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ABSTRACT

Twenty-three self-contained single concept physics demonstration packages were designed and constructed at Lamar University (Texas). Each package was available for loan to pre-college science instructors in southeastern Texas in the spring and summer of 1987. During the spring, three high school physics teachers used the demonstrations and provided evaluations that resulted in minor modifications in them. In the fall, five schools participated. Follow-up visits to the teachers who used the demonstrations revealed that some teachers needed both extensive help with the experiments and a broader conceptual base. The project continues by Lamar University with the addition of demonstrations to the lending library and increased school participation. A primary project focus is the establishment of communication with pre-college teachers in need of help but reluctant to seek it. A sheet for each of the demonstration packages provides a statement of the concepts illustrated, a description of the package, and suggested activites. (MSE)

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A LENDING LIBRARY OF PHYSICS DEMONSTRATIONS

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Joseph F. Pizzo, Jr. Principal Investigator

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AASCU/ERIC Model Programs Inventory Project

The AASCU/ERIC Model Frograms Inventory is a two-year project seeking to establish and test a model system for collecting and disseminating information on model programs at AASCU-member institutions--375 of the public four-year colleges and universities in the United States.

The four objectives of the project are:

- o To increase the information on model programs available to all institutions through the ERIC system
- o To encourage the use of the ERIC system by AASCU institutions
- o To improve AASCU's ability to know about, and share information on, activities at member institutions, and
- o To test a model for collaboration with ERIC that other national organizations might adopt.

The AASCU/ERIC Model Programs Inventory Project is funded with a grant from the Fund for the Improvement of Postsecondary Education to the American Association of State Colleges and Universities, in collaboration with the ERIC Clearinghouse on Higher Education at The George Washington University.

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Technical Description of Project and Results

In accordance with the proposed goals of this project, twenty three physics demonstration packages have been designed, constructed and assembled into a "lending library". This library is housed and maintained in the physics building at Lamar University. Each package is complete in every detail and ready to use with no additional equipment needed. A list of the demonstrations available, a description of each demonstration package, and a copy of the letter sent to the pre-college physics teachers and some selected physical science teachers in the South-east Texas area follows.

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August 27, 1987

Dear Physics Educator,

This is an invitation to make use of the Lamar University "Lending Library of Physics Demonstrations". I have enclosed a list of the demonstrations available, along with a packet which includes a brief description of each demonstration.

If you see anything that you can use in your physics or physical science classes, please call and have a demonstration package sent out to you. Each package is complete down to the last detail - you do not have to worry about searching for any auxiliary equipment. There is absolutely no charge for this service. It is made possible through a grant from the National Science Foundation. The demonstration packages will be delivered and picked up each Friday afternoon starting September 4. There is no charge for this service either. If this is not a convenient time for you to receive the demonstrations, you can make arrangements to pick them up at the Lamar University Physics Building at your convenience.

Each demonstration package may be kept for one week (we suggest you try out most of the demonstrations yourself before you use them in class). We will not limit the number of packages (within reason) that may be checked out at one time unless the demand becomes too great.

I have already made duplicate copies of some packages, for which I anticipate heavy demand, and will continue to do so as conditions dictate. If you want to illustrate a concept for which I have no demonstration, let me know. I want to add to the holdings of the "Library".

As you use these demonstrations, you may discover that many are so simple that you could duplicate them yourself and start your own collection. I hope so! Let me know if I can ever help you locate anything you need. Finally, feel free to call on me for advice or suggestions at anytime. I look forward to working with you in the interest of Physics Education in our Community.

Your colleague,

Joe Pizzo Professor of Physics

Usage

The preceding letter, package list, and demonstration descriptions were sent to twenty two pre-college teachers, on August 27, 1987. Five teachers chose to participate during the Fall, 1987 semester. It is the opinion of the principal investigator that participation can and will be increased by follow up letters and personal contact. A list of participating schools and package

A list of participating schools and package distribution follows on the next page. The location of the schools and their approximate distance from Lamar is given below.

<u>School</u>	City	<u>Dist. from Lamar</u>
Stephen F.Austin High School (SFA)	Port Arthur	10 miles
Westbrook High School	Beaumont	10 miles
Port Neches-Groves High School (PNG)	Port Neches	15 miles
High Island High School	High Island	40 miles
Lumberton Intermediate School	Lumberton	20 miles

Ambient Noise Resonators Analysis of Sound Artificial Sunset Bed of Nails Center of Mass SFA Curved Space Diffraction Gumby Ride		
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Bed of Nails Center of Mass SFA * Curved Space Diffraction Gumby Ride	ی کارش میکند و جو بود اور او می اور او می و بین و بین و بین و بین و بین و	ager basan suun budan kites pauto gean maya an-a kates suun digen k
Center of Mass SFA * Curved Space Diffraction Gumby Ride	بر کندی بودی در بین وست درکتر وید. درسه وست ک	العالم وجود محدد موده كودو والحو عدي عدين وسع وقت وعن عنها كلمة و
Curved Space Diffraction Gumby Ride	با كليتي وشناء وعمم خطاب وكلوا وغواد ويشا خالبه كليه كليه عماله ا	للهوار منزود غاوية وليدو وتبود ابطه مركاء بونات فعليه كالله كفال غوات كموار ا
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Weight in Newtons

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Gumby Ride	arda firif Mila Mala Yuda ang Ghin part Mila doko Lud anis. 3	PNG	. المتلغ جهيم علايا، عاميم اللود مزادة عبدان عبدار العبر عادي وحد العبر المالي وحد
Inter ference	nage frære nære Malin Sillen Sille i Gerer (frave dåder Siller haver hanne h	مان کشت وسط کور، انگل کی کردی کردی دربار انگر ایران ایران ایران و برای و باری و باری و باری و باری و برای	، شماله العامة العامة الجوابة الألماء علمانة والارام كالمرة العالية الكافة ويتوارد العظير والعالية عيوات عيرها
Low Temperature Effects	nga pining agan danis tikin pina pina dan kenti. In ketu danis k	MF MALE ANN AND AND AND AND AND AND AND AND AND	، العالم بالعام عليهم المرجع العالم والمالة عليها العام والعام عليهم العالم عليهم والله بيرما
Mudslinger 1	nefe alema dinar talaha (Lada kanar kara dinar dinar talah talam talah dinar dinar di	nin wala bala diku dake unin man kara kara kain kain kain kain kain kain kain kai	, Marka baray merik danisi line, anter metro upug Mener atau anger gayan pada sasir sasir
Mudslinger 2	min, derte pente frees finte ging gene ung etant ante ster sere t	ant gala Nama gala kula kula kula data data yan dala maka aga bafa data kan	یکنان کاران اسک کارد: کرد: کرد و عادی است کردی ویلی میلی مربع بر این ویلی ویلی ویلی ویلی ویلی ویلی ویلی وی
Newtonian Gravity	49. Mét untu pane Mét dan keli and and and an	SFA	
Non-Inertial Ref. Frame	ner, 1966 ande ange Gest anne anne gyn, prig fing ange byjer f	Be Aller stadt figer, filler, aller som, over, livie, som soger som ange aven por	SFA ¥
Polarization: Scattering]	الله معالمة الملك الشني وملكو معادة الدول كالبين التاريخ والدار وربية ملكم معادي والولار للملة	ingin alayi alar bila kan yan yan bila ana alay kan bila ana alay alay kan
Polarized Light	nar, 1989 jana gaint anta katu datu datu anta anta unia duk guin kuna p	din banda apinin dagi antati, kerut dagi derine Dila dagin serapi dina ngan danin gapa.	هانده والمان المراقع الوارية الأمان والمان المانية المانية الأقلية بريانة المانية المانية والمانة والمانة والم
Rotating Platform		na ang ang ang ang ang ang ang ang ang a	anna ann bha ann Ann Ann Ann Ann Ann Ann Ann Ann An
Scattering	ann	na gada ann ann ann ann ann han han han tha gada ann ann han ann ann ann ann	annin talan gapa tanga daga palan gana anga daga daga daga talah talan sala anga anga
Singing Sewer Fipes			anna, ann 1997 Mille Mille Mille State
Spectra		na ann an Ann ann ann ann ann ann ann an	make diffe note force from POT water from over some ming over some
Standing Waves on a Rope	سه بیسی 1964 کمیں 1966 کمی ہیں۔ پیش 1966 کمی میں میں میں اور	na ann ann tha tha tha tha tha ann an a	NNN NNT-Act Acta Star atta part the star atta atta atta atta atta atta atta
Tablecloth "Trick" 1	الله مينيان ويتين بينين بينين بينين ويون ويون العام المراجع المراجع المراجع المراجع المراجع المراجع المراجع ال	یے گھی گائی ایک گھی کری ہیں۔ پری پہلی پری کری کری ہے۔	منعت اللغاي الاسلام منتقد اللغاي وروي وليتيه ولاية والمناج والمناج والمناج والمناج والمناج والمناج و
Tablecloth "Trick" 2	اللا طارب پرید پیش آات پیچ وید برای پیش برای هی برای ه	ها والدي العام الدين الم وعال المالي وعال المالي المالي المالي المالي المالي وعال المالي وعال الم	عوال عنه الس مربع علي من مربع لله الله الله الله الله الله الله الله
alan dan ang ang ang ang ang ang ang ang ang a	نی سوی بینی بادی بینی بردی بینی مینی میش مانی باده و داده مینی بینی به	کر میں ہیں ہیں الکار الیک الکار کی ایک کار ایک الکار کی ایک کار ایک کار ایک کار کار کار کار کار کار کار کار کا	ليست الهيد بمناو بيهنار بينين الجوة يبشرة ألغاء وتشار ماني والم بياني بتقد وتشار وتبر

Vibrating Membrane

ERIC

	10/23-10/30	10/30-11/6	11/6-11/13
Ambient Noise Resonators		والمراجع والمراجع والمحت الموري والمراجع والمراجع والمراجع والمراجع والمراجع والمراجع والمراجع والمراجع والمراجع	ganna Prod Rogen Millio anna conni - d'anna dhuf adda Ganti Millio adda Anda Mi
Analysis of Sound	an ann ann ann ann ann ann ann ann ann		ante mun puir filling print Burn Burn bury Billin Suis Bala Stra Burn Burn burn
Artificial Sunset	ning finite pulse from the first first streng finite first along fit. In party	ante dies bes ante and the disk way and and and and and and	anna hain ann nina ann airte ann ann an sua han ann ann ann ann ann ann ann
Bed of Nails	High Island		
Center of Mass			
Curved Space	PNG *		
Diffraction			
Gumby Ride		Wistbrok	
Inter ference			
Low Temperature Effects			
Mudslinger 1			
Mudslinger 2			
Newtonian Gravity	PNG	Hightstand	
Non-Inertial Ref. Frame	PNG	His h Island	
Polarization: Scatterin	g		
Polarized Light			
Rotating Platform	PNG		
Scattering			
Singing Sewer Pipes			
Spectra			
Standing Waves on a Rope			
Tablecloth "Trick" 1			
Tablecloth "Trick" 2			
Vibrating Membrane			
Weight in Newtons	HighJeland		

	11/13-11/20	11/20-11/25	11/25-12/4
Ambient Noise Resonators	محملة مؤسط فيهي بشرية مملة ومبلغ فينية فيريد فيسرة وتتبية ويهيت سميع طابيها ليهمه فوقت	ین میں دی ہے۔ میں میں کری ∙ میں میں ہیں میں میں میں میں میں میں میں میں میں م	ine Milling performangkan antipe kaning kaning bengin melang kaning kaning kaning kaning kaning kaning kaning k
Analysis of Sound	nders ment harer langes giving andige pinge single single filler dager. Dalah bilike	Balan Bilara Minar Aparis Billing Appen Sinter Statis Sanis ganan Spine Person 19, an anar Sa	90 - Teles gality Millio Willio galito galito galito alla sullo. Balis balis sullo estas estas antes
Artificial Sunset	anne erner deter allen. Die in berr binde bier, allen bier, gent ange brige	HighIsland	na Maray y ale unary aning aris, andri tagin pana anan man man pan. Mile aning pan
Bed of Nails	Balle Allen Jahrs M Dann gunn genn Stad Hall- ander tuger Daller Ander	nent were mine Brefande alle einer fung prin gent finne bein bein anne finne bein bein bein bein bein bein bein	ین وزنی وران کنی والی والی والی والی والی والی والی وال
Center of Mass		یستار کارو کارو کارو کارو کارو کارو کارو کا	ng Miling girlf Shang Miling girling nasin Sanga Shika girlin bugg daban Shirin Sanin garing Bakar
Curved Space	ann a na ann ann ann ann ann ann ann burn bhur abh ann ann ann ann		Westbrock
Diffraction	anne alem perer under men genn filme Gaus sinde Barr Gaust Bink anne	ماها وها الالله حسب الله وحد الالي يوب ويب ويار هياه الله الله ويار ويار	
Gumby Ride	الخلية هالات منتقد الإمارة الاست بوساط عملت البوب عبشت وعنه الهون وليون بوالية	ین بین نام دین این ولی این ولی می این این این ولی می این ولی این این این ولی این این این این این این این این ای	نیا ^{سری} پروان کورد کمی ویک ویک کیو کور کور کرد کرد و بر این کرد کرد و بر این ویک کرد کرد کرد کرد کرد کرد کرد کرد
Inter ference	الخلة الأماد هردات العرب عادي هربية ومعاة ويربه تشتية وسط يورود «يوي هيية	gara daire traig annas statu gara dana kana maka kalifa dana dalay gada kana qu	ng Milit gala dina dina paka paka nan iku aka paka paka pan san tang tang tang bana san tang tan
Low Temperature Effects	گوارد خانبه هایی اینده کنید کرد بیش بردند هیرد <u>مید</u> . چند چیرد چهن جهن ب	gern gern gen, hiller gern anlas genn dan, daer gene biga agus bair bida fis	ing angka angkan balan danin angka angka banya dikana s' ' kangka angkan diking angka alamba kanga
Mudslinger 1	سینی استار درود عدور اوری وروی وروی کرد شده میرد کرد این است.	hann agun triin haine arten Airis thain Main Anna agun ann ann an an	یے جسٹے چھکا کردیو پیری میں۔ ورماد کری کلیے معلم ولیو جندی انہیں ہوتی ہوتی ہیں۔
Mudslinger 2	بسنام وهول وليت الجزرة والازد طلولة كلواة كلواة واليات منكرة للمارة كليت والت	والمن مراجع والمراجع المراجع والمراجع والمراجع والمراجع والمراجع والمراجع والمراجع والمراجع والمراجع والمراجع	ین میران اوروپ شوید برای اوروپ
Newtonian Gravity	allen 2007 pinte annis dinn annis - die pass annis man appen pasy page	High Island	an sain, gain ang kang aint katis aint dan aint gan dan ang nang nang nang
Non-Inertial Ref. Frame		nana dalah ding penggana dari awa papa dan dalah dalah dari dari dari dalah dalah dalah dalah dari da	وه پالین برای ایرون وری ویلی ویلی بوده کردو میدر ویلی بروی ویلی ویلی ویلی ویلی ویلی ویلی ویلی و
Polarization: Scatterin	9	وجهر مربق ويشا حسن ويود ذلك جرائ ويبيد للبيد الدين ومعر وجهد يلام ويقا	ده هست زیوان همی همی امارد میماز کین هرک و بیش این و بیش ایرون مدیر با می ایرون و بیش ایرون و بیش ایرون و بیش
Polarized Light	علمه عمي ومع سبب عليه منه المنه منه عليه ومنه يليم ويس	High Island	الا الجام ليتلك البرية اللكي وعالد لديالة البرية ويوي مراة عليه ويولي ومار بعين الاخار البير
Rotating Platform	ngan man baku bulu mini gan kinin ing man man man man ang ang		n, pilon natio dana divina divina patri dinis pada anar kati, stro aras nati, anar ang.
Scattering			an Billin yardin Manar Balan ayadin Manji, Bilany yardin banay ganda kudun angan angan angan angan angan angan
Singing Sewer Pipes		یکورد خود ویژن مردی خود داری پریل پریل پریل کرد. در باری خود بر برای خود بر برای خود برای مرد برای برای برای ب میرد برای برای برای برای برای برای برای برای	er fille geft hann fille gift geft hann men veir gert gert hann hann trans
Spectra		anda dike dike pana diki papa tana ana pana pana pana pana pana	na minin danin Alaya Minin danin badin diga dinin asin , mase dana dinin dana dinin Kom
Standing Waves on a Rope	ست علي والله بلكة (195 والله تواله يوليه تعلي تريب علي الله الله علي علي علي الله الله الله الله الله الله الل 	ante pinte tinte ange aven, auge hange biere pinte event base press soldt base fit	هند کاره میرده ایند. ایند میآن سیاد و بین کالای بیای کسی کنید. بین می می همی هی می ا
Tablecloth "Trick" 1	angan galan galan angan angan ganga diri a tagan panga angan dalah dalah dalah dalah d	ماده میدود افغان مادانه همید وعدم هاده وعنی ماده و بروی مدیر وجود قلیت کم. _{اسطا} بیب مب	بة يوين كانية لينتر، يتيرية شعب كليل يدانة كمنة تحت كانية ويليد تحتير جدين جري يدين المانة .
Tablecloth "Trick" 2	البرية الملك عليه المركب الملك والمركب والمركب المركب المركب المركب المركب المركب المركب المركب الم	والبل	ng Bing dinih ding ding cinih masa dapi dini gant bany mata ang dan mini ding
Vibrating Membrane	مریخ چونی در این کال بری _{این} کال کال میک این	یستید کارستا انتهای پیشیده کاشاه عملیه بازیدی کارانه پیشود دوبالا کیوب علویه جامله کرده کرد.	ین پیش چانگا شورد کاری ورزند ورزند خود شود بعد ورزند ورزند ورزند ورزند ورزند ورزند ورزند

* make visit myself

•	12/4-12/11	1/4/88
Ambient Noise Resonators		
Analysis of Sound		بلغة تعلمه الألبان مراجع التلبار الكليار الألبار للمار يستلم مستلم بالبلغ مليال المراد وبالبر بوالار
Artificial Sunset		Lineberton *
Bed of Nails		
Center of Mass		
Curved Space		
Diffraction		
Gumby Ride		ner fran verie gett alas mans ten and andre men fals part but verie alas
Inter/erence		میں اور
Low Temperature Effects		
Mudslinger 1		an man man nan nan ann ann ann ann ann a
Mudslinger 2		an ann ann ann ann ann ann ann ann ann
Newtonian Gravity		
Non-Inertial Ref. Frame	1997 1997 1998 1998 1999 1999 1999 1999	afar Mille Affire Additi pinga dipilis Affire analis anagis kada, apata aladay kung apayo, alam,
Polarization: Scattering]	ny aka min' aya mu anin' ana ana ana ana kata kata kata kata kat
Polarized Light	nna gun Mai Gala Mai ann aine ann ann ann ann ann ann ann ann ann a	NY TRÀ Mào ann dao brin Mo ann bhao bhu nun nun ann ann ann ann
Rotating Platform	lifet Afrits Grifet Grifet Afrika andre andre hiddi yange Apant saka apak akka pina p	الله العام الارامة الارامة العام الارامة الارامة وروامة المحملة الارامة الكرية على المركزة الروامة المراجع الم المراجع المراجع
Scattering	ana dinan melan anan darin anan gener pana guya sama darin darin darin darin darin darin darin da	اهت الحد علمان البنان العلي مالغة الآلاب بعيش ليسبل ليشع يعشي وعليه عليه عن ويسب
Singing Sewer Pipes	میں مردرہ ہے کے موجعہ کیمی میں مردیہ میں پیشر کی در اور اور اور اور اور اور اور اور اور او	inis dana Minis Minis Pan. Minis Pala dalah katab kany masa panyi ayan pana anan
Spectra	Are refer bere door now case anny past gast gast gast door door door door door door door doo	الله الله الله الله الله الله الله الله
Standing Waves on a Rope	1999 - The State State Const and a set of the State	الله كالي اللك كالا الله عاليه كاله كاله منه معله عليه كليه عليه بعالية بعبال منه يربي ويبية
Tablecloth "Trick" 1	1999 - 2009 - 2009 - 2009 - 2009 - 2009 - 2009 - 2009 - 2009 - 2009 - 2009 - 2009 - 2009 - 2009 - 2009 - 2009 -	
Tablecloth "Trick" 2		an, anna anna 2000 ann anna ann 2008 ann ann ann ann ann ann ann ann ann an
Affine Affin fann anna anna anna affin anna affin Anna Affin airs anna anna anna anna anna anna anna an		مرمام وكبير عينية المانة عاري وينت المربع المربع المربع منت المربع ومنا ويتنه وليك وللا من

Vibrating Membrane

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Significance of the Project

While the number of participants was small, it is felt that the results are significant and the project is one that could be emulated by many colleges and universities.

The original goal of the project was to supply precollege teachers with ready to use physics demonstrations to enhance the traditional delivery of science education by lecture and laboratory. That purpose is certainly served. In fact two experienced educators who have used the packages have copied many of the demonstrations and are now building their own library.

However, the main significance of the project is one that was not fully anticipated. Three pre-college teachers of physics have used the demonstration packages as an "excuse" to open a dialogue with the principal investigator and reveal their lack of preparation in physics. (The best background among the three is two semesters of algebra based physics.) Why the Boards of Education should allow such situations to exist is not of immediate concern to the principal investigator. The main objective at this time is to offer every possible assistance in addition to the demonstration packages. The principal investigator has even been asked by two teachers to take over one of their classes while they observed.

The significant point is that without the demonstration packages as a focus, it would not have been easy for these teachers to identify themselves and take the principal investigator into their confidence. While either delivering the packages himself or making follow up visits, the college teacher has the opportunity to interact with the pre-college teacher in a way that is neither intimidating nor patronizing.

It is the opinion of this investigator that the availability of pre packaged demonstrations offers an excellent opportunity to open lines of communication with the pre-college teachers in the area.

Dissemination of Results

In order to share the results of this project with as many educators as possible, the principal investigator has made several presentations to science teachers at both the national and regional levels:

1. " Demonstrations to Go ", a workshop presented to the Science Teacher Association of Texas regional conference, in Beaugont, Texas, April 25, 1987.

2. " A Lending Library of Physics Demonstrations - A Pilot Project ", a presentation to the American Association of Physics Teachers national meeting in Bozeman Montana, June 17, 1987.

3. " A Lending Library of Physics Demonstrations ", a presentation to the Conference on the Advancement of Science Teaching in San Antonio, Texas, November 21, 1987.

4. " Demos to Go ", an invited paper to be presented to the national meeting of the American Association of Physics Teachers in Ithica, New York, June, 1988.

5. The principal investigator has been invited by the Region XIII Education Service Center to present a workshop for the Austin area Physics teachers. Date of presentation will be June 30, 1988.

Future Directions

The physics department at Lamar University vill continue the support of the project by supplying equipment, student assistance and transportation.

The principal investigator plans to extend the project in the following ways:

- 1. After using the demonstrations from Lamar's library, teachers will be offered encouragement and assistance in constructing their own library of demonstrations.
- 2. Ideas for new demonstrations will be solicited from pre-college teachers and added to the Lamar library.
- 3. Demonstrations will be cross referenced by topic.
- 4. Video tapes will be made, showing the principal investigator setting up and using each demonstration package. Upon request, a copy of the tape will be available with the demonstration package.
- 5. The principal investigator will continue to use the "carrot" of the demonstration packages to seek out and work with those teachers whose physics background is inadequate.

AMBIENT NOISE RESONATOR

CONCEPTS ILLUSTRATED

1. STANDING WAVES 2. SPEED OF SOUND IN AIR 3. FREQUENCY SPECTRUM OF NOISE

DESCRIPTION OF PACKAGE

1. EIGHT 1 1/2 INCH PVC PIPES OF DIFFERENT LENGTH 2. ONE PADDLE

SUGGESTED ACTIVITIES

 PLACE YOUR EAR CLOSE TO EACH PIPE AND LISTEN TO THE TONE. EACH ONE REINFORCES A NOTE OF THE SCALE TWO OCTAVES BELOW "MIDDLE C".
 STRIKE THE PIPES WITH THE PADDLE. TRY TO PLAY A "SONG".

ANALYSIS OF SOUND

CONCEPTS ILLUSTRATED 1. SOUND WAVES 2. HARMONIC COMBINATION

DESCRIPTION OF PACKAGE 1. FOURIER SYNTHESIZER 2. OSCILLOSCOPE 3. MICROPHONE 4. WIRES 5. SPEAKER

SUGGESTED ACTIVITIES

1. USE FOURIER SYNTHESIZER TO SHOW FIRST, SECOND, AND THIRD HARMONICS ON THE OSCILLO-SCOPE, LISTEN TO THEM, SHOW HOW FREQUENCY IS INDICATED ON THE OSCILLOSCOPE,

2. SHOW MBINATION OF HARMONICS ON THE OSCILLOSCOPE. POINT OUT THAT THE COMBINATIONS

ALL HAVE THE FREQUENCY OF THE FUNDAMENTAL, LISTEN TO THE DIFFERENT QUALITY OF EACH COMBI-NATION,

- 3. LET THE STUDENTS USE THE MICROPHONE TO SEE THE HARMONIC COMBINATIONS FROM THE VOICE. (VOWEL SOUNDS SUCH AS O AND E CAN HAVE A RELATIVELY SIMPLE HARMONIC CONTENT)
- 4. HAVE THE STUDENTS BRING MUSICAL INSTRUMENTS TO SCHOOL IN ORDER TO ANALYZE THE SOUND.

ARTIFICIAL SUNSET

CONCEPTS ILLUSTRATED 1. SCATTERING

2. WHITE LIGHT COMPOSED OF RED, GREEN, AND BLUE 3. FREQUENCY DEPENDENCE OF SCATTERING

DESCRIPTION OF PACKAGE 1. PLASTIC TANK WITH FLAT SIDES 2. "SUN SLIDE" 3. ONE BOTTLE OF 1 NORMAL HCL 4. ONE BOTTLE OF SODIUM THIOSULFATE SOLUTION 5. ONE GRADUATED CYLINDER 6. TWO BEAKERS 7. SLIDE PROJECTOR

SUGGESTED ACTIVITIES

1. SHOW THAT AS SCATTERING INCREASES, A BEAM OF WHITE LIGHT WILL LOSE BLUE AND GREEN, RESULTING IN THE TRANSMISSION OF RED 2. COMPARE THIS TO A SETTING SUN

BED OF NAILS

CONCEPTS ILLUSTRATED 1. PRESSURE IS INVERSELY RELATED TO THE AREA OVER WHICH A FORCE IS APPLIED

DESCRIPTION OF PACKAGE 1. BED OF NAILS SUFFICIENT FOR COVERAGE BY THE AVERAGE BACK OR BUTT 2. SAFETY LID 3. "PRESSURE TESTER" 4. CALIBRATED WEIGHTS 5. SCALES 6. PLATFORM FOR SCALES

SUGGESTED ACTIVITIES

 LIE ACROSS OR SIT ON THE BED OF NAILS TO SHOW THAT THE PRESSURE IS NOT SUFFICIENT TO CAUSE PAIN
 USE THE "PRESSURE TESTER" TO FIND THE AMOUNT OF PRESSURE THAT IS UNCOMFORTABLE
 MAKE SOME SEMI-QUANTITATIVE ESTIMATES OF PRESSURE EXPERIENCED ON THE BED OF NAILS (IN UNITS OF NEWTONS PER NAIL)

CENTER OF MASS

CONCEPTS ILLUSTRATED 1. BALANCED TORQUES 2. CENTER OF MASS

DESCRIPTION OF PACKAGE 1. "CUT OUT" OF THE STATE OF TEXAS 2. SUPPORT FROM WHICH TO SUSPEND "CUT OUT" 3. PLUMB-BGB 4. SCALE (READING IN NEWTONS) 5. PLANK (2 M LONG BY L5 CM WIDE) 6. PLATFORMS TO SUPPORT EACH END OF PLANK

SUGGESTED ACTIVITIES

1. SUSPEND THE STATE OF TEXAS BY TWO POINTS (ONE AT A TIME) AND DETERMINE THE GEOGRAPHICAL CENTER OF TEXAS.

2. PLACE A STUDENT ON THE PLANK, SUPPORTED AT HEAD AND FOOT. READ THE FORCE HOLDING UP ONE END. USE METHOD OF BALANCED TORQUES TO FIND THE CENTER OF MASS OF THE STUDENT.

CURVED SPACE

CONCEPTS ILLUSTRATED

1. EINSTEIN'S MODEL OF GRAVITY 2. SCATTERING BY AN ATTRACTIVE POTENTIAL A.) RELATION BETWEEN IMPACT PARAMETER AND ORBIT B.) RELATION BETWEEN KINETIC ENERGY AND ORBIT

DESCRIPTION OF PACKAGE

1. A SECTION (0.3M HEIGHT) OF A LANGE DIAMETER CYLINDRICAL TUBE (SONOTUBE) 2. ONE PIECE OF 2-WAY STRETCH FABRIC 3. ONE LARGE ELASTIC BAND 4. ONE SHOT-PUT 5. TWO SMALL BALLS

SUGGESTED ACTIVITY

 USE ELASTIC TO HOLD STRETCH FABRIC TIGHTLY OVER TUBE
 ROLL BALL ACROSS THE FLAT SPACE AND WATCH IT FOLLOW A STRAIGHT LINE
 PLACE SHOT-PUT IN CENTER OF FABRIC
 ROLL BALL ACHOSS "CURVED SPACE" AND WATCH IT FOLLOW A CURVED TRAJECTORY
 CHANGE THE IMPACT PARAMETER AND INITIAL SPEED TO SEE THE EFFECT ON THE ORBIT

DIFFRACTION

CONCEPTS ILLUSTRATED 1. DIFFRACTION 2. COLOR

DESCRIPTION OF PACKAGE

1. SMALL BRIGHT LIGHT IN A LARGE FRAME 2. TRANSFORMER 3. SEVERAL OBJECTS WITH SMALL APERTURES

SUGGESTED ACTIVITIES

1. LET STUDENTS VIEW THE BRIGHT LIGHT THROUGH THE DIFFERENT OBJECTS 2. HAVE STUDENTS FIND AND BRING OBJECTS FROM HOME THAT WILL DIFFRACT LIGHT

GUMBY RIDE

2. CENTRIPETAL FORCE

DESCRIPTION OF PACKAGE 1. DRILL 2. VARIAC 3. CIRCULAR CAGE 4. FINGER CLAMPS AND SUPPORTS 5. GUMBY

SUGGESTED ACTIVITIES

1. MOUNT CAGE ON DRILL AND SLOWLY INCREASE SPEED WITH VARIAC. PLACE GUMBY ON THE SIDE OF THE CAGE (FEET OFF THE FLOOR) WHEN SPEED IS SUFFICIENT

2. REDUCE SPEED AND WATCH GUMBY FALL 3. REPEAT STEP 1 AND THEN INVERT THE CAGE 4. REPEAT STEP 2

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INTERFERENCE - LIGHT

CONCEPTS ILLUSTRATED 1. INTERFERENCE 2. COLOR

DESCRIPTION OF PACKAGE 1. SODIUM VAPOR LAMP 2. TWO PIECES OF PLATE GLASS 3. LASER 4. DOUBLE SLIT SETS 5. BUBBLE SOLUTION AND BLOWER

SUGGESTED ACTIVITIES

 PUT ONE PIECE OF PLATE GLASS ON TOP OF THE OTHER AND ILLUMINATE WITH SODIUM VAPOR LAMP.
 LOOK FOR INTERFERENCE PATTERNS FORMED BY LIGHT REFLECTING FROM TOP AND BOTTOM OF AIR GAP.
 ILLUMINATE ONE DOUBLE SLIT SET WITH THE LASER AND EXAMINE THE INTERFERENCE PATTERN ON A DISTANT SCREEN. COMPARE TO THE PATTERN FORMED BY THE OTHER SLITS WITH A DIFFERENT SEPARATION.

3. LOOK AT THE COLORS ON A SOAP BUBBLE, THEY ARE FORMED WHEN DIFFERENT FREQUENCIES OF LIGHT COMBINE CONSTRUCTIVELY AT DIFFERENT THICKNESS OF THE SOAP FILM.

MUDSLINGER

CONCEPTS ILLUSTRATED 1. INERTIA

DESCRIPTION OF PACKAGE 1. ONE DOWEL 2. ONE PIECE OF SILLY PUTTY

SUGGESTED ACTIVITIES

1. STICK THE SILLY PUTTY ON THE END OF THE DOWEL. WHIP THAT END OF THE DOWEL TO A HIGH VELOCITY. STOP THE DOWEL ABRUPTLY AND WATCH THE SILLY PUTTY MAINTAIN ITS STATE OF MOTION.

NEWTONIAN GRAVITY

CONCEPTS ILLUSTRATED 1. NEWTON'S CONCEPT OF GRAVITY AS A FORCE 2. CENTRIPETAL FORCE 3. INERTIA

> DESCRIPTION OF PACKAGE 1. CIRCULAR PIECE OF PLATE GLASS 2. TWO AIR PUCKS 3. SUCTION CUP 4. BALLOON BLOWER

> > SUGGESTED ACTIVITIES

 GIVE AIR PUCK A PUSH AND WATCH IT GO IN A STRIGHT LINE ACROSS THE PLATE GLASS
 GIVE THE OTHER AIR PUCK (ATTACHED TO THE STRING ON THE SUCTION CUP) A PUSH AND WATCH IT GO IN A CIRCLE
 USE THE ANALOGY OF THE SUCTION CUP AS THE SUN AND THE AIR PUCK AS THE EARTH TO SHOW NEWTON'S IDEA OF GRAVITY AS A "TUG"
 NOTE THE IDEA OF INERTIA HERE: THE AIR PUCK WILL CONTINUE TO MOVE IN THE SAME DIRECTION UNLESS ACTED ON BY A FORCE

NON-INERTIAL REFERENCE FRAME

CONCEPTS ILLUSTRATED

1. LAW OF INERTIA

2. CENTRIFUGAL FORCE IS A FICTITIOUS FORCE

DESCRIPTION OF PACKAGE

1. ROTATING PLATFORM WITH PLATE GLASS TOP 2. MINIATURE GUMBY TO RIDE ON THE PLATFORM 3. AIR PUCK

SUGGESTED ACTIVITIES

1. BOTATE THE PLATFORM WITH GUMBY ATTACHED TO IT. WHEN GUMBY IS DIAMETRICALLY OPPOSITE YOU, PUSH AIR PUCK TOWARD HIM.

2. ASK THE CLASS TO DESCRIBE WHAT HAPPENS FROM GUMBY'S POINT OF VIEW.

3. REPEAT STEP #1, BUT HAVE A STUDENT STANDING ON THE FLOOR, DIAMETRICALLY OPPOSITE YOU, CATCH THE AIR PUCK. ASK STUDENTS TO DESCRIBE WHAT HAPPENS FROM HIS OR HER POINT OF VIEW.

POLARIZED LIGHT

CONCEPTS ILLUSTRATED 1. POLARIZATION BY SELECTIVE ABSORPTION 2. OPTICAL ACTIVITY 3. THREE-DIMENSIONAL VIEWING FROM A FLAT SURFACE 4. COLOR

DESCRIPTION OF PACKAGE

1. LARGE POLAROID OVERLAY FOR LOWER STAGE OF OVERHEAD PROJECTOR

2. SMALL POLAROID IN FRAME FOR TOP OF OVER-Head projector

3. 3-D POLAROID GLASSES

4. POLAROID SUN GLASSES 5. CELLOPHANE

6. PLEXIGLASS "STRESS TESTER"

SUGGESTED ACTIVITIES

1. DEMONSTRATE POLARIZATION BY SELECTIVE ABSORP-TION BY USING CROSSED POLARIZERS ON OVERHEAD PROJECTOR

2, SHOW DIRECTIONS OF POLARIZATION OF LENSES OF 3-D GLASSES

3. SHOW DIRECTION OF POLARIZATION OF POLAROID SUN GLASSES

4. USE CELLOPHANE AND PLEXIGLASS WITH CROSSED POLARIZERS TO DEMONSTRATE THE ROTATION OF THE PLANE OF POLARIZATION BY OPTICALLY ACTIVE MATERIALS

POLARIZATION - SCATTERING

CONCEPTS ILLUSTRATED 1. SCATTERING 2. POLARIZATION

DESCRIPTION OF PACKAGE 1. LASER 2. WATER TANK 3. POWDERED CREAMER 4. PIECE OF POLAROID

SUGGESTED ACTIVITIES

1. SHOW HOW ADDING A SMALL AMOUNT OF POWDER INCREASES THE SCATTERING

2. VIEW THE SCATTERED LIGHT THROUGH A PIECE OF POLAROID. ROTATE THE POLAROID.

3. LOOK AT POLARIZATION OF LIGHT SCATTERED AT RIGHT ANGLES OPPOSED TO LIGHT SCATTERED AT OTHER ANGLES.

4. LET STUDENTS GO OUTSIDE AND VIEW THE SKY THROUGH THE POLAROID.

ROTATING PLATFORM

CONCEPTS ILLUSTRATED

1. CONSERVATION OF ROTATIONAL (ANGULAR) MOMENTUM 2. VECTOR NATURE OF ROTATIONAL MOMENTUM 3. ROTATIONAL INERTIA

> DESCRIPTION OF PACKAGE 1. ROTATING PLATFORM 2. BICYCLE WHEEL WITH HANDLE 3. WEIGHTS

> > SUGGESTED ACTIVITIES

1. STAND ON THE ROTATING PLATFORM, SPINNING WITH ARMS OUTSTRETCHED. BRING YOUR ARMS DOWN TO YOUR SIDE

2. ACCEPT BICYCLE WHEEL (HANDLE VERTICAL) WHILE STANDING ON THE PLATFORM. ROTATE HANDLE 180 DEGREES

3. HAVE SOMEONE TRY TO TURN THE PLATFORM WHILE YOU STAND ON IT, HOLDING WEIGHTS DOWN AT YOUR SIDES; NOW TRY IT WITH ARMS OUTSTRETCHED (STILL HOLDING THE WEIGHTS)

SCATTERING

CONCEPTS ILLUSTRATED 1. SCATTERING 2. COLOR

DESCRIPTION OF PACKAGE 1. SLIDE PROJECTOR 2. "BEAM SLIDE" 3. AQUARIUM 4. POWDERED COFFEE CREAMER 5. WHITE CARDBOARD

SUGGESTED ACTIVITIES

1. OBSERVE BEAM FROM THE SIDE WITHOUT AND WITH SCATTERING PARTICLES IN THE WATER. (NOTE THE COLOR OF THE SCATTERED LIGHT.) 2. OBSERVE THE TRANSMITTED BEAM BY HOLDING A PIECE OF WHITE CARDBOARD IN FRONT OF IT. WHY IS IT YELLOW?

SINGING SEWER PIPES

(HOT AIR RESONATORS)

CONCEPTS ILLUSTRATED 1. SOUND 2. STANDING WAVES 3. BEATS

DESCRIPTION OF PACKAGE 1. THREE PVC PIPES (10 CM DIAMETER) OF LENGTHS: 113 CM, 120 CM, 150 CM 2. TWO MEKER BURNERS 3. GAS HOSES 4. T-CONNECTOR 5. PROPANE BOTTLE ADAPTED TO FIT GAS HOSE 6. INSULATED GLOVES

SUGGESTED ACTIVITIES

1. SLOWLY LOWER EACH PIPE OVER A BURNER UNTIL THE FLAME IS ABOUT 5 CM INTO THE PIPE, LISTEN TO THE TONES PRODUCED, RELATE FREQUENCY TO LENGTH OF PIPE,

2. USING TWO BURNERS, SOUND THE 113 CM PIPE AND THE 120 CM PIPE SIMULTANEOUSLY. THEIR FREQUENCIES ARE CLOSE ENOUGH TOGETHER TO PRODUCE BEATS.

SPECTRA

CONCEPTS ILLUSTRATED 1. COLOR 2. EMISSION LINES 3. DIFFRACTION

DESCRIPTION OF PACKAGE

1. HG "YARD LIGHT" (IN HOUSE) 2. NA "YARD LIGHT" (IN HOUSE) 3. LOW PRESSURE NA LAMP (IN HOUSE) 4. TUNGSTEN FILAMENT BULB (IN HOUSE) 5. THIRTY CARDBOARD MOUNTED DIFFRACTION GRATINGS 6. ONE "HIGHER QUALITY" DIFFRACTION GRATING 7. BICYCLE FENDER SPECTROMETER

8. MULTI-COLORED OBJECT5

SUGGESTED ACTIVITIES

1. EXAMINE THE COLORED OBJECTS UNDER EACH TYPE OF ILLUMINATION.

2. LOOK AT EACH SOURCE THROUGH A DIFFRACTION GRATING.

3. USE THE SPECTROMETER TO MEASURE THE WAVELENGTH OF SOME OF THE BRIGHTEST LINES IN THE VAPOR SOURCE.

STANDING WAVES ON ROPE

CONCEPTS ILLUSTRATED 1. TRANSVERSE WAVES 2. STANDING WAVES

DESCRIPTION OF PACKAGE 1. SABRE SAW 2. STAND AND CLAMPS FOR SABRE SAW 3. WEIGHTS FOR TENSION 4. VARIAC 5. STROBE LIGHT

SUGGESTED ACTIVITIES

 SET UP A STANDING WAVE ON THE ROPE BY DRIVING THE SABRE SAW AT AN APPROPRIATE FREQUENCY
 INVESTIGATE THE STANDING WAVE UNDER THE STROBE LIGHT IN ORDER TO SEE THE ACTUAL DISPLACEMENT OF EACH PART OF THE JUMP ROPE AS A FUNCTION OF TIME
 USE THE VARIAC TO CHANGE THE FREQUENCY, THUS SHOWING THAT ONLY CERTAIN FREQUENCIES WILL RESULT IN A STANDING WAVE
 VARY THE TENSION IN THE ROPE

TABLECLOTH TRICK

CONCEPTS ILLUSTRATED 1. INERTIA (MAYBE) 2. FRACTION (STATIC AND SLIDING) 3. ACCELERATION PROPORTIONAL TO FORCE 4. FINAL VELOCITY DEPENDS ON TIME OF ACCELERATION

> DESCRIPTION OF PACKAGE 1. ONE TABLECLOTH (FLOWERED) 2. ONE DINNER PLATE 3. ONE CUP AND SAUCER 4. ONE GLASS

> > SUGGESTED ACTIVITIES

1. PULL THE TABLECLOTH OUT FROM UNDER THE SETTING WITHOUT DISTURBING THE DISHES

VIBRATING MEMBRANE

CONCEPTS ILLUSTRATED 1. STANDING WAVES IN TWO DIMENSIONS

DESCRIPTION OF PACKAGE 1. SPEAKER ENCLOSED IN A CANNISTER 2. THIN RUBBER MEMBRANE OVER CANNISTER 3. VARIABLE FREQUENCY SINE WAVE GENERATOR 4. AMPLIFIER 5. STROBE LIGHT

SUGGESTED ACTIVITIES

1. USE AMPLIFIED SINE WAVE THROUGH SPEAKER TO DRIVE THE RUBBER MEMBRANE IN FORCED OSCILLATIONS.

2. VARY THE FREQUENCY UNTIL THE MEMBRANE ACHIEVES A LARGE RESPONSE, AT THIS POINT, A STANDING WAVE HAS BEEN SET UP. 3. INVESTIGATE THE BEHAVIOR OF ALL PARTS OF THE MEMBRANE UNDER A STROBE LIGHT. TRY TO IDENTIFY NODAL LINES, IN SOME MODES THEY WILL BE CIRCLES; IN OTHER MODES THEY WILL BE STRAIGHT LINES,

4. FIND AS MANY DIFFERENT STANDING WAVE MODES AS YOU CAN.

WEIGHT IN NEWTONS

CONCEPTS ILLUSTBATED 1. S.I. UNIT OF FORCE 2. WEIGHT IS A FORCE

DESCRIPTION OF PACKAGE 1. BATHROOM SCALE READING IN NEWTONS 2. A 1N WEIGHT 3. A 10N WEIGHT 4. A BOX FILLED WITH WEIGHTS

SUGGESTED ACTIVITIES 1. ASK WHAT A POUND IS 2. PASS AROUND THE 1N AND 10N WEIGHTS 3. ASK EACH STUDENT TO ESTIMATE THEIR WEIGHT IN NEWTONS

4. USE SCALES TO MEASURE WEIGHT IN NEWTONS
5. HAVE STUDENTS LIFT THE BOX OF WEIGHTS
A.) ASK SOME STUDENT FOR ESTIMATE
IN POUNDS
B.) ASK OTHER STUDENTS FOR ESTIMATE IN NEWTONS
C.) CHECK THE ANSWERS

NOTE: THESE SCALES ARE NOT ACCURATE FOR SMALL WEIGHTS (LESS THAN 100N)