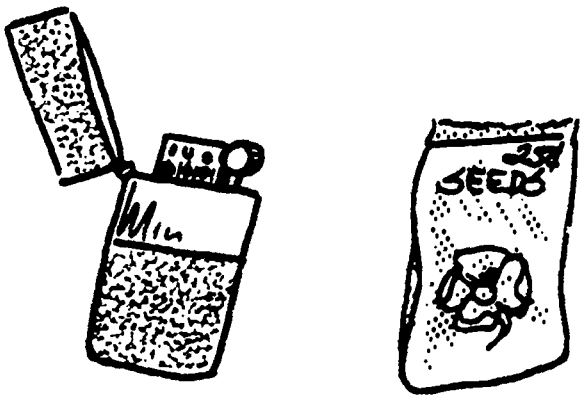
The student will know that two different air pollutants such as smoke from a match and smoke from a cigarette lighter have harmful effects on the growth of plants.

TEACHER INFORMATION

Scientists are finding that many plants are being harmed by air pollution. Here is a project that will enable your class to investigate the effects of two different pollutants on a particularly sensitive plant. Some introductory questions might be: "What are some of the visable ways that air pollution affects plants?" "Why do some trees show a yellow coloration in populated areas?"







MATERIALS NEEDED

For each group:
- Six Flowerpots
- Packet of white petunia seeds
- Soil for planting
- Wooden or paper matches
- Cigarette lighter
- Six glass jars which will cover plants and flowerpots
- Lids for jars
- 3 x 5 cards with metric or inches placed on for a measuring device

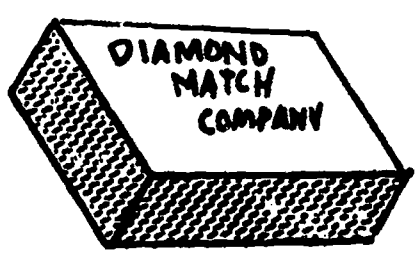
TEACHER BACKGROUND

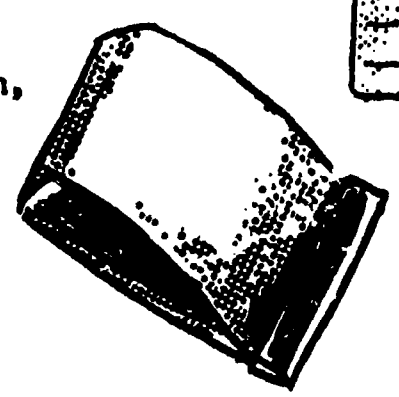
PRE-ACTIVITY

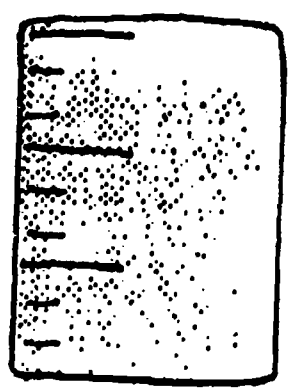
Time: 15 minutes. Work in small groups.

Plant several white petunia seeds in each of the six flowerpots. During the project, give all the plants the same kind and amount of care.

When the seedlings are about 1 to 2 inches high, start Task A.







ACTIVITY

ACTIVITY

Task A — TIME: 20 minutes

Two of the flowerpots will be the control group.

Strike two wooden matches in an ashtray. Immediately invert a large jar over the ashtray, making sure to catch the initial fumes. After one minute, clamp a lid over the jar opening. Then remove the lid and quickly place the jar over the seedlings growing in the flowerpot. Keep the jar over the plants for 15 minutes. Label the pot with the name of the pollutant.

Repeat the procedure with two more matches and another pot of petunia seedlings.

Task B and C may be run in conjunction with Task A by assigning various group members to each task.

TASK B — TIME: 20 minutes

Pollute two pots of seedlings with fumes from a burning cigarette lighter following the procedures outlined in Task A. Use separate labeled jars for each pollutant.

TASK C — TIME: 15 minutes

Place a jar of clean air for 15 minutes over two plants which are serving as a control group.

TASK D — TIME: same as before

Repeat Tasks A, B and C once a week. When you are treating the plants, remove them from the area where the others are and keep them separate for at least one hour afterward. This will avoid the problems of contamination.

TASK E TIME: 15 minutes

Make daily notes of the appearance of each plant, such as height, color and general condition. You might even take pictures each week to give you a good record of your project. A color wheel for color comparisons would be helpful.

POST-ACTIVITY

After 4 weeks, compare the condition of your control plants with that of your polluted plants.

Which is the most harmful pollutant?
What kind of common air pollutant could the fumes from a cigarette lighter be compared to?
What kind of common air pollutant could the fumes from burning matches be compared to?

RELATED ACTIVITIES

Simulation game involving an air pollution control board hearing by an environmental group against an industry with air pollution which effects local plant life.

Construct a graph representing growth of plants.

Construct color chart comparisons of plants at the beginning of the experiment through to the end.

Plan art projects centering around harmful aspect of air pollution to plants.

Debate issue of industry vs. plant life.

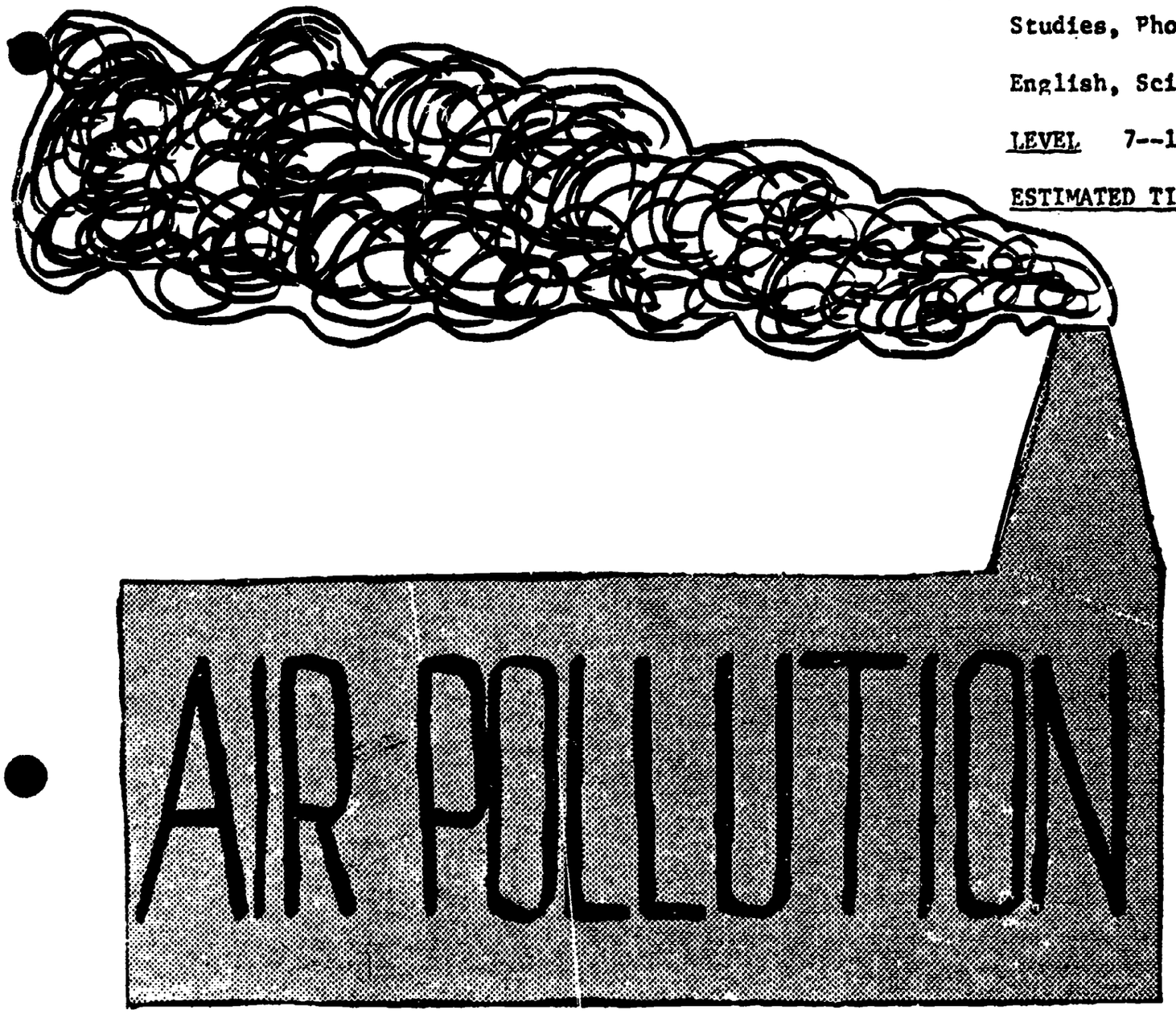
Research history of a specific industrial plant and the long range effects of its air pollution upon the plant life.

A-4

SUBJECT AREAS Social Studies, Photography, English, Science

LEVEL 7--12

ESTIMATED TIME 2 weeks

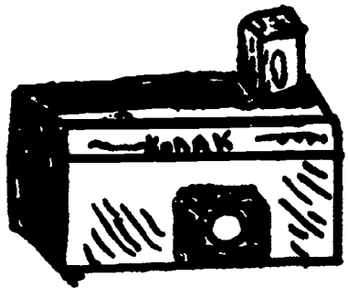


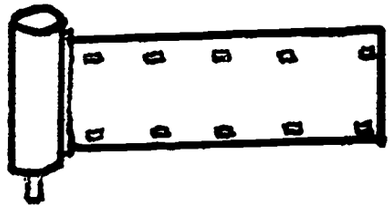
Sources of Air Pollution

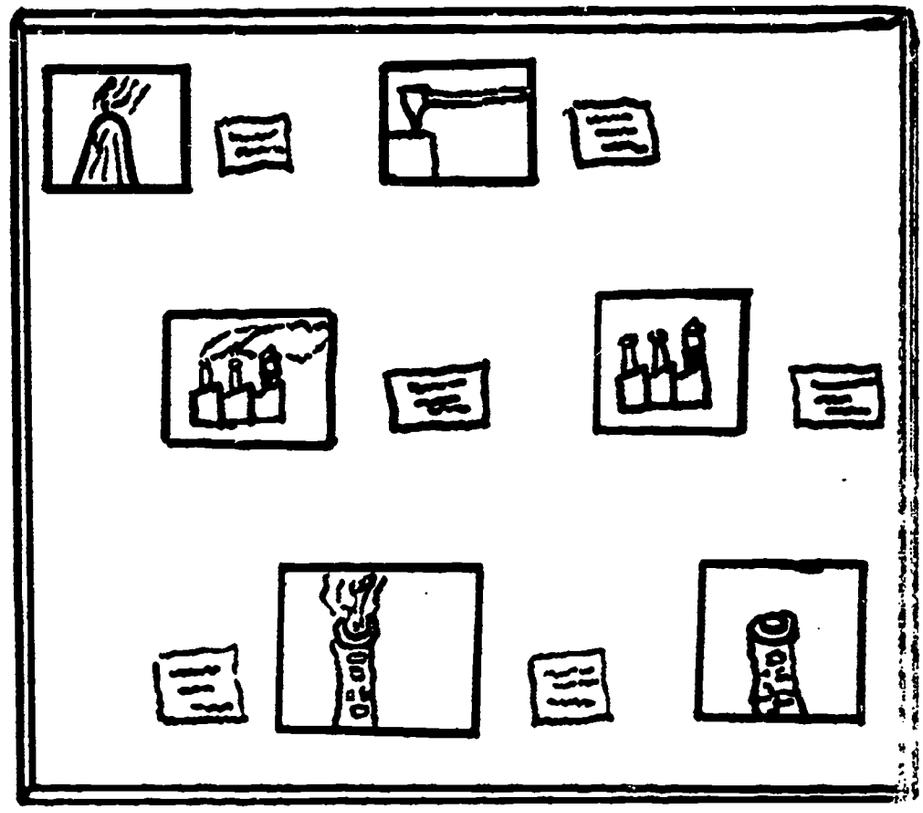
within our area.

PHOTO ESSAY

Construction of a photo record of air pollution within the local environment.







LEVEL VI OBJECTIVE

The student will know major sources of air pollution within his community.

TEACHER BACKGROUND

Prepare a list of sites which may be of interest to the students. Locate these sites for the students and obtain permission for the photographing of these sites. Allow enough time for the assignment to cover the photographing and developing of the film (approximately two weeks). Have a model of a photo essay ready to give the students some idea as to how one is constructed. It is suggested that one format may be before and after pictures or a sequence of events. A bulletin board may be another means of portraying a central idea.

Example: A picture of a tepee burner in a lumber mill with smoke coming out and a card describing the types of pollutants emitted into the air.
Another picture with a description card may be placed next to it showing an alternate way of disposal which has little or no pollution.

Some introductory questions might be: "What are some of the areas of air pollution in our community?" "Are there ways of controlling this pollution?"

REFERENCES

Operation Manual for Camera Film Speed and Camera Settings from the Film Box, and a Photo Essay model.

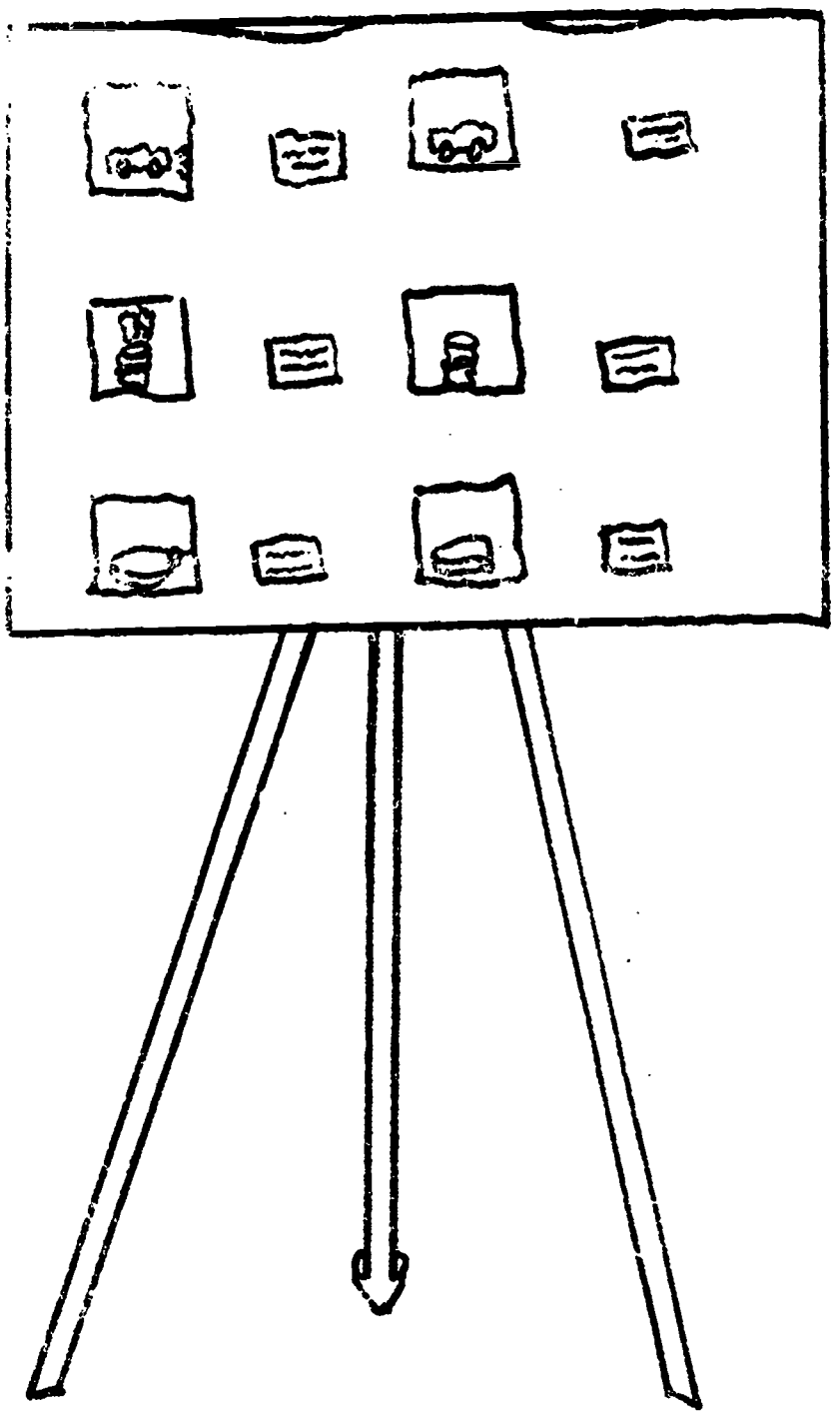
Sites: Sultan, Arlington

MATERIALS NEEDED

Camera, black and white film or colored slide film if slides are to be used.
List of sites to be visited
Model of a photo essay
Means of transportation

PRE - ACTIVITY

Select the local sites to be visited and locate them on a map. Plan the sequence and photo format to be used. Collect the needed equipment and decide whether a bulletin board or slide show is to be used.



ACTIVITY

Visit sites, taking pictures of air pollution. Try to get different types of pollution. Example: smoke stack emissions, trash burning, auto emissions, aircraft emissions, boat emissions, oil refinery emissions, chemical plant emissions, etc. Take film to be developed.

POST-ACTIVITY:

Upon receiving film, the group should construct a bulletin board display showing the various sources of air pollution and give possible ways of controlling or eliminating these pollutants.

Classroom discussion should follow, evaluating the description of the photos by the groups.

Discuss the possible solutions to some of the existing pollution problems today.

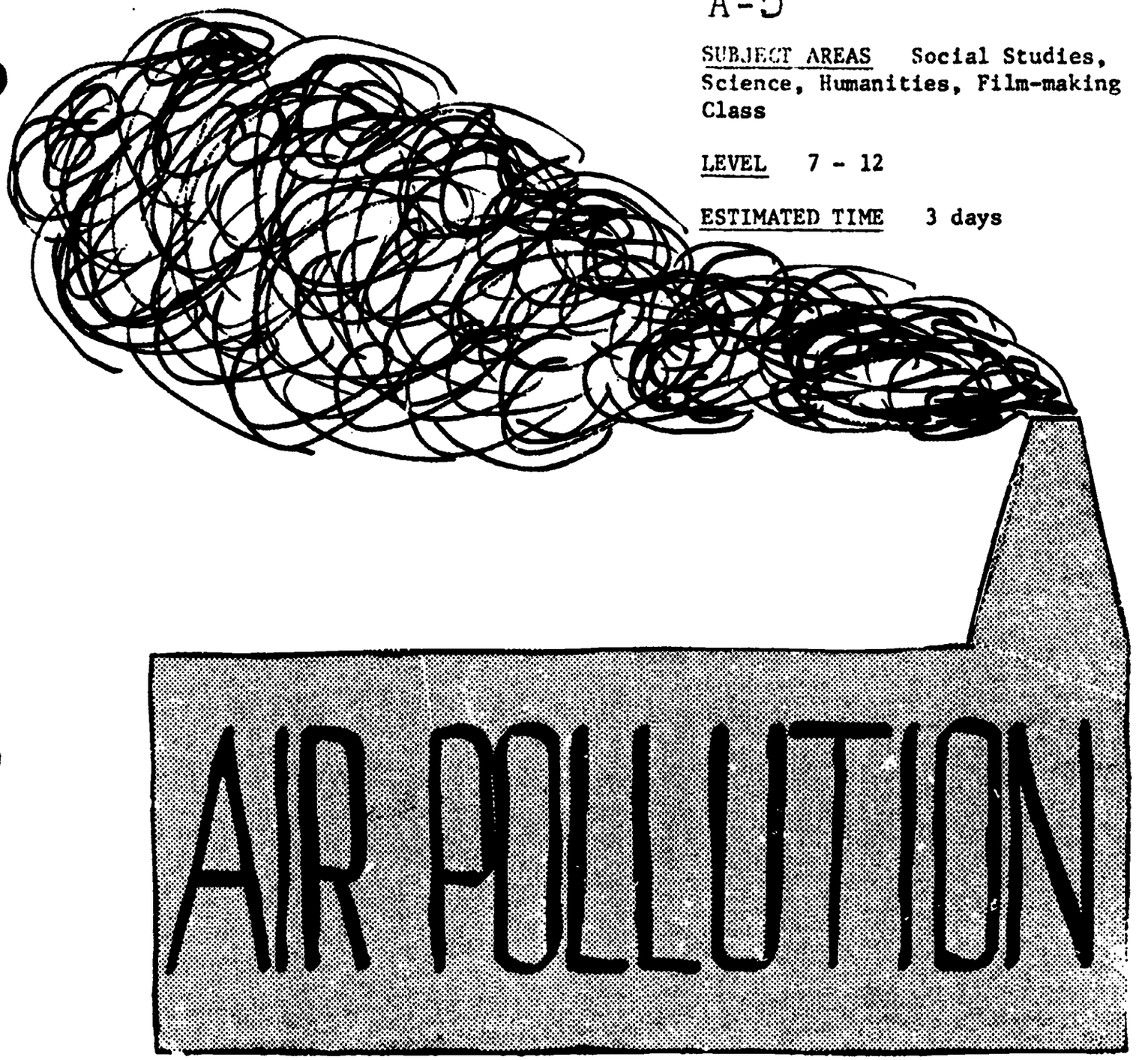
Some discussion questions might be: "What types of air pollution have been portrayed in the photo essays?" "Did you have trouble finding examples of air pollution control devices?"

A-5

SUBJECT AREAS Social Studies, Science, Humanities, Film-making Class

LEVEL 7 - 12

ESTIMATED TIME 3 days

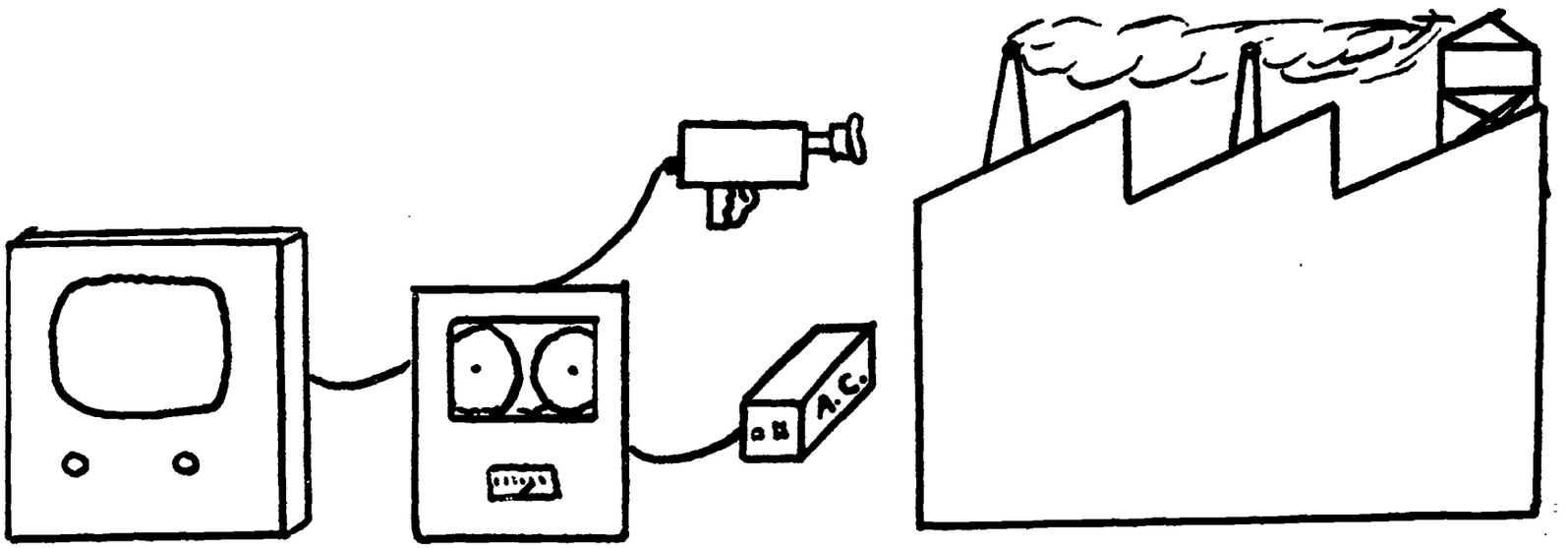


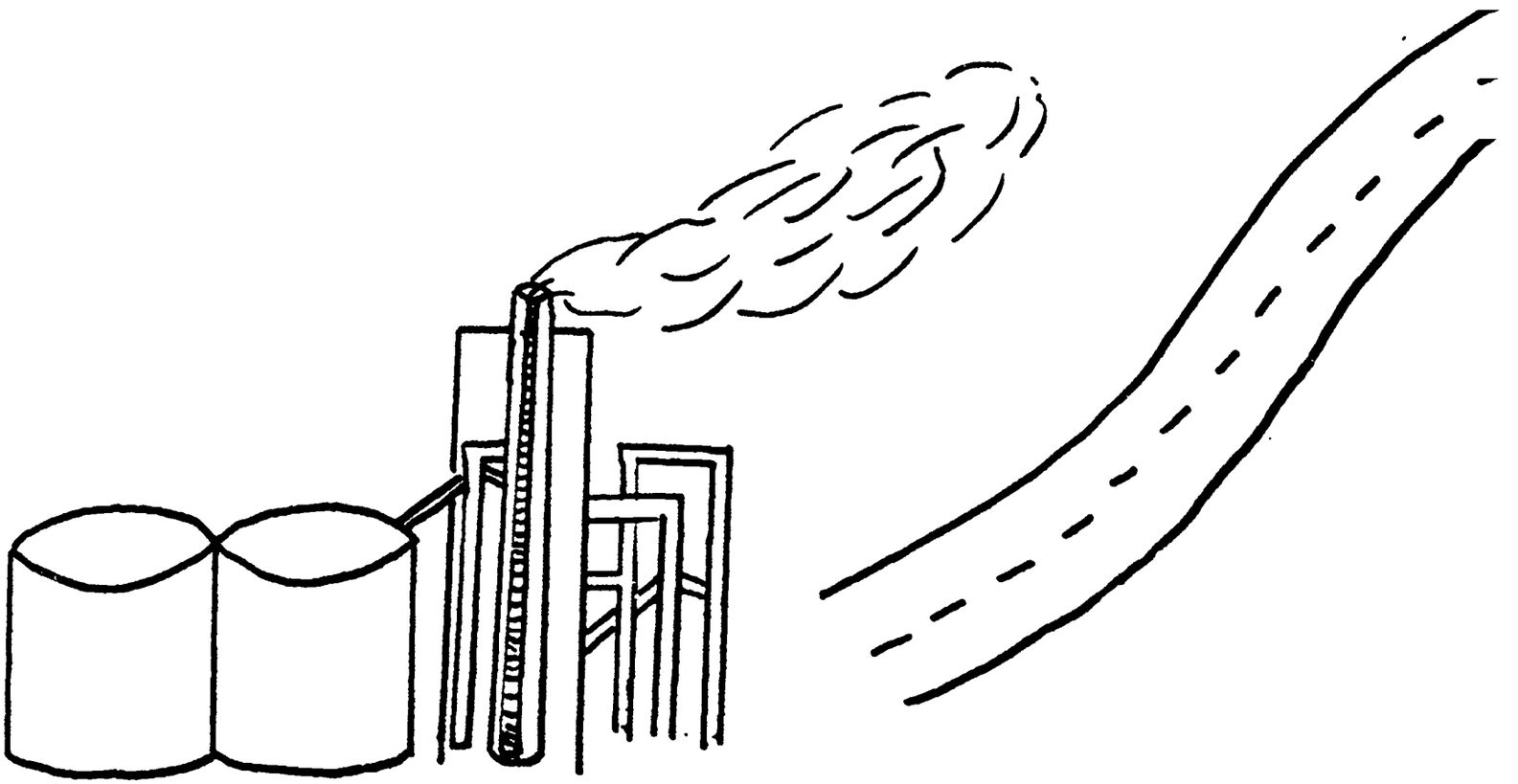
Sources of Air Pollution

within our area.

PHOTO ESSAY

Discovery of sources of air pollution within the local environment.





LEVEL VI OBJECTIVE

The student will know major sources of air pollution within his community.

TEACHER BACKGROUND

It is important to warn the students not to point lens or leave the camera pointed at direct sunlight or strong artificial light sources. This will burn out the camera. Possible sites for the project are: factories, forest products industries, boat emissions, freeways during peak hours, incinerators (possibly on school grounds), burning of grasslands, jet airplane exhaust, railroads, smoking, heating plants, electrical generating plants using fuel as an energy source. It would be most prudent to obtain permission to photograph most of these sites. Otherwise, there is the telephoto zoom lens.

Some introductory questions might be: "Can you identify some sources of air pollution in our community?" "In what ways are some of the industries controlling the air pollution?"

MATERIALS NEEDED Portable video tape recorder (V.T.R.) with camera, A.C. adaptor, V.T.R. Monitor Receiver, 30 minute Blank Video Tape, V.T.R. Operational Manual. Transportation, List of probable sites.

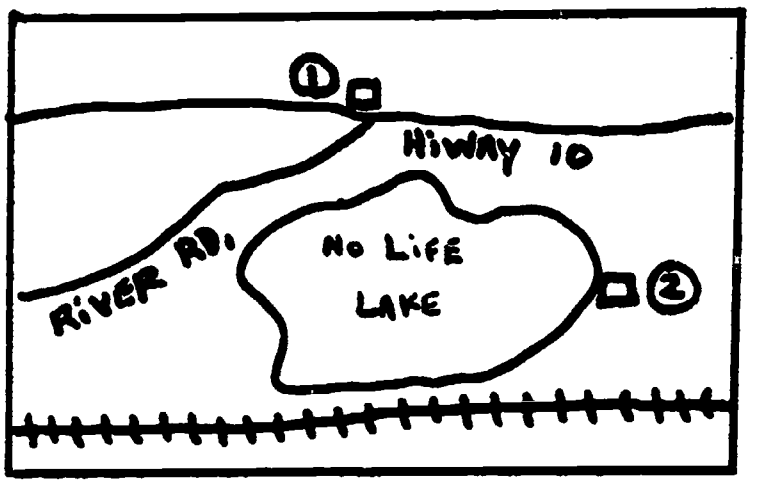
REFERENCES

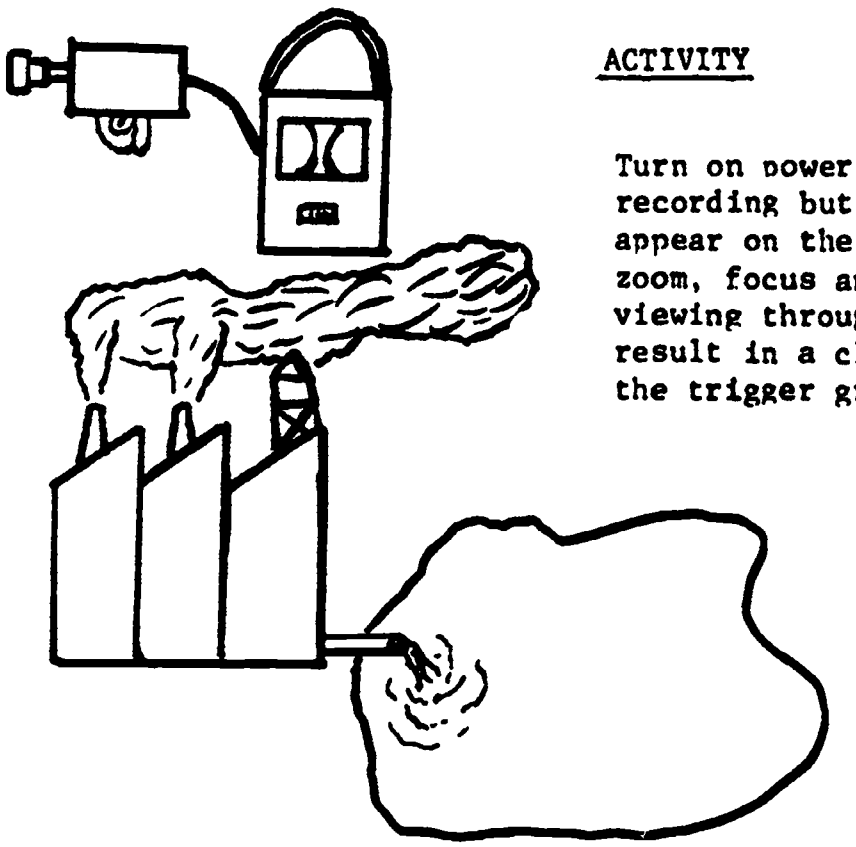
Video Tape Recorder Operations Manual

"The Student Movie As A Teaching Tool", pp. 39-41, Science Activities, June 1970

PRE-ACTIVITY

Select the local sites to be visited and locate on a map. Plan the sequence and photo format to be used. Charge batteries with an A.C. Adapter up to "Fully Charged" as indicated on the meter. Select approximately 30 minutes worth of filming.





ACTIVITY

Turn on power switch of portable V.T.R. Depress recording button and play button. Image should appear on the viewfinder of the camera. Adjust the zoom, focus and iris of the portable camera while viewing through the view finder. Once adjustments result in a clear image, depress the switch on the trigger grip of the camera and record the subject.

POST ACTIVITY

Most video tape recorders now have dubbing devices which permit the adding of an audio track without affecting the video signal on the recorded tape. A narrative which depicts a central theme may be written after viewing the completed tape. This narrative may then be added as an audio signal on the video tape.

Have the class discuss how well the group has covered their topic in pictures and how well they have narrated their video message.

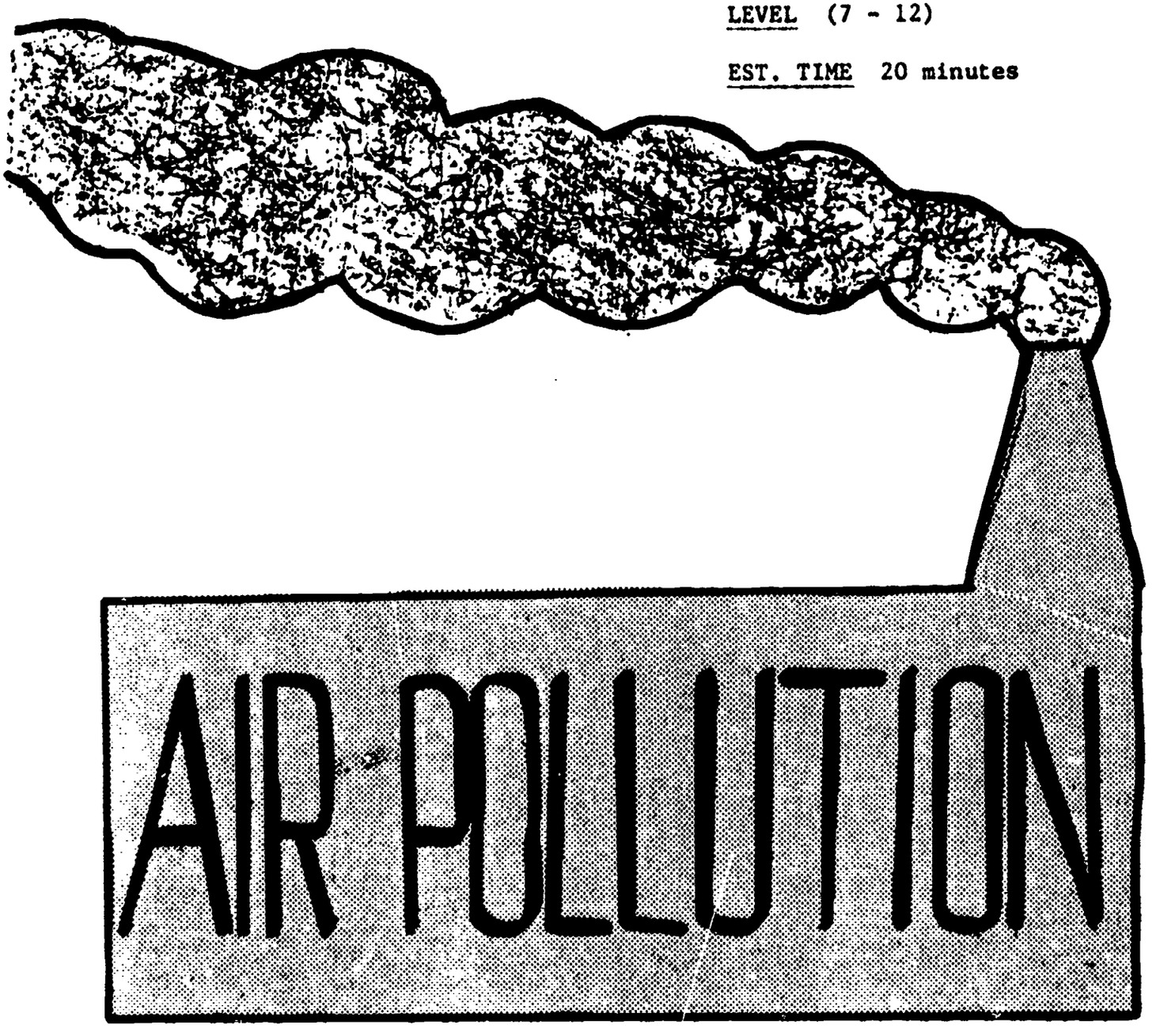
A-6

SUBJECT AREAS

Math
Social Studies

LEVEL (7 - 12)

EST. TIME 20 minutes



THE RATIO OF OXYGEN PRODUCTION TO OXYGEN CONSUMPTION IN THE UNITED STATES

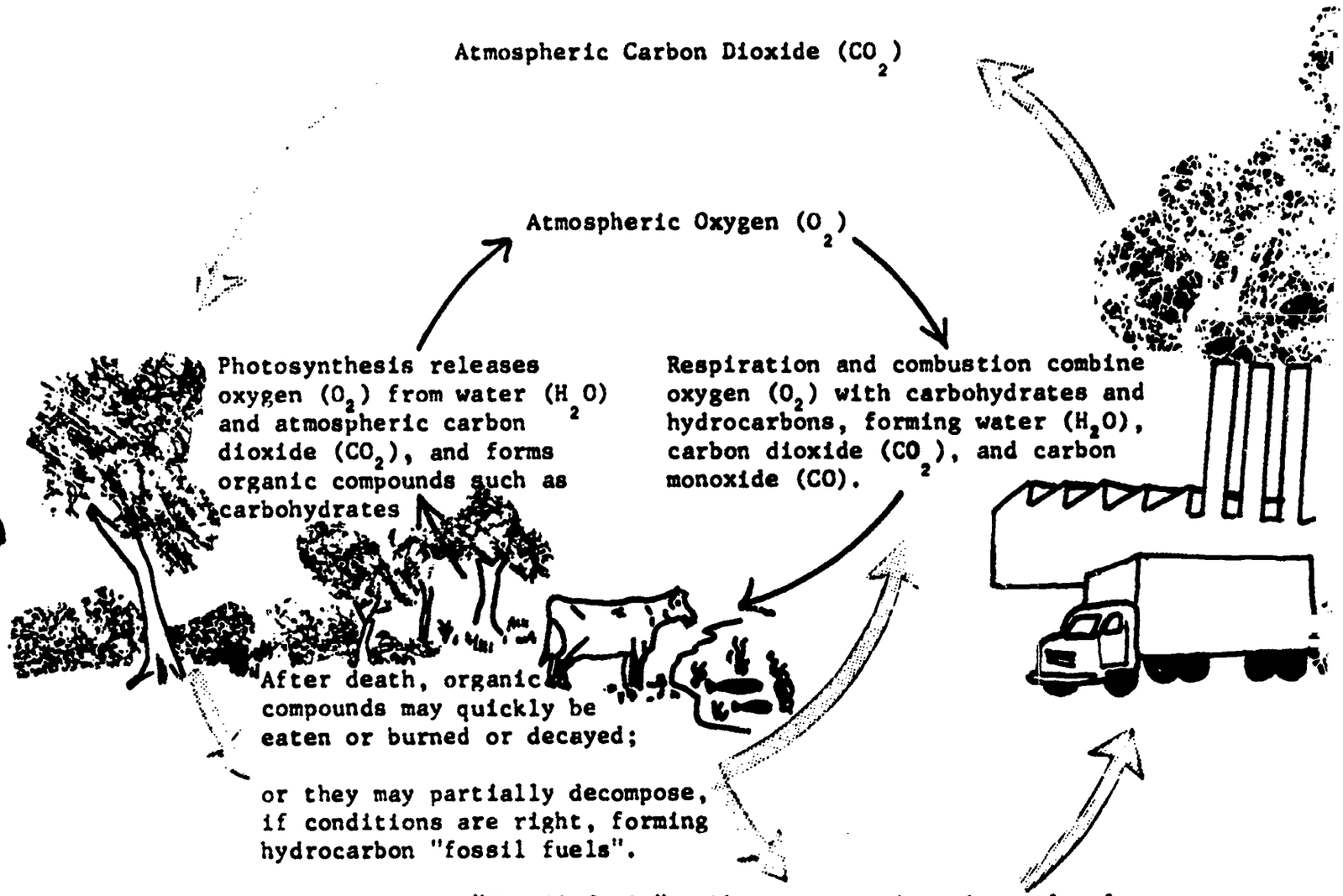
Supply and demand of natural resources

LEVEL VI OBJECTIVE

The student will know the ratio of oxygen produced to the consumption of oxygen in the United States.

TEACHER INFORMATION

The yearly production of oxygen of all the plants on the earth is 128,300,000,000 tons. The greenery in the U.S. produces about 2,882,000,000 tons. The consumption rate amounts to about 4,906,000,000 tons.



Path of Oxygen: ⟶

Path of Carbon Dioxide:

MATERIALS NEEDED

Pencil and paper

PRE - ACTIVITY

Methods of problem solving:

Review the mathematical process of figuring percentages.

ACTIVITY

Determine the ratio of the production of oxygen to the consumption of oxygen in the United States.

POST ACTIVITY

One million acres of land are being taken out of production per year. What analysis may be made regarding the production rate versus the consumption rate of oxygen per year in the United States?

ACTIVITY

A-7 SUBJECTS

Science, Social Studies

LEVEL (7-12)

EST. TIME (45 minutes)

CARBON DIOXIDE

LABORATORY INVESTIGATION

Carbon dioxide is a measurable part of the air pollution problem.

LEVEL VI OBJECTIVE

The student will understand the role of CO_2 in the carbon cycle.

Carbon dioxide is the natural product of plant and animal respiration. The level of CO_2 is maintained with a relative constancy by the interaction between photosynthesis and respiration and the fact that the oceans act as a storage reservoir for CO_2. Increased burning of fossil fuels is upsetting this by adding CO_2 to the atmosphere at a rapid rate. Scientists are not in total agreement what the results may be, but some dire predictions are an increase in storms; the increase in cloud cover causing another ice age or the melting of ice caps due to the greenhouse effect and the rising of the ocean level anywhere from 100-300 feet.

MATERIALS

Calcium Oxide (CaO) - lump
Distilled H_2O
Flask
Straw
Gallon Jar
Bag of collected exhaust gases

RESOURCES

Environmental Pollution, Andrews, William A. et al. Prentice-Hall, Inc. 1972. Contours: Studies of the Environment Series.

Environmental Pollution Experiences/ Experiments/Activities: Elbert C. Weaver. Holt, Rinehart and Winston Inc. 1971

Air Pollution Experiments for Junior and Senior High School Science Classes 2nd Ed.
Ed Hunter, Donald C. et al.
Air Pollution Control Association

PRE-ACTIVITY

Place a large lump of CaO in a gallon jug of water. Shake and let sit overnight. Decant clear liquid above sediment and use this. Keep stoppered.

Collect gas samples as previously directed from a variety of sources. These could be auto engines both tuned and untuned, a burning candle, or a student's breath.

ACTIVITY

1. Slowly squeeze the bagful of auto emissions through the lime-water. These emissions were collected as directed in a previous laboratory exercise. Use a 50 ml. quantity of limewater.
2. As you approach the end point where no more white precipitate forms go very slowly. When no more precipitate forms, note the time.
3. As you compare various sources of CO_2 the time it takes to reach the end point of precipitate formation is a measure of the amount of CO_2 present in the sample.

POST-ACTIVITY

COMPARE AND DISCUSS:

1. Draw a graph comparing amount of precipitate formed and the source of CO_2.
2. Since CO_2 is a common product of plant and animal respiration what danger is there in the increased production due to the burning of fossil fuels?
3. Is the rate of CO_2 production proportionately larger in an animal such as a human, or in a machine that burns fossil fuels?
4. What are the major sources of CO_2 in the world today?
5. What organisms require carbon dioxide?
6. How can carbon dioxide effect living things?

Source:

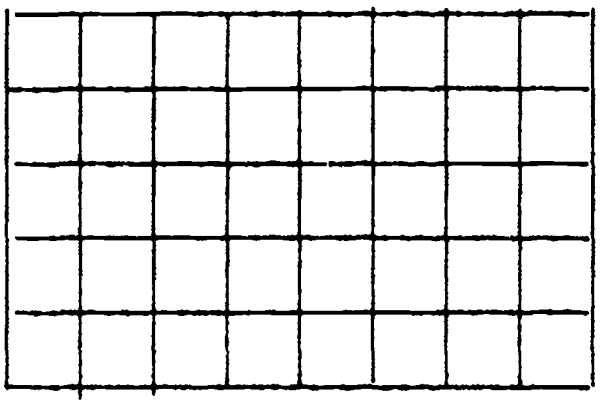
1._____

2._____

3._____

4._____

5._____



Amount of Precipitate:

A-8

SUBJECTS

Science

LEVEL (7 - 12)

EST. TIME (45 min.)

CARBON MONOXIDE ANALYSIS

LABORATORY INVESTIGATION

Carbon monoxide is a measurable component of air pollution.

LEVEL VI OBJECTIVE

The student will be able to determine the levels of CO_2 in auto emission samples and cigarette smoke samples.

Carbon monoxide is the result of the inefficient combustion of fuels.

When carbon containing materials such as coal, wood, oil, gas, etc., are burned under normal conditions and with sufficient air, carbon combines with oxygen in the air to form harmless carbon dioxide:

$$C + O_2 \quad CO_2$$

If insufficient air is present, or if the flames are allowed to contact cold surfaces, incomplete combustion results and carbon monoxide is formed:

$$2C + O_2 \quad 2CO$$

Carbon monoxide is combustible, and can be burned with more air to form carbon dioxide.

$$2CO + O_2 \quad 2CO_2$$

The inherent danger in carbon monoxide is the affinity of red blood cells for carbon monoxide.

When presented with the choice of oxygen or carbon monoxide, hemoglobin binds with CO at a rate 200 times greater than that of oxygen. Hemoglobin thus bound to CO cannot function in its major role of carrying oxygen to the cells for respiration.

Industrial hygienists have established tolerance limits in parts per million. These were 50 ppm for an 8 hour working day. 5-30 ppm limits have been suggested for continuous exposure. Only 10 ppm in air can cause illness whereas 1300 ppm will kill.

Although a short one hour exposure to 500 ppm has been claimed to have no physiological effect, others state that exposure to 120 ppm will effect driving responses. The hemoglobin can be "scrubbed" of CO rapidly when fresh air is introduced. Over 51% of the total annual air pollution in the U.S. is made up of CO so it is a major factor. The automobile is the main culprit contributing 95% of the total CO pollution.

Even closer to the students world is the fact that cigarette smoke contains 200-400 ppm CO and when exposed for 8 hours to 80 ppm CO, 15% of the blood is bound up, an amount equal to 1 pint.

Through this exercise the student can isolate and identify sources of carbon monoxide.

RESOURCES

Magill, Holden and Ackley, "Air Pollution Handbook", McGraw-Hill Book Company, New York, 1956.

"Threshold Limit Values for 1967" American Conference of Governmental Industrial Hygienists, 1014 Broadway, Cincinnati, Ohio.

Air Pollution Experiments-High School Edition: Cooperative Extension Service, College of Agriculture and Environmental Science, Rutgers-The State University, New Brunswick, New Jersey 08903; 1967.

Ward's Natural Science Establishment, Inc. P.O. Box 1749, Monterey, CA.

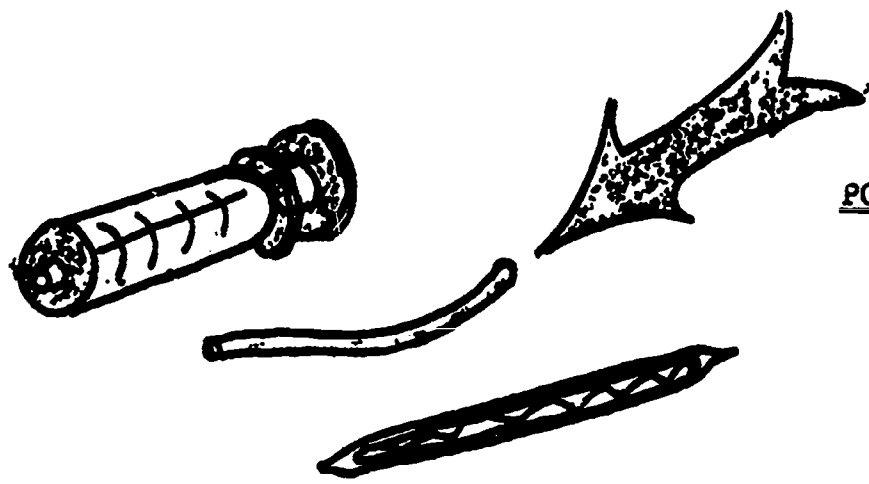
MATERIALS

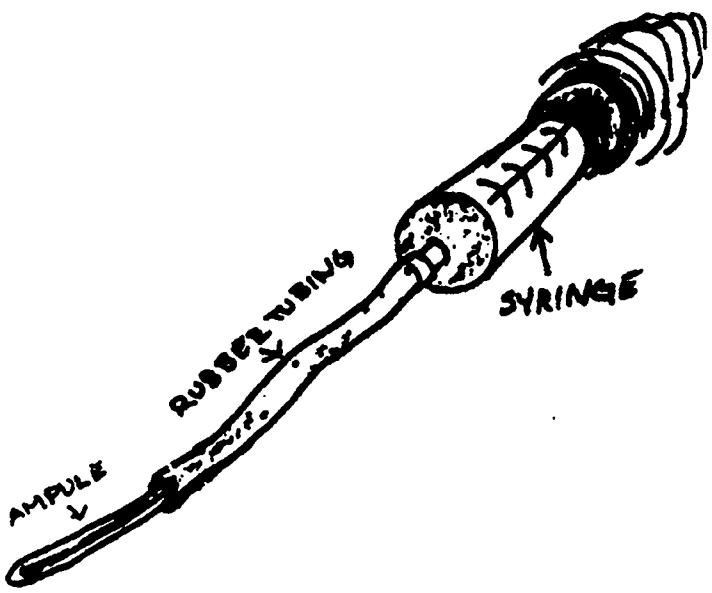
- Large Plastic Syringe
- CO test ampules for air pollution test. (Availabe from Ward's Natural Science Est.)
- Rubber Tubing
- Bagfull of Auto Emissions
- Blood (butcher shop)

PRE-ACTIVITY

1. Collect auto emissions as directed in a previous experiment. Take the blood from the butcher shop and divide it into two samples. Dilute the samples with water to make a light red solution.

2. Assemble the sampler as follows:





ACTIVITY

1. Bubble the exhaust emissions through the blood. If it turns dark, CO is present.

2. Duplicate the above task by bubbling cigarette smoke through the blood.

3. Using a fresh detector tube for each activity, draw the air sample through the tube. (The tubes contain silica gel covered with palladuim sulfate and ammonium molybdate. Its yellow color is changed to a series of greens and blue-greens. The darker the more the CO concentration.

POST ACTIVITY

1. Graph CO concentration compared to source.

2. Which is higher concentration CO, an automobile exhaust or a cigarette? At what levels?

3. If for every gallon of gasoline burned, 3 lbs. of CO are formed, calculate how many lbs. are formed in:

   a. One week of student driving
   b. One year of student driving

4. How could CO production be reduced in an automobile?

5. List community sites that have high CO levels as a result of auto, industry or social behavior.

5. How does carbon monoxide effect the human system?

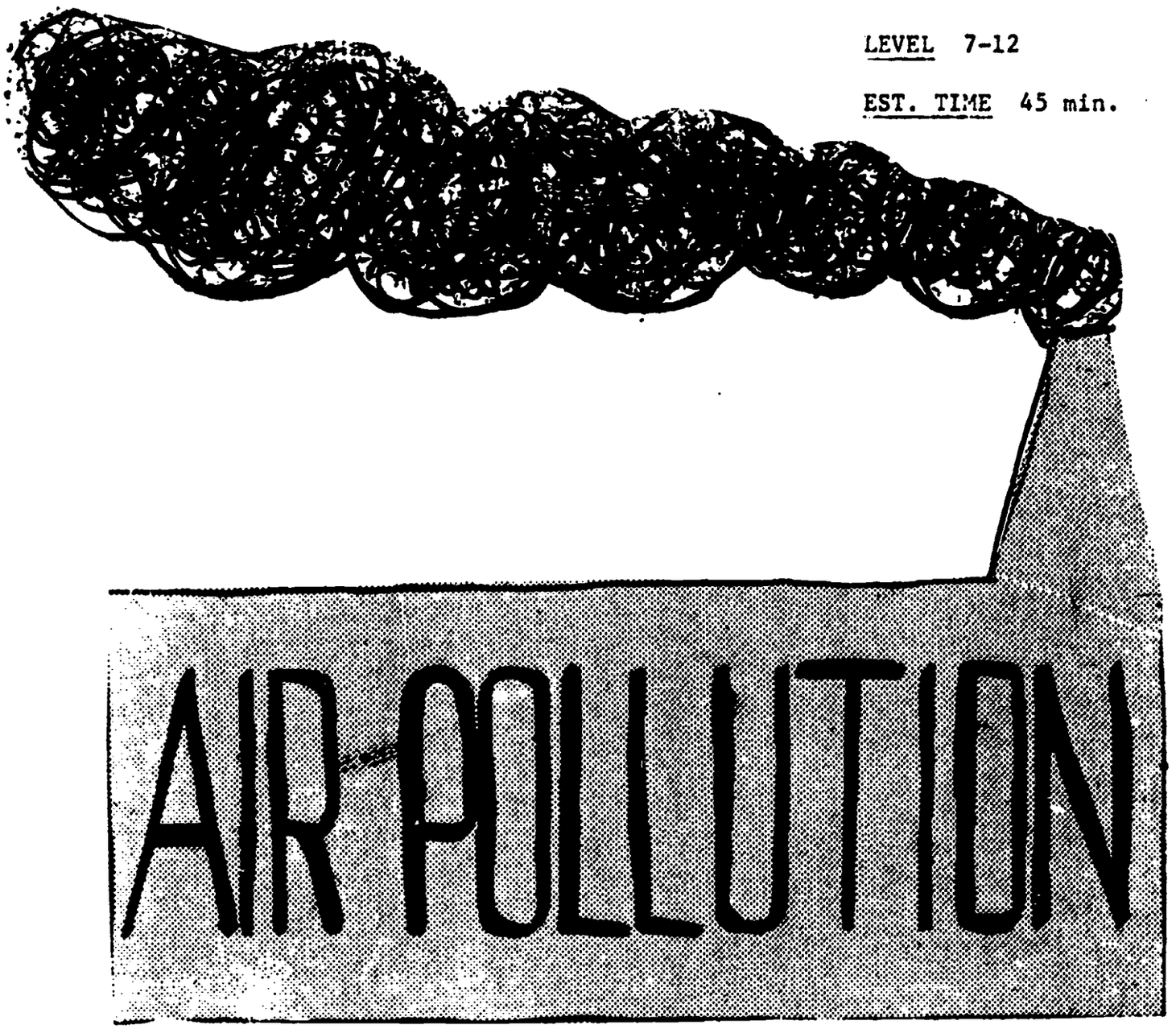
6. Does cigarette smoke contain high levels of carbon monoxide?

SUBJECT AREA

Science
Industrial Arts

LEVEL 7-12

EST. TIME 45 min.



SULFUR DIOXIDE

LAB. INVESTIGATION

Air pollution is made up of substances that can be measured, one of which is sulfur dioxide, SO_2.

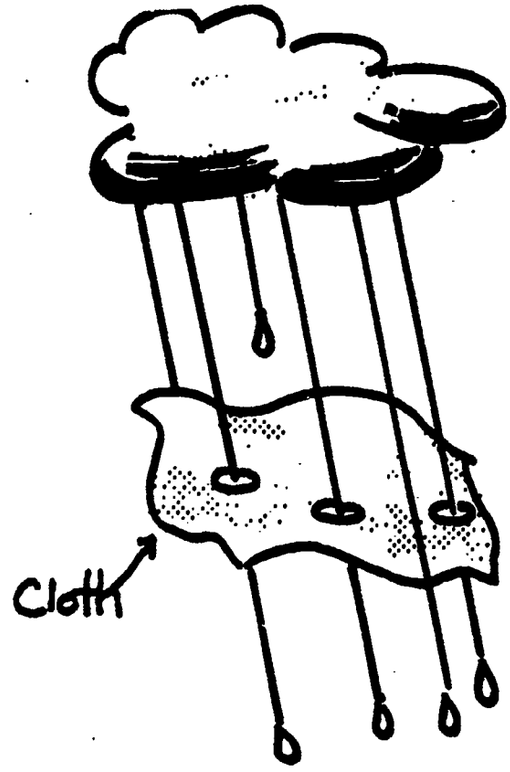
LEVEL VI OBJECTIVE

The student will be able to determine the levels of sulfur dioxide in the air we breathe.

OBJECTIVES

Sulfur exists as an air pollutant primarily in the form of SO_2 sulfur dio ide. The major source is from the oxidation of hydrogen disulfide (H_2S) gas which in itself is the natural product of decay of organic matter. However an ever increasing source of this colorless gas is the burning of sulfur rich fuels such as some coals and petroleum products.

It is in the products formed when SO_2 combines with water vapor that the damage is done. The resulting sulfurous nnd sulfuric acids attack plants, animals (ph levels in lakes and streams) and man's products. Our legacy in stone especially in Europe is being eroded beyond recognition by the action of sulfurous fumes.

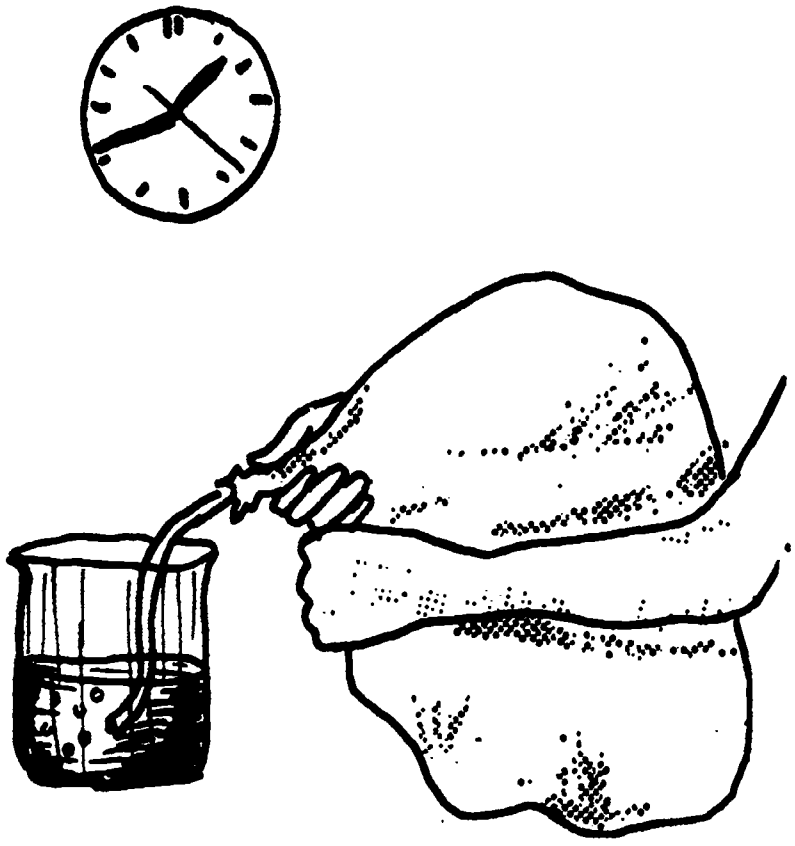


MATERIALS

1. Potassium Permanganate $KMnO_4$
2. Distilled Water
3. Polyvinyl or saran bag of auto exhaust collected according to the method in the activity on exhaust collection.
4. 1 Liter beaker
5. Rubber tubing
6. Clock with sweep second hand

Environmental Pollution, Andrews William A., Et. al. Prentice Hall, Inc. 1972 Contours: Studies of the Environment Series

Environmental Pollution, Experiences / Experiments / Activites Elbert C Weaver; Holt, Rinehart, and Winston, Inc. 1971



PRE-ACTIVITY

Prepare:

To 1 liter of distilled water add 0.25 grams of $KMnO_4$. Collect the bagful of auto emissions as directed in the previous activity on auto emissions. Fix a short piece of rubber tubing into the bag to provide a method to bubble the exhaust through the beaker. Have the students work in groups of four (4).

Use as a source of auto emissions exhaust from:

1. A cold car and a warm car
2. Regular gas and ethyl gas
3. Various brands of gasoline

QUESTIONS

What is a way to measure the amount of SO_2?

Is the amount of SO_2 present in the air around school measurable?

Does regular gasoline produce more SO_2 than ethyl does?

ACTIVITY

TASK

1. Using a steady force, squeeze the bag slowly, bubbling the exhaust through the $KMnO_4$ solution.
2. Record the time it takes to change the $KMnO_4$ from purple to colorless. Be careful as you approach the end point and squeeze slowly.
3. Use fresh solution for each bag of exhaust.

POST-ACTIVITY

DISCUSS

1. Do the factors such as engine temperature, brand of gasoline, type of gasoline, or the performance of the engine have any influence on the production of SO_2? If so, show it in a graph.
2. Should oil companies be required to "scrub" the sulfur from their gasoline in the refineries?

EXTENDED ACTIVITIES

1. Sample air near a refinery, pulp mill, smelter, or in the community and compare with a known standard.
2. Check the effect of SO_2 gas (can be generated in chemistry class) on the following plants. See effect of air pollution on plants investigation.

RELATIVE SENSITIVITY OF THE LEAVES OF PLANTS TO SO_2
(R-28)

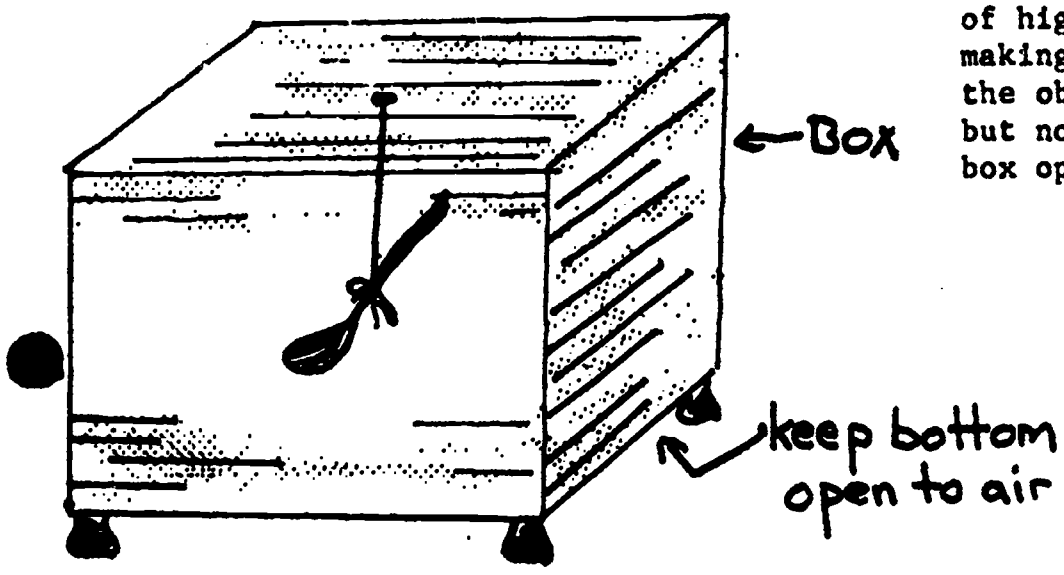
SENSITIVE				
alfalfa	barley	endive	tobacco	cotton
California poppy	salvia	chicory	rhubarb	cosmos
sweet pea	lettuce	sweet potato	adish	spinach
squash	bean	broccoli	pumpkin	brussel sprout
oats	salsify	table beets	carrot	wheat
turnip	swiss chard	clover		
INTERMEDIATE				
cauliflower	parsley	sugar beet	aster	tomato
parsnip	apple	cabbage	zinnia (C)	marigold
pear	begonia	grape	peach	apricot
rye (C)	iris	plum	cherry	gladiolus
watermelon				
RESISTANT				
rose	Irish potato	Virginia Creeper		lilac (common)
boxelder	onion	corn		lilac (Persian)
				chrysanthemum

SILVER PLATE

Tarnishing of silver is caused by compounds of sulfur, including hydrogen sulfide.

MATERIALS NEEDED

Some object that is silver or silver-plated (a spoon is fine).



PRE-ACTIVITY

Make sure the silver object is polished but not coated with some protective coating. Cover up part of the object with a piece of high-grade tape (such as electrical tape), making sure to press it on firmly. Hang the object outside in shelter open to air but not to weather or sun (perhaps in a box open to the air at the bottom only).

ACTIVITY

After 30 days, remove tape from the object and note the difference between the exposed not exposed part.

Repeat with another similar object and compare the results. All samples should be stored in an airtight jar in a dark place after exposure.

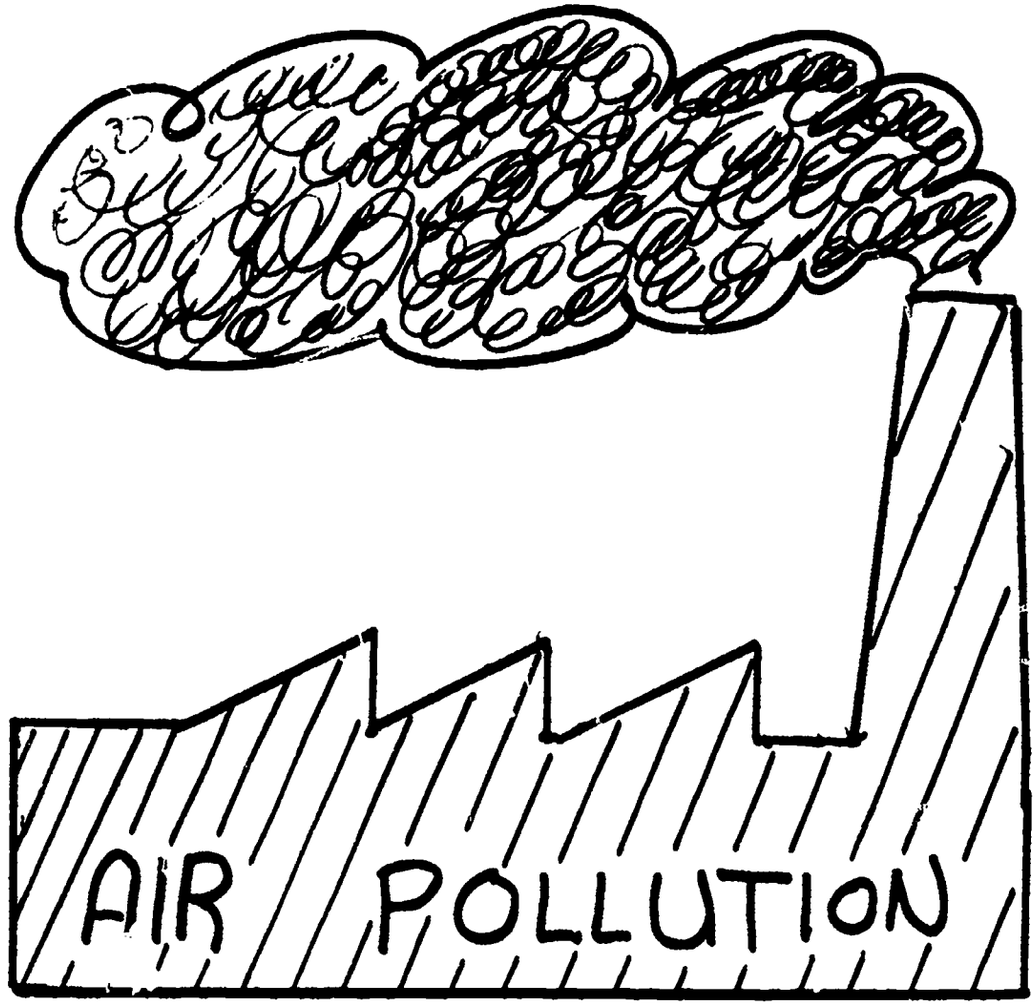
A-10

SUBJECTS

Science, I. A.

LEVEL (7 - 12)

EST. TIME (45 min.)



L E A D

LABORATORY INVESTIGATION

The elements in air pollution can be collected and measured.

LEVEL VI OBJECTIVE

The student will determine the difference of lead levels between four, six and eight cylinder engine exhaust emissions.

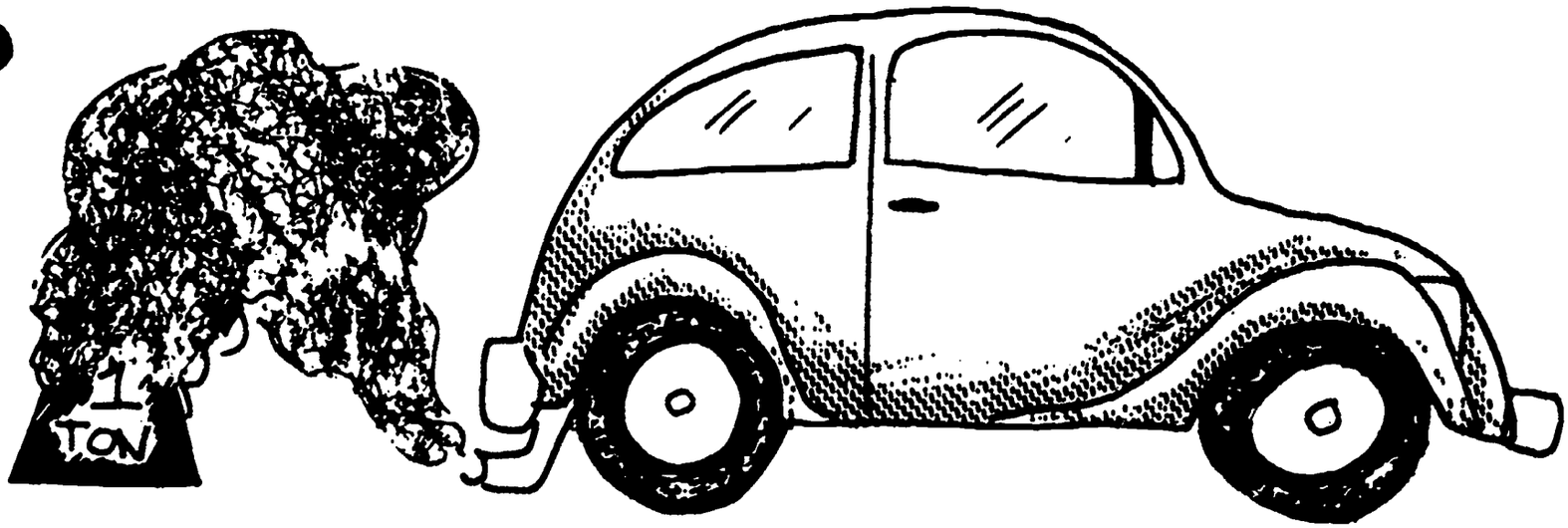
Although lead is a natural component of air, the increased use of tetraethyl and tetramethyl lead compounds to reduce the knocking or pinging of automobile engines has increased at a rapid rate. Approximately 2/3 of the lead in gasoline is emitted to the air with the result that the average North American has 100 times more lead in his system now than before the introduction of tetraethyl lead.

Lead is a cumulative poison that attacks the central nervous system causing dizziness, anemia, miscarriage, and weakness. Its more harmful effect is on the red blood cells, which become brittle. Lead poisoning can result in death.

In this exercise, although it is not precise, the student is able to get a quantitative measure of the amount of lead present in some fuels.

MATERIALS

Acetic Acid
Chromic Anhydride
Beaker
Saran or polyvinyl chloride bag



RESOURCES

Environmental Pollution: Experiences/ Experiments/ Activities, Elbert C. Weaver, Holt, Rinehart and Winston, 1971.

Environmental Pollution: William A. Andrews et al, Contour Series, Prentice-Hall, 1972.

TEACHER BACKGROUND

PRE - ACTIVITY

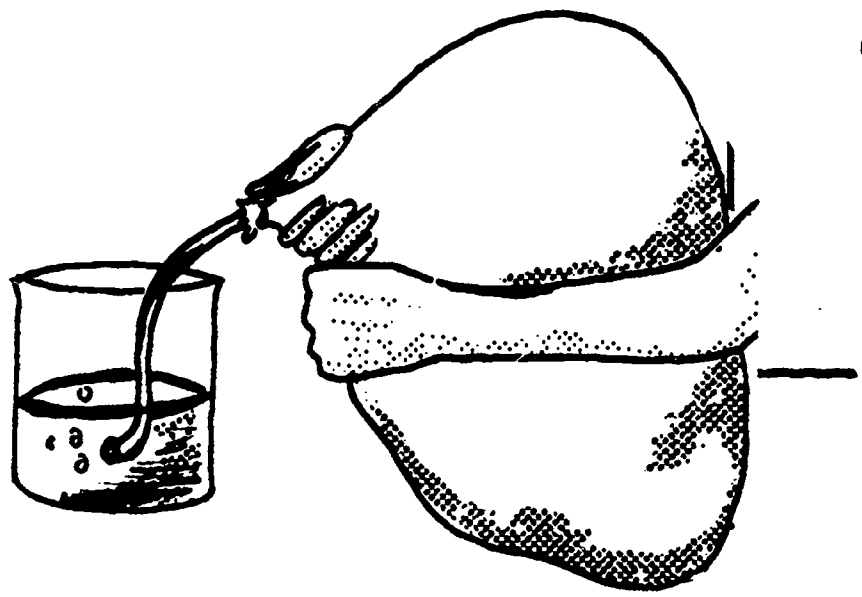
COLLECTION & PREPARATION

Collect a bagful of engine exhaust.

Prepare solutions:

Mix (10 ml - H_2O
(+ 5 ml - Concentrated glacial acetic acid (CH_3COOH).
(+ 5 g - Chromic Anhydride CrO_3 or chromic acid.

Make a large enough quantity to use easily.



ACTIVITY

1. Squeeze the bag gently to bubble the gas through the solution.
2. When the bag is empty there should be a quantity of yellow precipitate formed. This is lead chromate which gives the amount of lead present in the exhaust.
3. You can measure the amount of lead formed by either measuring the depth of the precipitate or weighing the precipitate.
4. Draw a bar graph comparing the sources of lead.

POST-ACTIVITY

COMPARE AND DISCUSS

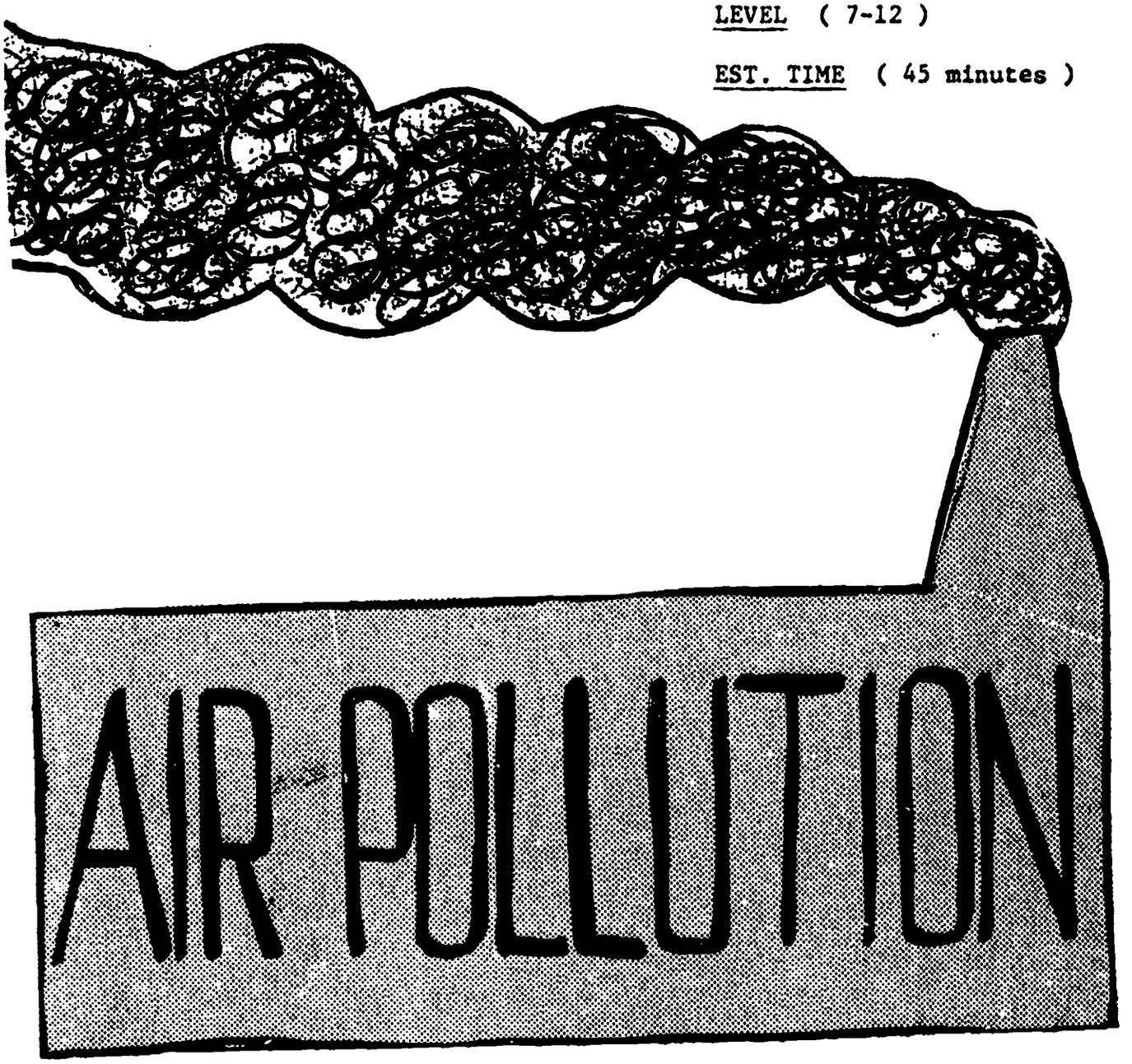
1. Collect exhaust emissions from tuned and untuned cars, 4, 6, and 8 cylinder cars, and warm and cold cars.
2. Compare the quantities of lead found in lichens at increasing distances from a freeway or major thoroughfare described in another lab in this packet.
3. How do the student's cars compare as to lead production?
4. What is the difference between low lead and regular gasoline?
5. Do all gasolines have lead content?

A-11 SUBJECTS

Science, Soc. Studies, Math

LEVEL (7-12)

EST. TIME (45 minutes)



TOTAL POLLUTION

CAR vs BUS

MATH PROBLEMS

The quantity of pollutants produced by various vehicles can be compared.

LEVEL VI OBJECTIVE

The student will determine the total amount of auto emission such as hydrocarbons, CO_2, oxides of nitrogen from 45 cars as compared to 1 diesel bus.

All too often the student speaks to the issue of air pollution, points a finger at the offenders, and then drives off in his own, often ill-tuned car, to add his quota of pollutants to the atmosphere. Education of the public to the advantages of mass-transit or some form of public transportation is essential if the air pollution problem is to be solved.

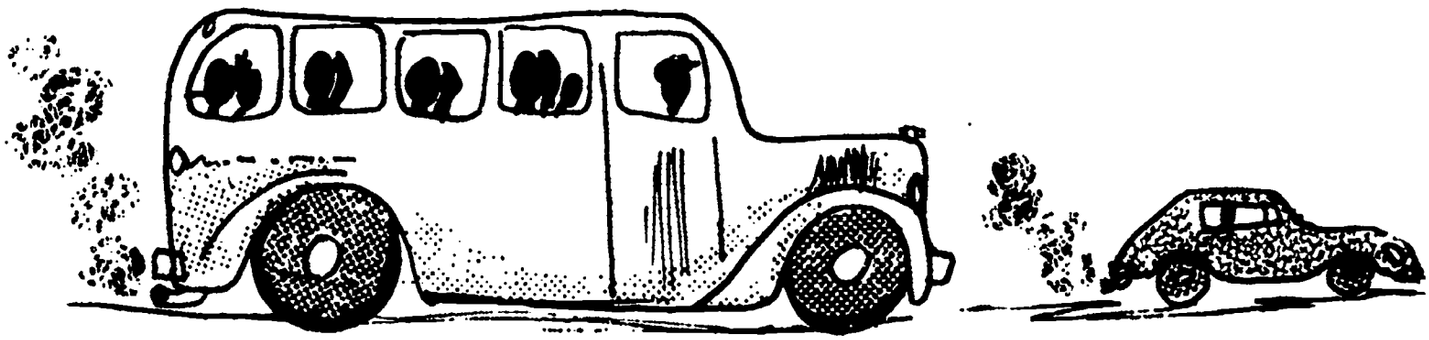
This exercise should awaken the students to how close to him the problem is. He should be made aware of the issue of decision making to weigh the factors influencing private versus public transportation.

MATERIALS

Paper
Pencil

RESOURCES

Man's Environment - How may it be Improved- Cental Washington-Learning Packages- Project No. 01-6410



TEACHER BACKGROUND

PRE-ACTIVITY

Make a survey of the cars driven to school by the students. This could be done in class rooms or a count taken in the student parking lot. Get a count of the number of passengers in each car.

Record the following information:

1. Number of cars
2. Number of passengers
3. Average number of passengers per car
4. Number of 45 passenger buses necessary to transport the same number of students.

ACTIVITY

TASK - Using the following chart:

A COMPARISON OF EMISSIONS OF G-M DIESEL BUS WITH THE EMISSIONS OF 40 AUTOMOBILES MAKING A 9-MILE URBAN TRIP

	40 CARS	1 BUS
Carbon Monoxide	74 lbs.	0.7 lbs.
Hydrocarbons	11 lbs.	0.1 lbs.
Oxides of Nitrogen	0.3 lbs.	0.7 lbs.

1. Determine the total exhaust emissions for cars driven to school.
2. Determine the total exhaust emissions for buses carrying a comparable number of students .
3. What is the ratio of exhaust emissions of cars to buses?

1. [ ]
2. [ ]
3. [ ]

ACTIVITY

POST-ACTIVITY

Discuss The Problem Of Student Driving

a. Are there alternative ways to get to school?

b. Can there be community action, ie., ride sharing? Bonus for bicycles?

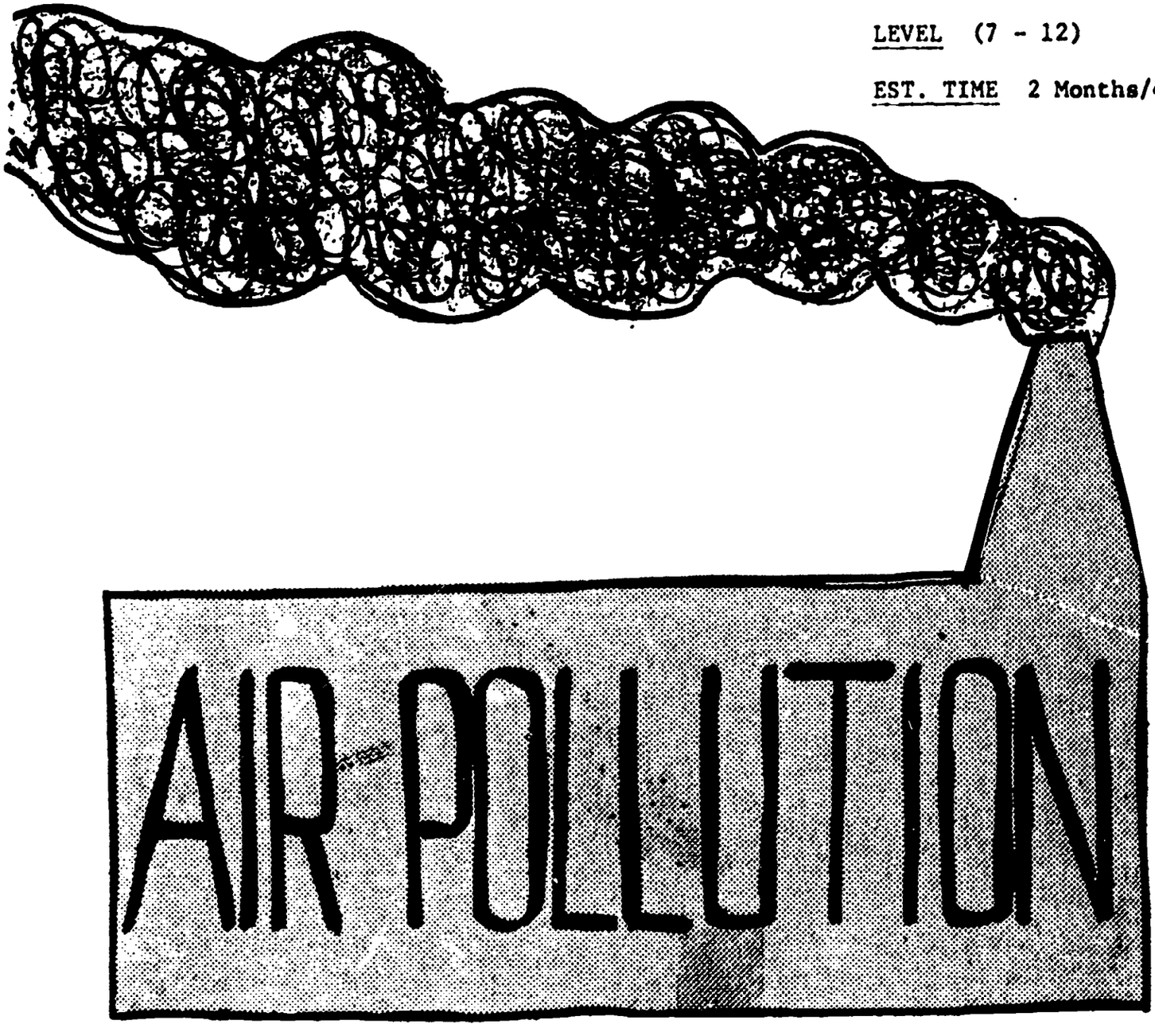
ACTIVITY

SUBJECT AREAS

Science
Home Ec.

LEVEL (7 - 12)

EST. TIME 2 Months/45 min.



SOLID PARTICLES

AND GASES

ACTIVITY

LAB. INVEST.

The particulate matter in air pollution can be measured.

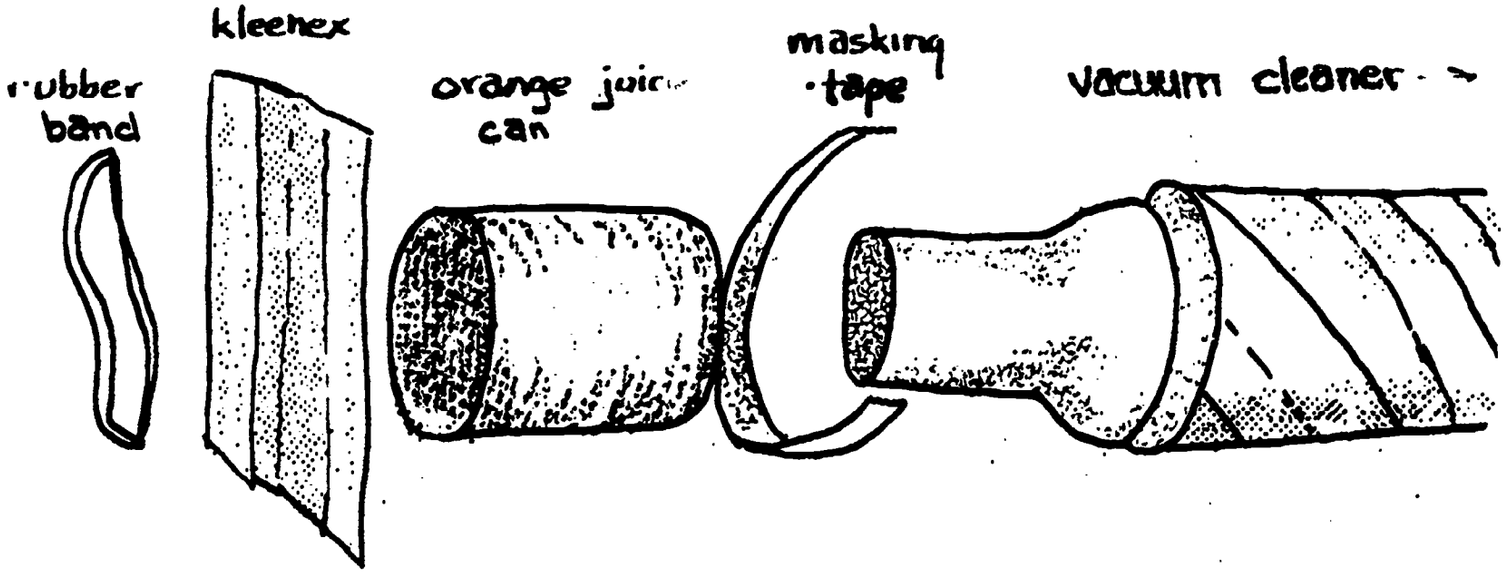
The gaseous components of air pollution are also measurable, but require different equipment.

LEVEL VI OBJECTIVE

The student will know that the air we breathe contains many particles such as soot, dust, pollen, spores, etc.

MATERIALS

Box of high grade facial tissue
One small orange juice can (with both ends out)
Large rubber band and tape
Vacuum cleaner (should have medium to heavy duty motor and hose)
A Ringelmann Chart or a light meter or camera with a light meter, preferably a single-lens reflex type.



RINGELMANN CHART

How To Use It

Hold the scale at arm's length, at which distance the lines on the scale will blend into uniform shades.
Compare the smoke from the stack or other source with the chart, determining the shade in the chart which most nearly corresponds to the shade or density of the smoke. It may be possible to record a number like 2-1/2, if the shade of the smoke is obviously between Ringelmann number 2 and 3.
Your line of observation should not be less than 100 feet nor more than 1/4 mile from the stack.
Avoid looking toward bright sunlight.
The background immediately beyond the top of the stack should be free of buildings or other dark objects.

Pollution can be divided into two major groups: primary and secondary. Among the primary pollutants are Sulfur Dioxide (SO_2) and particulate matter which is composed of soot, ash, and droplets. As you inhale, each breath brings into your lungs about 40,000 of these particles if you are fortunate and live in a "clean' country air and about 70,000 if you live in an industrialized city. The source of these particles can range from the emissions from smoke stacks to the little particles of rubber spun off from tires.

The effects of these air-borne particles, this particulate matter, should be obvious to the students. The increased cleaning of ourselves and our buildings, cars and goods, the suspected increase in allergies, respiratory diseases and cancer due to the inhalation of these particles have all received a great deal of attention. But, the more ominous and long lasting effect may be the alteration in the world's weather as this layer of "haze" blocks the sun's rays.

This blocking can result in the greenhouse effect in which the heat is trapped in the atmosphere. This could lead to the melting of the polar ice caps with the resultant rise of the sea level around the world. Conversely the haze could obscure the sun's rays resulting in a drop in temperature that would lead us back into another ice age. Not a very happy forecast in either case.

RESOURCES

ENVIRONMENTAL POLLUTION, Andrews, Willam A. et al. Prentice-Hall, Inc. 1972 Contours: Studies of the Environment Series

ENVIRONMENTAL POLLUTION, Experiences/Experiments Activities, Elbert C. Weaver; Holt, Rinehart, and Winston, Inc. 1971

LOW-VOLUME AIR SAMPLES FOR PARTICULATE AND GAS SAMPLING

The high-volume air sampler, described in the October issue of "Life - Pass It On," is useful for many projects involving the evaluation of atmospheric contaminants.

Often, in order to obtain a representative air sample, long sampling times at low flow rates may be required. Moreover, low flow rates are desirable for airborne particle count and size distribution studies and when analyzing air for gaseous pollutants.

To meet the needs of students and teachers interested in doing air pollution studies, a low-volume air sampler was developed for the Environmental Education Workshops presented by the EPA's National Environmental Reasearch Center in Las Vegas and the University of Nevada, Las Vegas during the summer of 1972.

The low-volume samples can be the basis for a variety of student projects in general science, biology, and chemistry as well as for making environmental surveys. Using filter paper, the mass of particulate matter per unit volume of air may be determined. Particle counts and particle size distribution studies may be done by collecting samples in distilled water and observing aliquots with a microscope. Filter paper can be rendered transparent with immersion oil and particles or spores examined with a microscope. Either filters or liquid samples may be placed on nutrient media and incubated for bacterial studies. Qualitative and quantitative chemical analysis of particulates and gases may be carried out.

The low-volume sampler uses a modified aquarium pump as the air mover and several types of interchangable sampling heads which may be easily constructed from inexpensive materials.

CONSTRUCTING THE LOW-VOLUME AIR MOVER

The Air mover in this low-volume sampling device is a modified aquarium pump. The pump used in this project and illustrated in (Figure 1) is a Metaframe Hush I. However, any inexpensive aquarium pump can be easily modified in a manner similar to that described. Most aquarium pumps have no air inlet connector. The air uaually moves in around the bottom edges of the case and/or through the hole where the power cord enters the case. Therefore, it is necessary to install an air inlet connector and to seal the pump case.

To install the air inlet, a small hole, approximately 1/4 inch in diameter, is drilled in the top of the pump case. A hose adapter is inserted and fastened with epoxy as illustrated in (Fig.2.) If a hose adapter is not available, a piece of metal or glass tubing, approximately 1-1/2 inches long, may be substituted.

To insure that all the air which moves through the air inlet is collected, it is necessary to completely seal the pump case. This is accomplished by applying bathtub caulking compound around the base of the pump and in the power cord hole.

SAMPLING FOR PARTICULATES

The modified aquarium pump may be used to sample either particulates or gases. Particulates may be collected either on filter paper or in distilled water, but specific reagents are required for gas sampling and analysis.

To sample for particulate materials, using filter paper, it is necessary to add a filter holder to the pump as il-

illustrated in (Fig. 2.) Filter holders may be obtained from scientific supply houses for approximately $2 to $3 each, or they may be improvised from garden hose repair kit available in most hardware and variety stores at a cost of about fifty cents. To convert the hose repair kit to a filter holder requires only the addition of a small screen wire disc, as illustrated in (Fig. 3.)

To collect particulates in distilled water it is necessary to construct a simple collection device from either a test-tube or a flask and to add an air flow control valve and a water trap to the system. The collection device consists of an Ehrlenmeyer flask, a rubber stopper, and two pieces of glass tubing assembled as shown in (Fig. 4a.) The water trap, used to keep water out of the pump mechanism, may be constructed from a 2- or3 inch piece of glass or plastic tubing and two rubber stoppers. The trap should be filled with silica gel or some other dessicating material. The air flow control is an aquarium valve which may be obtained in the pet department of most variety stores.

SAMPLING FOR GASES

The sampling device used to collect particulates may be modified for use as a gas sampler. To accomplish this, replace the longer, tapered piece of tubing in the particulate sampler with an aquarium "breaker" as shown in (Fig. 4b.) The "breaker", obtainable in most pet and variety stores, is needed to reduce the size of the air bubbles and to increase the collection efficiency of the sampler.

To prevent particulates from entering the system the filter holder and filter, used for sampling particulates, should be placed in front of the inlet of the gas sampling device.

To collect and analyze the air for a particular gas, a reagent which will react with the gas of interest must be added to the flask. For example, if you are interested in determining the carbon dioxide content of the air (a good project for gaining familiarity with gas sampling techniques), barium chloride ($BaCl_2$) dissolved in distilled water could be used as the collecting reagent. The carbon dioxide reacts with the barium chloride to form a barium carbonate ($BaCO_3$) precipitate. This precipitate can be filtered, dried, and weighed. Using the dry weight of the barium carbonate formed, the amount of carbon dioxide which reacted with the barium chloride can be calculated. If the volume of air which passed through the sampler is known, the parts per million (ppm) of CO_2 in the atmosphere can be determined.

For additional suggestions, procedures, methods or reagents for specific gas analyses, your science or chemistry teacher should be consulted. A device for calibrating the low-volume air sampler will be published in the next issue of "Life-Pass It On."

1. Determine the number of particles per cubic meter of air in your community.

2. Determine the size distribution of particles in the air in your community.

3. Investigate the relationship between particle size distribution and health effects.

4. Determine the amount of carbon dioxide (in ppm) present in your home, classroom, or laboratory.

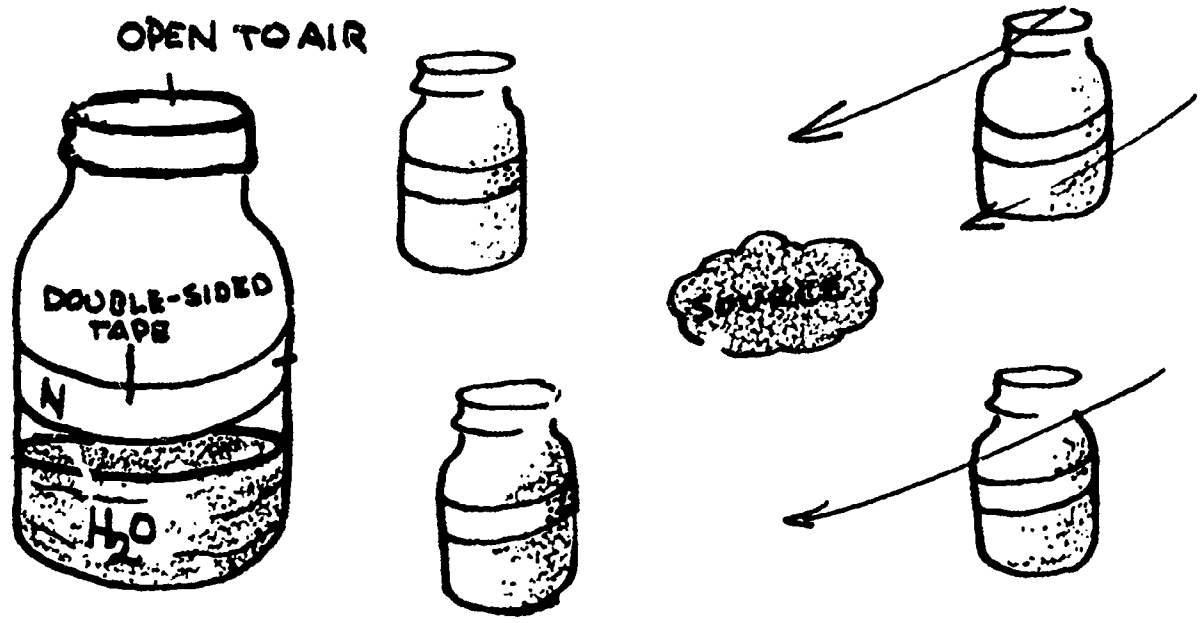
5. Determine if carbon monoxide, nitrogen oxides, sulfur dioxide, or hydrogen sulfide are present in the air of your community. If facilities are available, determine the parts per million of each pollutant in the air.

ACTIVITY

DUST COLLECTION JARS

MATERIALS

Mason or large mayonnaise jar(s)
Scotch tape
Water
Inexpensive microscope and clean slides



PRE-ACTIVITY

Wrap tape (sticky side out) in single band around outside of jar.
Put on a few pieces of tape, sticky side in, along the edge of the tape to hold it up.
Mark NORTH on tape and bottle.
Fill jars approximately one quarter full with water and leave uncovered.

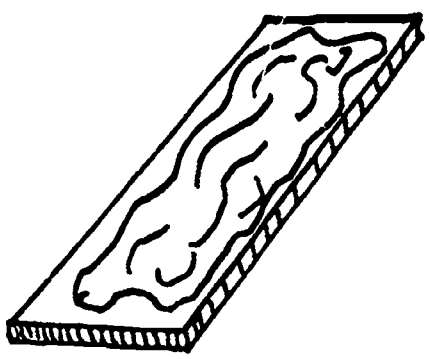
Place jars outside in open area free from obstructions (away from trees, walls or fences). Elevate slightly by placing them on top of a box or roof to avoid surface effects and tampering.
Orient towards NORTH.
If you suspect that most of the dust is coming from one source, place four or more jars around the source. Maintain the level of the water.
Jars should be kept at least one week at the same site.

ACTIVITY

TASK

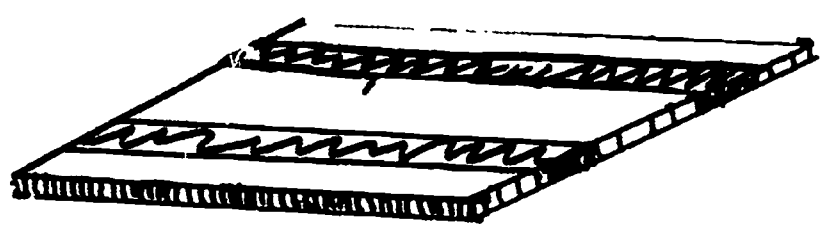
Stir up water, mixing all material in jar. Take a couple of drops of water from the jar and place them on a slide. Let the slide dry and then view it to get a general idea of the characteristics of the dust particles. Later, if a significant increase is noted in the amount of dust captured in the jars, prepare new slides and view particles for changes. A change in the character of the dust may indicate a new source in the area.

PRE-ACTIVITY



Vaseline covered slide

Have students bring in or fabricate pieces of glass approximately 4 inches square, 1" x 3" slides can be used. Coat the slides with vaseline or similar transparent adhesive. Place these collection plates in pre-selected sites, such as school, industrial site, home, park, farm or other area of concern. Fasten securely and in such a fashion that particles will descend by gravity. Wind currents should be avoided unless the effects of wind currents are to be studied.



Tape on glass plate

QUESTIONS

How much dust and other material does an Edmonds student breathe?

Where is the dirtiest part of the community?

TASK

1. Collect the plates after the pre-determined length of time has been reached. Do not disturb the other plates on the schedule. For example, take the one week plate and leave the one month and two month plates.

2. Place the plate or slide under the microscope lens and examine it at the various powers.

3. Look for animal hairs with their scale-like qualities, plant pollen, dust, metal particles, and other particles.

4. Count the number of particles in the field of view and record to obtain a comparative density.

5. Draw and record the number of types of particles in the field of view.

POST-ACTIVITY

TABLE

Plate location _____

Magnification _____

Number of Particles Per Field of View	Kinds of Particles	Appearance of Particles

CONCLUSIONS

1. Graph the comparative densities of particles versus location obtained from the class.

2. How does wind direction affect particle distribution?

3. What physical factors of the environment could affect or alter the daily rate of deposition on your plate?

EXTENDED ACTIVITIES

1. Alternate sampling methods can be tried following the methods described in the accompanying materials.*

   * Many thanks to Dick Holub, Department of Environmental Health, University of Washington, for his paper on Home-made Air Pollution Instruments.

PRE-ACTIVITY

Place four thicknesses of tissue on one end of can and seal with a rubber band. Connect can to vacuum cleaner hose with tape or other suitable material. Place the unit outside away from obstructions so that filter does not pick up dust stirred up by vacuum. Run vacuum for at least two hours; if no significant darkening of filter is noted, run for another two hours. Record total time sampled.

CAUTION

You probably won't be able to run the vacuum very long before it starts to overheat from the strain of drawing air through all that kleenex. Check it every few minutes, stop it to let it cool when necessary, and record the total time it was running.

Repeat the process several times on different days, changing the tissue filters each time.

ACTIVITY

Place the Ringelmann Chart next to the tissue which has been used as a filter. Back away from them until you can no longer see the actual lines on the chart but only a solid block of color. Assign one of the 4 Ringelmann numbers to the tissue according to which one it most closely matches. You may be able to assign a number like 1-1/2 if the tissue is obviously between Ringelmann numbers 1 and 2.
Record the value computed in step 3 as well as the date on which sampling was done and the length of time sampled.

Method Of Reading Filters With Light Meter Or Camera

Place two layers of clean tissue over the light meter window or lens (if it is a sing-lens reflex camera), making sure that no light leaks in at the sides.
Aim the meter or camera at some source of light that will have a constant and even intensity for a couple of minutes such as a window.
Set the camera focus at infinity and adjust the film speed and ASA settings until the meter is balanced at an f-16 or f-11 setting.
Leaving all the camera settings alone, replace the clean tissue with the top two layers of tissue that have been used as a filter. Make sure that no light can leak through at the sides. Re-aim the camera at exactly the same light source as in step 2 above.
Now adjust only the f-stop until the meter is balanced.
Now compute the difference in f-stop readings between the clean and dirty tissue. Count each major stop (22, 16, 5.6, etc.) as 2 and each 1/2 stop (midway between two stops) as 1. Therefore, if with a clean tissue the meter was balanced at f-16, and with the dirty tissue, the meter was balanced at f-8, the difference would be 4, as f-stops go 22, 16, 11, 8, 5.6, 4, 2.8, 1.7,1.4, and 1.2. An original reading of 16 on clean tissue nnd a reading midway between f-5.6, and f-4, on a dirty tissue would be a difference of 7.
Record the value of the difference computed in step 7 as well as the date on which sampling was done and the length of time sampled.

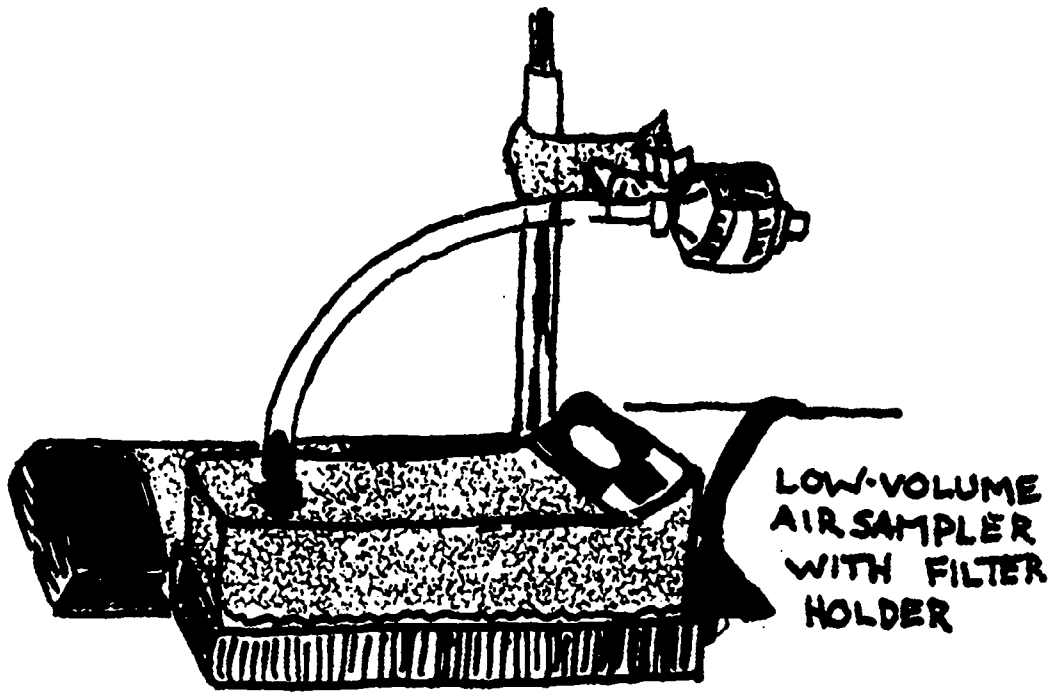
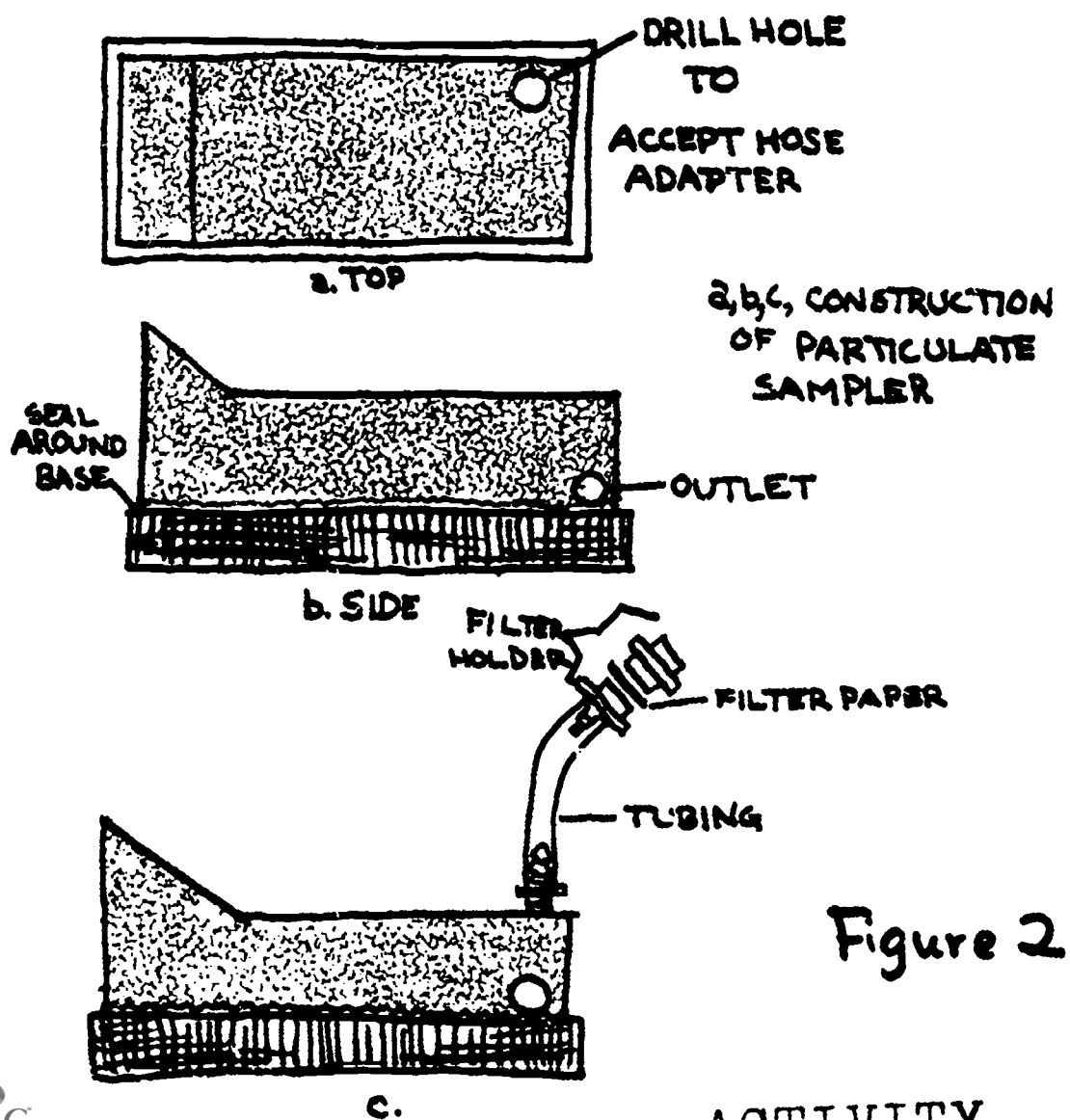


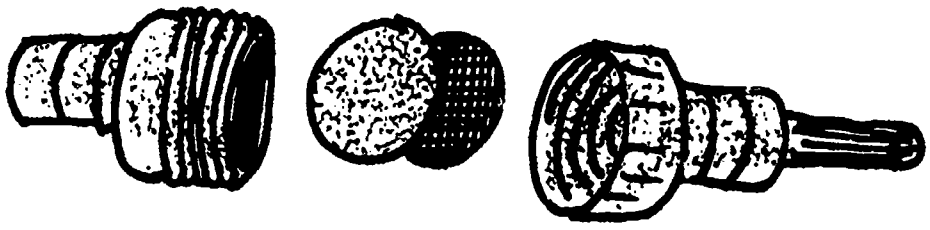
Figure 1



a,b,c, CONSTRUCTION OF PARTICULATE SAMPLER

Figure 2

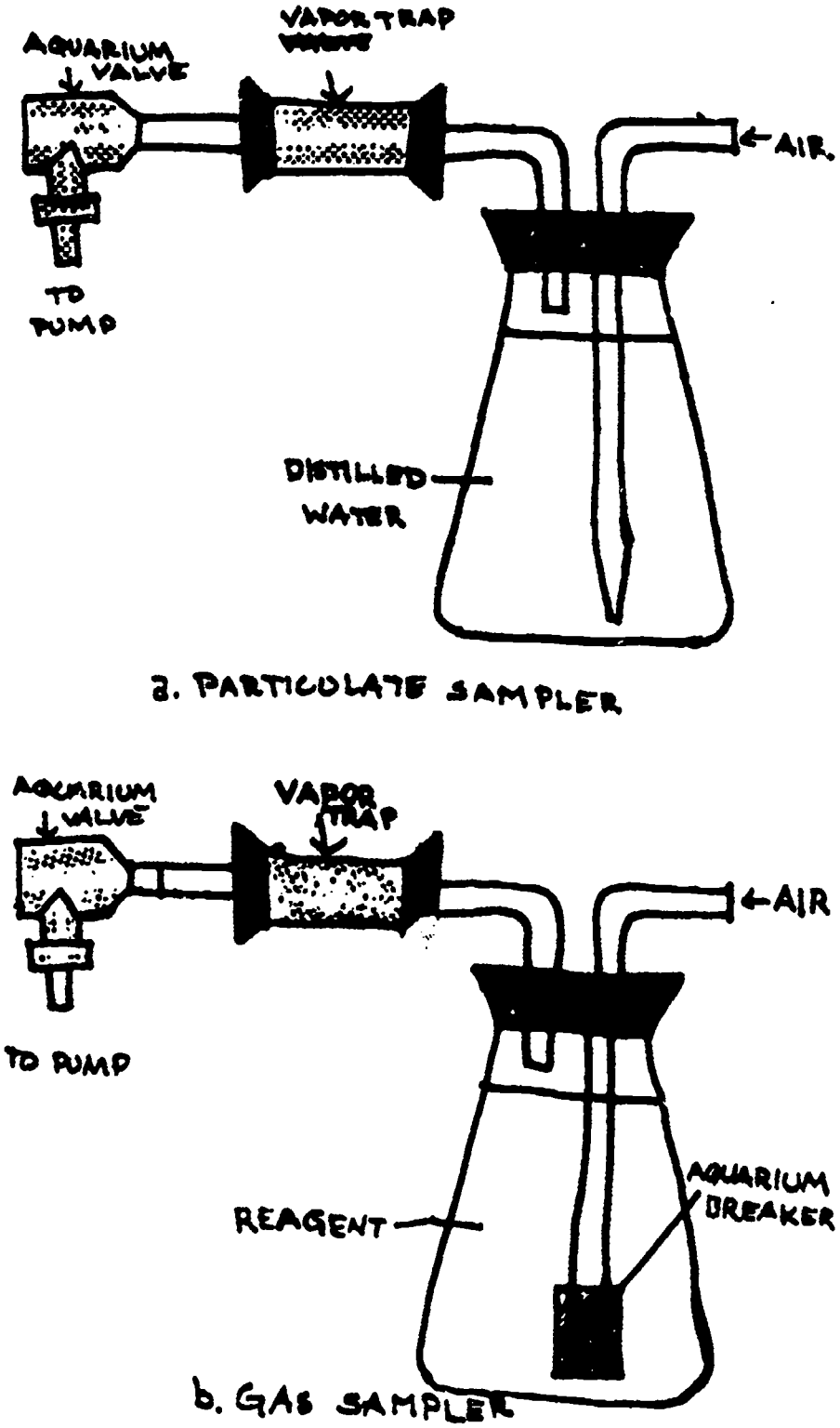
ACTIVITY



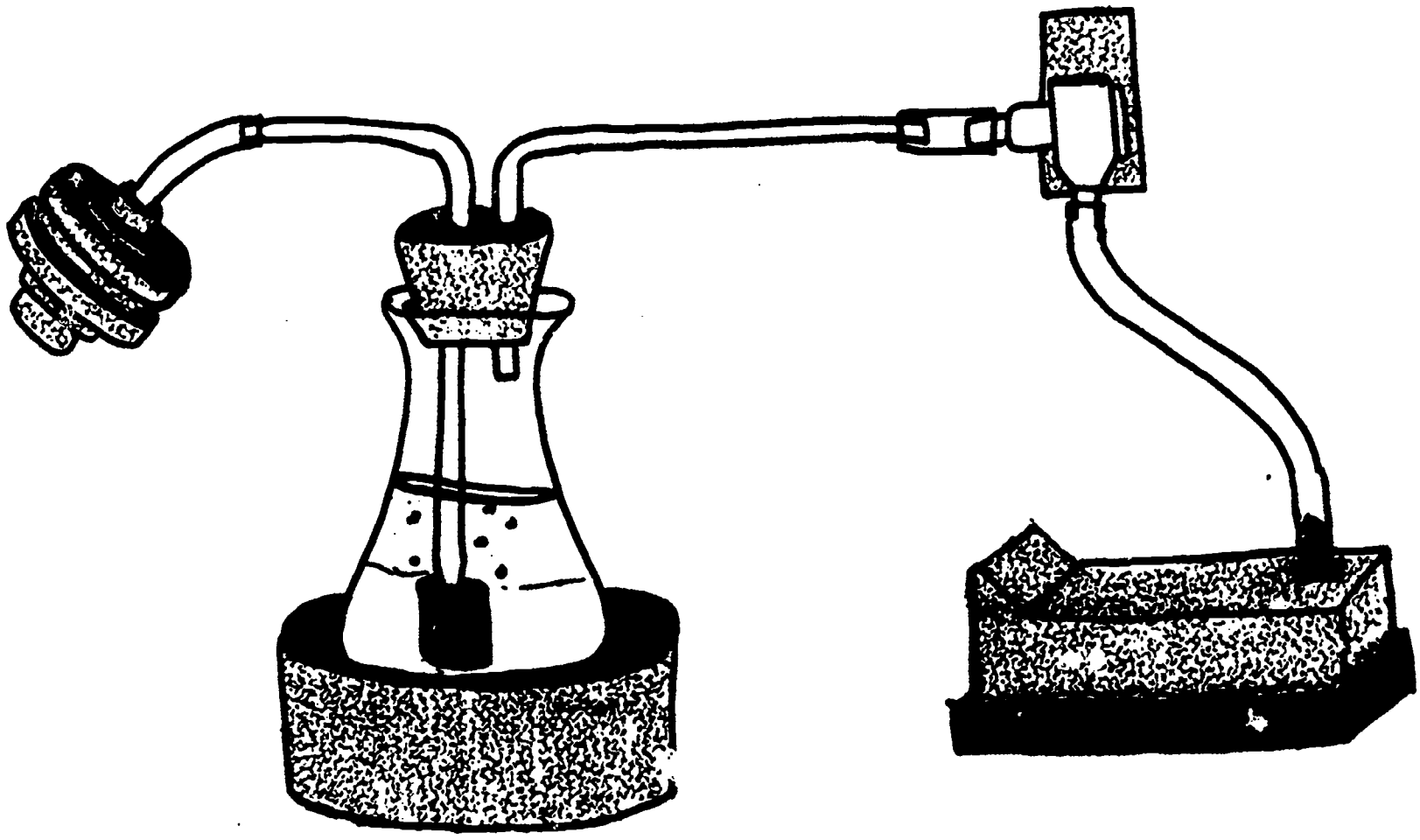
FILTER HOLDER CONSTRUCTED
FROM HOSE REPAIR KIT

Figure 3

Figure 4



ACTIVITY



PUMP AND GAS SAMPLING DEVICE

Figure 5

ACTIVITY

A-13 SUBJECT

Science

LEVEL (7 - 12)

EST. TIME (45 min.)

EXHAUST COLLECTION LABORATORY INVESTIGATION

Automobile emissions can be collected and measured.

LEVEL VI OBJECTIVE

The student will be able to determine the amount of water and hydrocarbons from auto emissions.

Air pollution is one of the most obvious and ever present environmental problems. Over 60% of all air pollution has been attributed to the automobile. Annually each car produces about 1600 pounds of:

CO - carbon monoxide
NO - nitrous oxide
NO_2 - nitrous dioxide
CH_n - hydrocarbons

plus small amounts of other chemicals. Most of these chemicals are secondary type of pollutants in that when they are under the influence of sunlight, they react with other substances to form new compounds which are even more harmful. These photochemicals are the major constituents of the famous Los Angeles "smog".

Each of the activities on a particular pollutant gives more information on that pollutant.

USE CARE IN THIS ACTIVITY!

MATERIALS

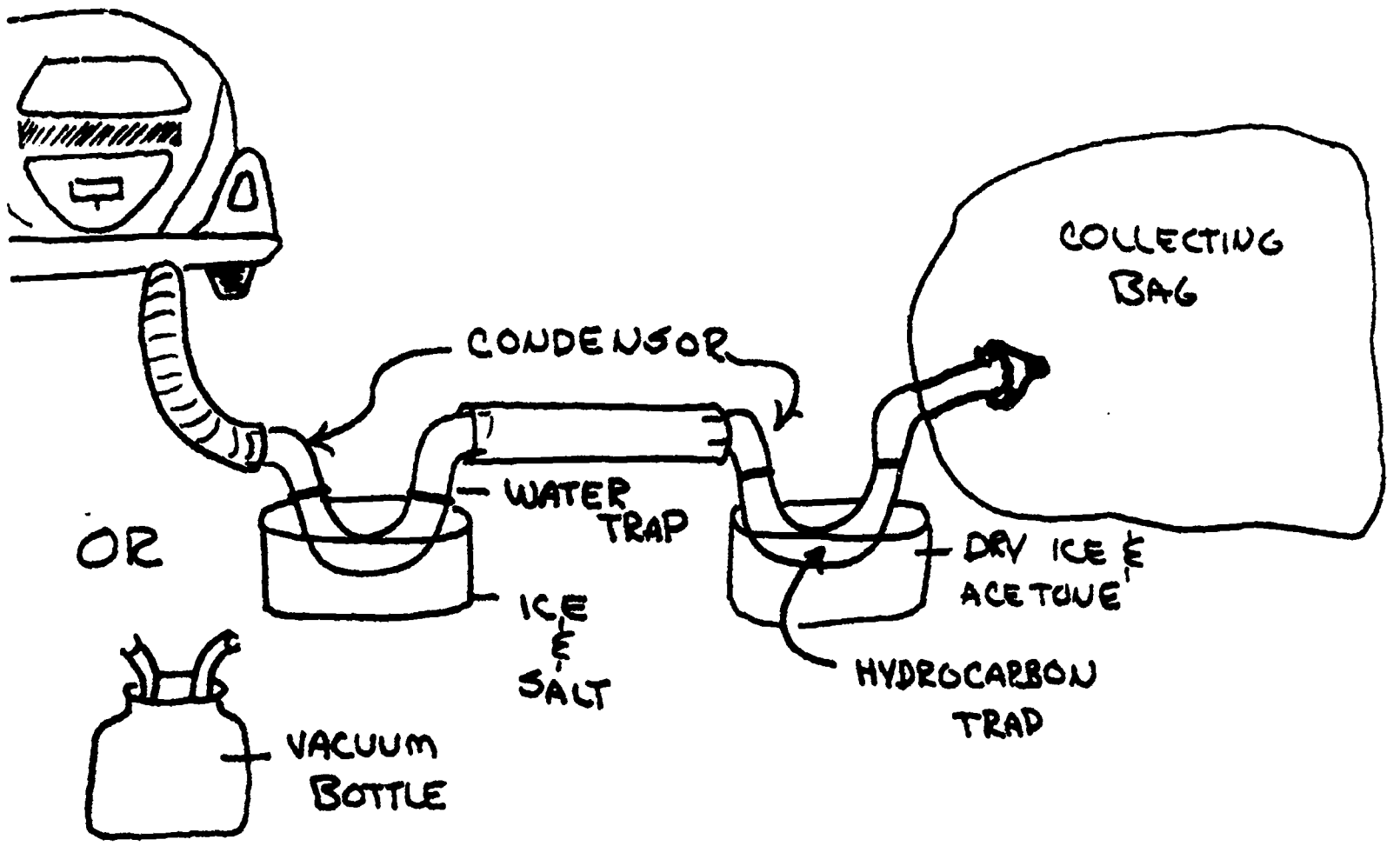
Flexible hose
Plastic Bag (poly, vinyl or saran)
Glass or metal U tubes
Vacuum bottle
Crushed ice
Acetone
Salt
Dry ice
Caliper

RESOURCES

Environmental Pollution: Experiences/ Experiments/ Activities, Elbert C. Weaver, Holt, Rinehart and Winston, Inc., 1971

Environmental Pollution, Andrews, William A., et. al.Prentice-Hall, Inc. 1972 Contours; Studies of the Environment Series

Air Pollution Experiments for Junior and Senior High School Classes, 2nd ed. Ed. Donald C. Hunter et al. Air Pollution Control Association 1972



TEACHER BACKGROUND

ACTIVITY

1. Start engine and collect the gases from the exhaust. Condensors should be checked for leaks as they condense out water and condensable hydrocarbons. All joints should be checked.

2. The gases collected can be used for further analysis.

   In the water trap, the student can recover the water and measure it in a graduated cylinder and do the following calculation:

   Calculation 1
   Assume each ml of water weighs 1 g.

   If the gasoline burned is octane then the ratio of water formed to gasoline burned by weight is

   $$\frac{81}{57}$$

   Therefore,

   $$\frac{\text{number of grams of water}}{\text{"x" g of gasoline}} = \frac{81}{57}$$

   The student can find the number of grams of gasoline burned. This number should be calculated for varying conditions.

   Cold engine vs. warm engine
   Slow idle vs. fast idle
   Tuned engine vs. untuned engine

3. Measure the quantity of hydrocarbons collected in the trap using a graduated cylinder. This is in turn compared to quantities of hydrocarbons collected in varying conditions.

PRE-ACTIVITY

Assemble the equipment as illustrated. For best results all joints should be air tight and the automobile exhaust system should be in good condition.

CAUTION SHOULD BE USED.
Do the experiment in a well ventilated area. Handle the condensed hydrocarbons with care.

This activity may be done by the auto shop class as an exercise to test automobile emissions.

POST-ACTIVITY

1. Compare the emissions from a pre-pollution-control-device car with those of a post-pollution-control-device car.

2. What possible effect would the formation of water as a combustion by-product have on the performance of a car?

3. Investigate the methods to further analyze the component elements in the emissions.

4. If hydrocarbons are in fact a major irritant in air pollution, how does a person sample that part of air pollution?

5. How do you collect the auto emissions safely?

6. What kinds of vehicles produce the most air pollution?

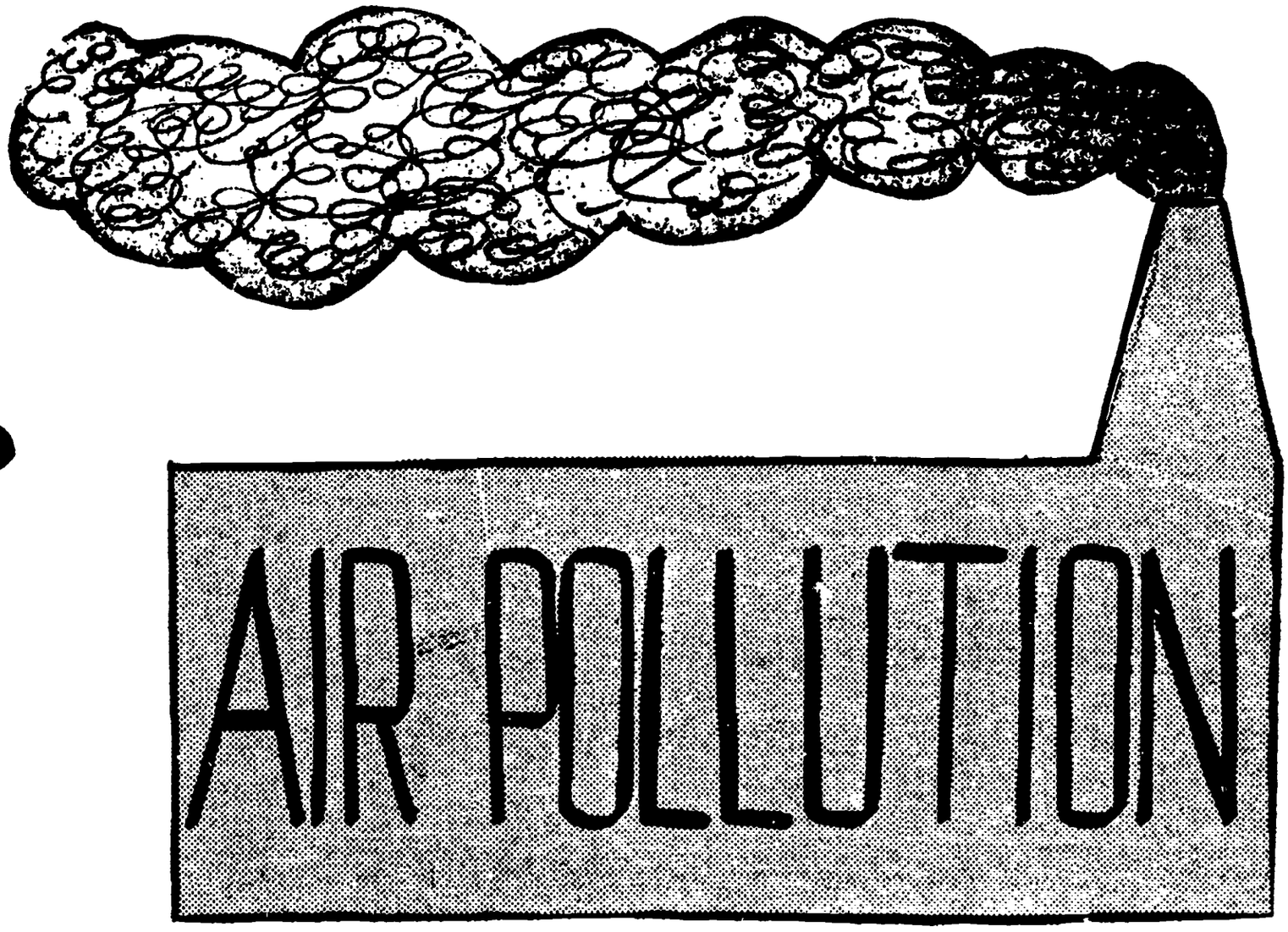
A-14

SUBJECTS

Science, Soc. Studies,
I.A., L.A.

LEVEL (7 - 12)

EST. TIME (2 days)



FIELD TRIP

Air pollution is an observable problem.

LEVEL VI OBJECTIVE

The student will be able to identify environmental problems in his local community.

OBJECTIVES

Much time, money and energy has been expended through advertising and accumulating data in bringing the pollution problem to the attention of the public. The teacher should make an effort to have the students actually visit areas of pollution or potential pollution. To be objective in environmental problems, industries and municipalities should have the opportunity to present their problems and the methods they have developed to deal with them. Most welcome the opportunity to entertain field trip groups. In some cases the only recourse is to just observe, but it can still be worthwhile.

MATERIALS

Pencil
Paper
Transportation

RESOURCES

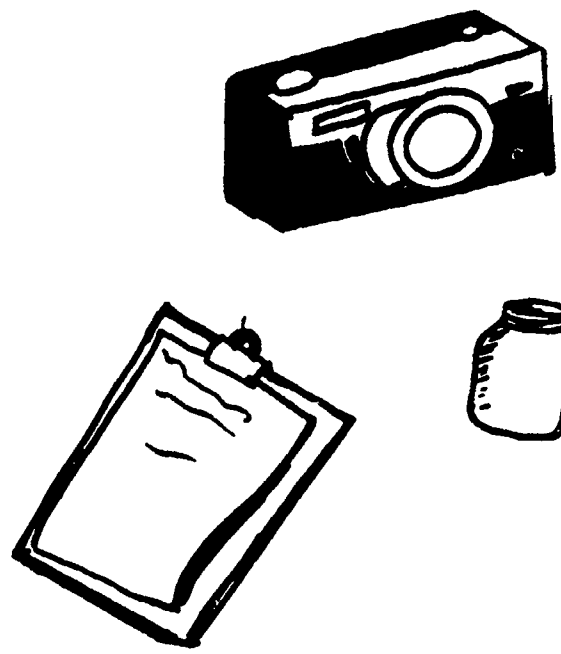
Environmental Pollution, Andrews, William A., et al. Prentice-Hall Inc., 1972. Contours: Studies of Environment Series.

Environmental Pollution Experiences/ Experiments/ Activities: Elbert C. Weaver. Holt, Rinehart and Winston Inc. 1971.

Air Pollution Experiments for Junior and Senior High School Science Classes 2nd Ed. Ed. Hunter, Donald C. et al. Air Pollution Control Association

PRE-ACTIVITY

Arrange transportation and decide where the students will go. List observable data that can be gathered and objectives. Have the student know the reasons they are going.



ACTIVITY

Observe the environmental site and record the information in the following possible ways:

A. Photographs

B. Sample the air through collecting bottles.

C. Log in a notebook, characteristics such as:

color
odors
haze
effect on surrounding plants
effect on surrounding metals
effect on surrounding paints

POST-ACTIVITY

1. Discuss what the offending problem is.
2. Discuss what can be done or is being done to clear up the problem.
3. Display for other students, graphs, photos, or charts of the local problems.
4. This can lead to community action activities.
5. Where in the community might you find sources of air pollution?
6. Are there any sources in your neighborhood?
7. What methods are available to gather data on air pollutions?

A-15

SUBJECTS

Science

LEVEL (9 - 12)

EST. TIME (1 - 2 hrs.)

LEAD IN LICHEN

LABORATORY INVESTIGATION

The lead content in plants can be measured to indicate the lead content of their environment.

LEVEL VI OBJECTIVE

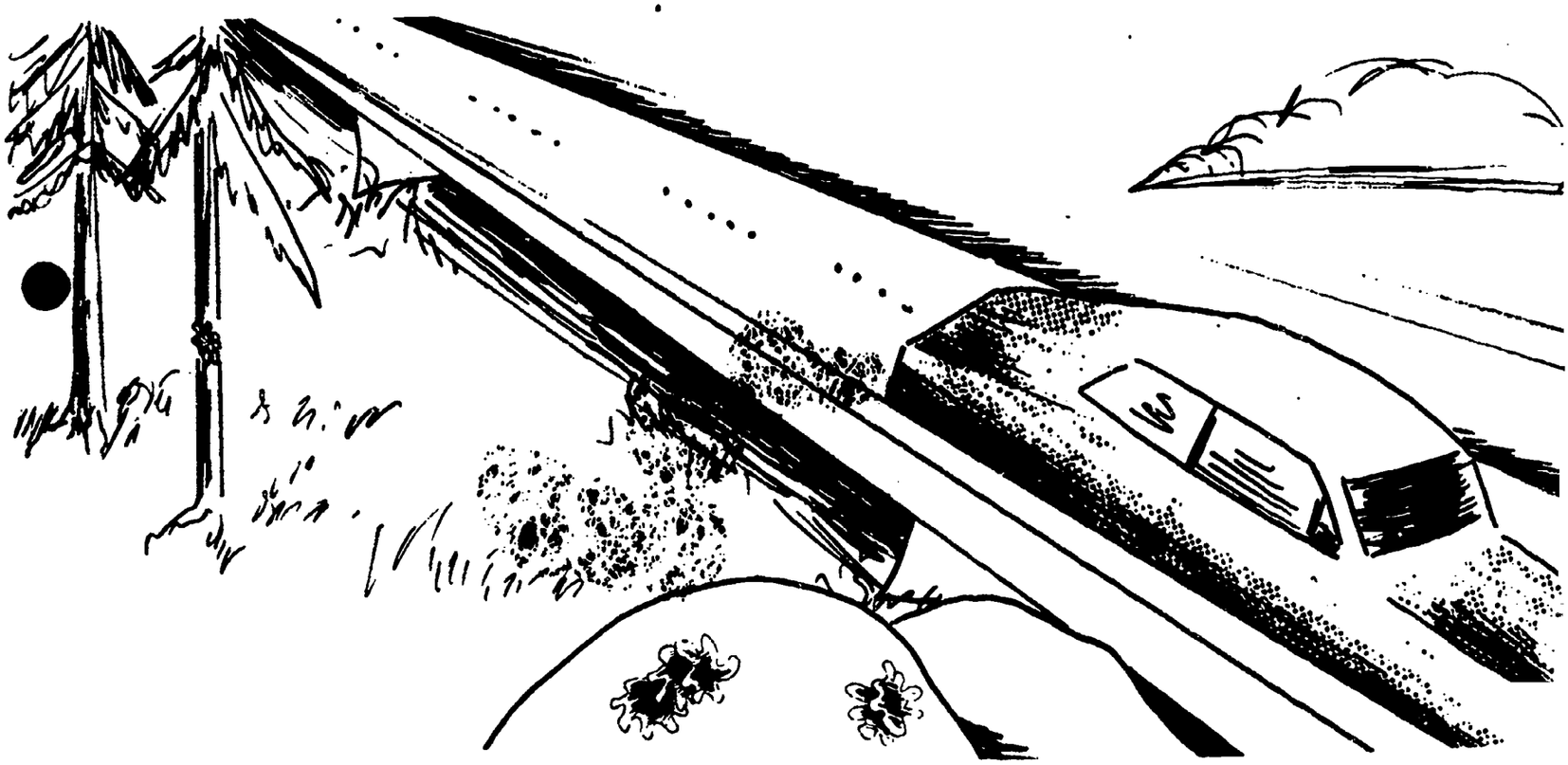
The student will be able to determine the lead content in lichens located near a freeway.

OBJECTIVES

Many plants absorb lead and concentrate it in their roots. One of the most widespread plants to show this characteristic is the lichen. Here in the northwest where they are so common, the plants can be collected easily by the students. A map showing the distances from the freeway can be constructed for the local area adjacent to the freeway as well as a map for the area near a secondary road. The students can see graphically the dispersal of the airborne lead that is primarily a product of the combustion of lead containing fuels.

MATERIALS

Ammonium Citrate
Ammonium Hydroxide
Ethyl Alcohol
Phenol Red (indicator)
Potassium cyanide
Hydroxylamine hydrochloride
Chloroform
Dithizone
Brown Bottles
Screw cap vials
Separatory funnel
Beaker



RESOURCES

Washington Science Teachers Journal, December 1972

PRE-ACTIVITY

FIELD SCREENING PROCEDURE FOR LEAD

Reagents for Lead Procedure:

a. Buffer Solution: Prepare by dissolving 1 gram of hydroxylamine hydrochloride and 10 grams of ammonium citrate in 150 ml of distilled water. Make the solution alkaline to phenol red indicator by adding reagent grade ammonium hydroxide. Add 5 grams of potassium cyanide, 975 ml of ammonium hydroxide (sp. gr. 0.9), and 1315 ml of distilled water to complete the buffer solution. Add 16 ml of prepared buffer to an 8-dram vial for the field test. Label this vial "A".

b. Dithizone: Add 75 mg of dithizone to a 25 ml volumetric flask, dissolve in conditioned chloroform (prepared as in (c) below), and dilute to volume. For the field test add 0.1 ml of prepared dithizone solution (3 mg/ml) to a 1-dram screw cap vial and evaporate to dryness. Label this vial "B".

c. Conditioned chloroform: Place 1 liter of redistilled chloroform in a 2-liter, glass-stoppered borosilicate glass separatory funnel. Dissolve approximately 10 grams of hydroxylamine hydrochloride in 50 ml of distilled water and make the solution alkaline to phenol red indicator by adding reagent grade ammonium hydroxide. Add this solution to the chloroform in the separatory funnel and shake well. Allow the aqueous layer to separate and filter the chloroform through a fluted paper into a brown glass-stoppered bottle containing 20 ml of absolute ethyl alcohol. Shake well and store in a refrigerator when not in use. For the test, add 3.75 ml of this mixture to a 1-dram screw cap vial or seal in a glass ampule. Label this vial "C". (Note: preparing Vial "C" in an ampule is preferable since preventing evaporation is critical.)

ACTIVITY

ACTIVITY

Field Screening Procedure for Lead:

a. Select several lichens on a transect at increasing distances from the freeway or major thoroughfare. Record the sites on a map. Weight out 5 g of lichen from each sample. Dry it, grind it up in a mortar and place in a 50 ml beaker.

b. Add a sufficient volume of 5% acetic acid to each item so that the level comes with 1/4" of overflowing. (if acetic is unavailable, any brand of white distilled vinegar can be used.) Let stand for 30 minutes.

c. Add the chloroform from Vial C to the dithizone powder in Vial B.

d. Using a pipette, mix acetic acid in the unit being tested; then transfer 4 droppersful (4 ml) to Vial A (buffer) and mix by shaking.

e. Add the dithizone solution from Vial B to Vial A, stopper tightly, and shake vigorously for 30 seconds. (see next column).

f. Set the vial down and allow the layers to separate. Observe the color of the lower (chloroform) layer.

If color is green--sample has no lead present.

If color is red--sample will contain over 7 ppm of lead after 24-hour leaching and is violative.

If color is grayish purple to cream orange--sample may contain over 7 ppm of lead after 24-hour leaching and may be violative. (Test is sensitive to approximately 2 ppm.)

POST-ACTIVITY

Compare and Discuss:

1. Graph the level of lead versus distance from the road way.

2. Compare different sides of the roadway and different areas.

3. What could be the long term effect on life?

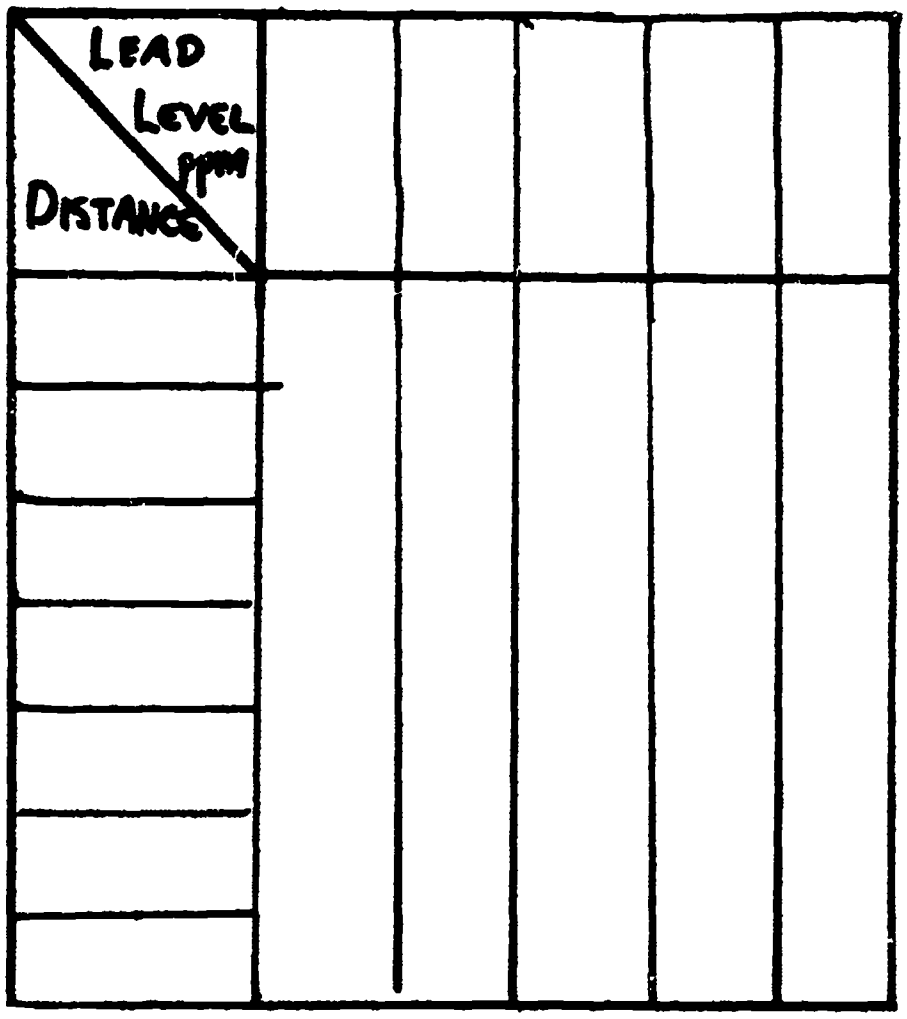
4. Do other plants collect and accumulate the lead in the air as well as lichens do?

5. Is there an indicator animal that accumulates the lead?

6. Is the lead content higher near the freeway than farther away from the freeway?

GRAPHS

Lichen sample						
Color						
Lead ppm						



ACTIVITY

A-16

SUBJECTS

Home Ec., Science,
Soc. Studies

LEVEL (7 - 11)

EST. TIME (1 week - 6 months)

EFFECT OF AIR ON SYNTHETICS

LABORATORY INVESTIGATION

Some kinds of air pollution have a harmful effect on certain manmade materials.

LEVEL VI OBJECTIVE

The student will know that certain chemical pollutants have an adverse effect on dyed fabrics, nylon and rubber.

Although the irritating and potential health hazard aspects of air pollution receive most publicity, the economic loss due to damage to materials is also important.

No one pollutant is solely responsible. The acid materials in the air attack cloth and ozone has a harmful effect on rubber and dyes. The total combination acts to break down the chemical bonding of the materials and reduces the life span of mans' products.

MATERIALS

15 denier nylon hose
hand lens
microscope
slide mount or cardboard
weights
dyed fabrics
clip

RESOURCES

Environmental Pollution, Andrews, William A. et al. Prentice-Hall Inc., 1972. Contours: Studies of the Environment Series.

Environmental Pollution Experiences/ Experiments/ Activities: Elbert C. Weaver, Holt, Rinehart, & Winston Inc. 1971.

Air Pollution Experiments for Junior and Senior High School Science Classes 2nd. Ed. Ed. Hunter, Donald C. et al. Air Pollution Control Association

PRE - ACTIVITY

Prepare nylon samples by cutting out small squares and taping or stapling them to a piece of cardboard or a slide mount. Place them outside in a sheltered spot. Try to avoid direct sunlight. Treat the dyed fabrics in the same manner.

For the rubber, use some rubber dam material available from a dentist. Cut it into strips and suspend them from a support in a sheltered spot.

All of the above materials should be placed in a sheltered location. Other samples should be placed in a closed container to act as a control. One group could also be placed in an area subject to wind or weather.

Questions to consider:

Do you think synthetic materials which come from chemicals are affected by the chemicals present in air pollution?

What effects might air pollution have on clothing materials?

How long must materials be exposed to air pollutants before measurable damage occurs?

ACTIVITY

After 7 days, examine the materials for the following conditions:

a. Dyed fabrics - look for color fading and breakdown of threads.

b. Nylon - under the hand lens or low power microscope, examine the nylon threads for breaking.

c. Rubber - using the hand lens, examine the rubber for cracking and breakdown. Also compare with a bit of fresh rubber for lo loss of elasticity.

POST ACTIVITY

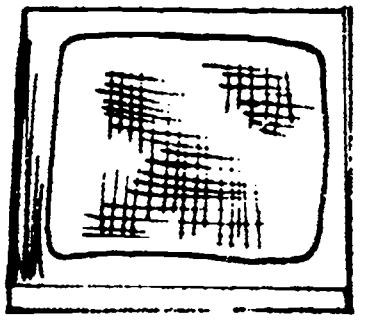
These experiments should be carried out over many days, even many months, to thoroughly understand the long-term effects of pollutants. The class may wish to place the samples in many areas other than the school grounds, perhaps upwind and downwind of industry, freeways, and bodies of water.

Controlled situations can be established using bottled gases or those generated in the laboratory. This should be done under a fume hood to prevent the inhalation of noxious fumes.

Some summary questions you might ask:

a. What conclusions might you draw concerning economic loss due to damage to materials?

b. Are you personally affected by this economic damage?



AIR POLLUTION BIBLIOGRAPHY

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Air Pollution Primer, National Tuberculosis and Respiratory Disease Association, 1740 Broadway, New York, N.Y. 10019 104 pp.

Air Conservation, American Association for the Advancement of Science 1515 Massachusetts Avenue, N.W., Washington, D.C. 20005: 335 pp. ($8.00)

Community Action Program for Air Pollution Control, National Association of Counties, 1001 Connecticut Avenue, N.W., Washington, D.C. 20036: 100 pp. ($1.00)

Environmental Engineering: A Guide to Industrial Pollution Control McGraw Hill, Inc., 330 West 42nd Street, New York, N.Y. 10036

REPORTS

Environmental Pollution: A Challenge to Science and Technology, 1966, 90 pp. 20¢ I67.2:W29/2

Digest of State Air Pollution Control Laws, 1968, 556 pp. $2.75 FS2.93:967

A Strategy for a Livable Environment, 1967, 90 pp. 20c FS1.2:En8

Air Quality Act of 1967, 1967, 97 pp. 30c, 90-1:H.rp.728

Air Pollution Publications: A Selected Bibliography, 1969 522 pp. $4.50, FS2.24Ai7/966-68

Automotive Steam Engine and Other External Combustion Engines, 1968 272 pp. $1.00 Y4.C73/2:90-82

Progress in the Prevention and Control of Air Pollution, 1968, 85 pp. 30¢ 90-2:Sdoc92

Automotive Air Pollution, 1967 13 pp. 90-1S.doc.47

These are available from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402. Air pollution publications are listed in GPO price list PL5..

BOOKLETS, PAMPHLETS, REPRINTS

The Revolt Against the Internal Combustion Engine	(NAPCA)
Air Pollution ($1.00)	(SIPI)
The Ambient Air	(NAPCA)
Physicians Guide to Air Pollution	(NAPCA)
The Air Quality Act of 1967	(NAPCA)

NEWSLETTERS (weekly)

Conservation Report
National Wildlife Federation
1412 16th Street, N.W.
Washington, D.C. 20036

Environmental Action Bulletin
Rodale Press, Inc.
Emmaus, PA 18049
($10.00/yr.)

Air & Water News ($120.00/yr.)
McGraw-Hill, Inc.
330 West 42nd Street
New York, N.Y. 10036

Air/Water Pollution Report
Business Publishers, Inc. ($90.00/yr.)
Box 1067, Blair Station
Silver Springs, MD 20910

PERIODICALS

Environment ($8.50/yr.)
Committee for Environmental Information
438 North Skinker Blvd.
St. Louis, MO 63103

Journal
Air Pollution Control Association
4400 Fifth Avenue
Pittsburgh, PA 15213

Science (weekly)
American Association for the Advancement of Science
1515 Massachusetts Ave. N.W.
Washington, D.C. 20005
($12.00/yr.)

Pollution Engineering ($12.00/yr.)
1301 South Grove Avenue
Barrington, Illinois 60010
(bi-monthly)

CITIZEN GROUPS

Citizens for Clean Air
40 West 57th Street
New York, N.Y. 10019

Citizens Against Air Pollution, Inc.
110 Roundtable Drive, 14-1
San Jose, California 95111

Scientists' Institute for Public Information (SIPI)
30 East 68th Street

Ecology Action
Box 9334
3029 Benvenue
Berkeley, California 94709

Carr, Donald E., The Breath of Life, 1965, New York: Norton ($4.95, $0.75)

Cloud, Preston & Abraham Gibor, The Oxygen Cycle, 1970, Scientific American, September: 110-123

Craig, W.S., Not A Question of Size, 1970, Environment, June: 2-5. On automobile exhaust.

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Navarra, John G. and others, Wide World Weather, 1968, New York: Doubleday ($3.95)

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U.S. Public Health Service, Handbook of Air Pollution, 1968, Washington, D.C. U.S. Government Printing Office: $2.25

Problems of Conservation: Air, Produced by Encyclopedia Britannica - 28 minute Color/Sound - Describes air pollution causes, effect, and some methods of control: Puget Sound Air Pollution Control Agency

Air Pollution-A First Film, Produced by BFA Education media - 8 minutes/color for elementary grades 1 - 5. Explains causes, effects of air pollution, what individual can do, and what is being done by government & industry: Puget Sound Air Pollution Control Agency

Air is For Breathing, Color and Sound film on Air Pollution, Shell Oil Company

Sweetening the Air, Color and Sound, EPA (Region 10) Puget Sound Air Pollution Control Agency.

The Automobile & Air Pollution A Program for Progress, 1967

The Air We Live In James Marshall, 1968.

Killer Smog, 1968 William Wise

Air Pollution Primer, National Tuberculosis and Respiratory Disease Association, New York, 1969. Probably the best general text available. Get a copy through your local TB & RD Association.

A Primer on Air Pollution, Mobil Oil Corporation. Elementary text on air pollution. Available free through the Mobil Oil Corporation, 150 East 42nd Street, New York, N.Y. 10017.

Stern, Arthur C., Air Pollution, Second Edition, Academic Press, New York, 1968. A three volume set that is the standard text for people actually involved in air pollution. See a copy at your local university or public library.

Hindawi, I. D., Air Pollution Injury to Vegetation, U.S. Department of Health, Education and Welfare, Public Health Service, Environmental Health Service, 1970. A good text for this area of air pollution. Available from the U.S. Government Printing Office for $1.25.

Recognition of Air Pollution Injury to Vegetation: A Pictorial Atlas, Informative Report No. 1, TR-7 Agriculture Committee. Air Pollution Control Association, 1970. Probably the best text available on this area of air pollution. Available for $7.00 from the Air Pollution Control Association, 4400 Fifth Avenue., Pittsburgh, PA 15213

Schneider, Herman, Everyday Weather and How it Works, McGraw-Hill, New York 1971. Has a very good section on building your own weather station. Available at most public libraries, usually in children's department.

Hunter, D.C. and Wohlers, H. C., Air Pollution Experiments for Junior and Senior High School Science Classes, Education Committee Mid-Atlantic States Section, Air Pollution Control Association, 1968. More advanced experiements than those presented in this paper. Available for $1.00 from the Air Pollution Control Association, 4400 Fifth Avenue, Pittsburgh, PA 15213. ($1.50/copy) A laboratory manual of 38 experiments ranging from comparatively simple to those involving some degree of sophistication. A good manual.

Environmental Pollution: Experiences/Experiments/Activities, Weaver, Elbert C. Holt, Rinehart and Winston, Inc., 1971: A student manual designed for junior high primarily, but could also be used in senior high. Directions are very clear.

Andrews, William A. et al, Environmental Pollution, Prentice-Hall, 1972: Part of the Contours: Studies of the Environment Series, A well organized resource with much information on various kinds of pollution as well as experiments.

KITS AND RECORDS

Air Pollution Study Program, Eduquip Incorporated, 1220 Adams Street, Boston, Massachusetts 02124. Kits for experiments on detection and analysis.

McFarland, Gary, America the Beautiful, Skye Label, A musical account of its disappearance.

Audubon Ecology Chart, National Audubon Society, 1130 Fifth Avenue, New York, New York 10028 ($1.25 for maps and charts (33" x 50").

Conservation Kit, American Petroleum Institute, School Program, 1271 Avenue of the Americas, New York, New York 10020. Free pictures and discussion kit, 1970.

Earth Island, (An Introduction to Ecology in Action) Educational Division, Department EC, Simon and Schuster, Inc., 1 West 39th Street, New York N.Y. 10018: A multimedia set of materials to help students understand how we are destroying our environment, and what they can do to save the earth from negligence. The kit contains three full-color animated filmstrips by the illustrator Manny Stollman; two 12-inch soundtrack LP records; one Teacher's Manual; 22 different Eco-Data cards (4 copies of each) with illustrated readings of important ecological issues; four large posters. Also available for $1.25 extra (net $1.00) are student workbooks. Price of the package is $75.00.

Ecology Poster Cards, Milton Bradley, Springfield, Massachusetts. $3.00

Earth Rot, A musical comment on the state or the environment. David Axelrod: Columbia Records.

Ecology-The Game of Man and Nature, Urban Systems, Inc., 1033 Massachusetts Avenue, Cambridge, Massachusetts, 1971. ($10.00. While advancing through four ages of development, players try to achieve a balance between man's activities, and the natural environment.

Environmental Overheads, Hammond-Newsweek, Visual Study Series, Hammond, Incorporated, Education Division, 515 Valley Street, Maplewood, New Jersey 07040. Various overhead transparencies on urban and world problems of natural resources, environment, and conservation.

Environmental Posters, Environmental Protection Agency, Seattle, Washington

Extinction: The Game of Ecology, Sinaver Associates, Incorporated. 20 Second Street, Stamford, Connecticut ($11.95): Examines the key processes by which species survive and evolve or become extinct.

Guidance Associates, Pleasantville, New York: Environmental and vocational filmstrips-the most valuable being The Wisdom of Wildness, by Charles A. Lindbergh.

Man and the Environment, Houghton-Mifflin Company, 1970-1971 science catalog for grades 7-12: Lists books, films, programs, kits, and overhead transparencies relating to ecological problems. New ecology-based life science course, Man and the Environment, utilizes games, role playing, and simulation.

Paradise Island, Simile II, P. O. Box 1023, La Jolla, California 92037: In this population game, students deal with such concepts as incentives for population growth in young nations, population mix, and the need for population control as a society increases its technological base. A sample set is available for $3.00; the complete kit for a class of 18 to 35 students is $25.00.

Pollution Detection Kit, Oak Ridge Associated Universities, Tennessee, and National Science Foundation. This Atomic World, c/o Edward Aebischer, Head, Information Services Department, ORAU Incorporated, P. O. Box 117, Oak Ridge, Tennessee.

Posters on Pollution, Argus Communications, 3505 North Ashland Avenue, Chicago, Illinois 60657

Principles of Modern Biology, Behavioral Research Laboratories: Nine-volume, complete introduction to ecology/biology in programmed format, self-paced. Produced by Kenneth B. Armitage, Richard W. Holm, and Paul R. Ehrlich. Includes nine corresponding teacher's manuals and the test booklets. Intermediate grades.

Smog/Dirty Water, Strategy games for children or adults @ $10.00. Urban Systems, Incorporated, 1033 Massachusetts Avenue, Cambridge, Massachusetts 02138.

Starpower, Simile II, P. O. Box 1023, LaJolla, California 92037. This simulation games deals with the whole question of power structures within a society. It is particularly applicable with regard to industrial pollution and governmental controls over environmental pollution. Sample instructions are available for $3.00; the complete kit for a class of 18 to 35 students is $25.00.

The Blue Wodjet, Simile II, P. O. Box 1023, La Jolla California 92037: Using this simulation game, students become more aware of the problems pollution control efforts create for industry and of the ways in which citizens and industrial leaders can deal with those problems. Sample sets are available for $3.00; the complete kit for a class of 18 to 25 students is $25.00.

The Environmental Challenge of the 1970s, Six taped interviews of scientists and politicians. Washington Tapes, Incorporated, 5540 Connecticut Avenue, N.W., Washington, D. C. 20015.

The Pollution Game, Houghton-Mifflin Company: Students simulate in a game of progressive contamination of our environment, then try to reverse the contamination to preserve the environment; students experience the antagonisms and frustrations of trying to change technology and social behavior. Junior and Senior high school level.

AIR QUALITY FILMS

TITLE	TIME	COST	FILM #	COMPANY	GRADE
1. Don't Leave It To the Experts	16	Free	m-1739	National Medical Audiovisual Cntr Station K Atlanta, Ga. 30324	
2. Beware the Wind	22	"	m-1707-X	"	
3. The Run-Around	11	"	m-1774-X	"	
4. On A Clear Day You Can Almost See Terminal Tower	22	"	m-1712-x	"	
5. The Poisoned Air	50	"	m-1418-x	"	
6. Air of Disaster	50	"	m-1419-x	"	
7. Something In The Wind	30	"	tfr-1308-x	"	
8. With Each Breath	30	"	m-1430-x	"	
9. Ill Winds On A Sunny Day	28	"	mls-984	"	
10. The Business Of Air	30	"	m-1420-x	"	
11. It's The Only Air We've Got	25	"	m-1431-x	"	
12. A Matter Of Attitudes	30	"	m-1530-x	"	
13. Air Pollution: Take A Deep Deadly Breath					
Part I		"	m-1540-xa	"	
Part II		"	m-1540-xb	"	
Part III		"	m-1540-xc	"	
14. Pollution	3	"	m-1529	"	
15. Air Pollution In New York					
16. New Jersey Interstate Area	15	"	m-1624-x	"	
17. Beware Of Ill Winds (filmstrip)		"	f-1745-x	"	

AIR QUALITY FILMS

TITLE	TIME	COST	FILM #	COMPANY	GRADE
18. Air Pollution And You (filmstrip)		"	f-1528 x	"	
19. Something In The Air	28	"	A 72-00002	MTPS	
20. Gas-The Clean Air Fuel	13	"	A 72-00005	"	
21. The Answer Is Clear	14	"	A 72-00007	"	
22. To Live And Breathe	11	"	A 72-00008	Aetna	
23. Air Is For Breathing	29	"	*A 72-00012	Shell Oil	
24. Your Car And Clean Air	13	"	*A 72-00013	Motor	
25. Leaded v.s. Unleaded Gas-The Facts and Myths	27	"	A 72-00029	Ethyl Corp.	
26. Air Pollution and Plant Life	35	"		EPA	
27. Toward A Clearer Air (filmstrip)		"	f-701	Associated Films, Inc.	
28. The Great Clean Air Car Race		"		EPA	
29. Ill Winds On A Sunny Day	60	"		EPA	
30. The Clean Air Race		"		EPA	
31. Air Pollution (filmstrip)		"		Univ. of Nevada EPA Environmental Studies 290 Las Vegas, Nevada	
32. The Poisoned Air (CBS-TV)	50	"	m-1418-x Film C	U.S. Dept. Of H.E.W.	