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ABSTRACT

This booklet, one of a series developed by the Frederick County Board of Education, Frederick, Maryland, provides an instruction module for an individualized or flexible approach to secondary science teaching. Subjects and activities in this series of booklets are designed to supplement a basic curriculum or to form a total curriculum, and relate to practical process oriented science instruction rather than theory or module building. Included in each booklet is a student section with an introduction, performance objectives, and science activities which can be performed individually or as a class, and a teacher section containing notes on the science activities, resource lists, and references. This booklet presents an investigation of sound, sound production and sound waves. The estimated time for completing the activities in this module is two and one-half weeks. (SL)

Vibes

AIDS TO INDIVIDUALIZE THE TEACHING OF SCIENCE

MINI-COURSE UNITS

BOARD OF EDUCATION OF FREDERICK COUNTY

1974

Marvin G. Spencer

CAN YOU HEAR MY VIBES?

A MINI-COURSE ON SOUND

Prepared by

Charles Buffington

Estimated Time for Completion

2½ weeks

Frederick County Board of Education

Mini Courses for

Physical Science, Biology, Science Survey, Chemistry and Physics

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1974

FOREWORD

The writing of these instructional units represents Phase II of our science curriculum mini-course development. In Phase I, modules were written that involved the junior high disciplines, life, earth and physical science. Phase II involves senior high physical science, biology, chemistry, physics and science survey.

The rationale used in the selection of topics was to identify instructional areas somewhat difficult to teach and where limited resources exist. Efforts were made by the writers of the mini-courses to relate their subject to the practical, real world rather than deal primarily in theory and model building.

It is anticipated that a teacher could use these modules as a supplement to a basic curriculum that has already been outlined, or they could almost be used to make up a total curriculum for the entire year in a couple of disciplines. It is expected that the approach used by teachers will vary from school to school. Some may wish to use them to individualize instruction, while others may prefer to use an even-front approach.

Primarily, I hope these courses will help facilitate more process (hands on) oriented science instruction. Science teachers have at their disposal many "props" in the form of equipment and materials to help them make their instructional program real and interesting. You would be remiss not to take advantage of these aids.

It probably should be noted that one of our courses formerly called senior high physical science, has been changed to science survey. The intent being to broaden the content base and use a multi-discipline approach that involves the life, earth and physical sciences. It is recommended that relevant topics be identified within this broad domain that will result in a meaningful, high interest course for the non-academic student.

ALFRED THACKSTON, JR.
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CAN YOU HEAR BY VIBES?

A MINI-COURSE ON SOUND

The world around us is filled with many kinds of energy. In this unit we will be looking at the form of energy called sound.

Since sound energy travels through different materials by the use of waves, we will begin this unit with a study of the types of waves and their parts.

We will follow this with a study of methods of sound production, some of the characteristics of sound, and some of the other phenomena that occur with sound.

Sound is very important in our daily life. We have it with us from the time the alarm clock or our mother wakes us in the morning, until the last sound we hear before we fall asleep. Radios, record players, and tape players entertain us with sound. Our friends talk to us with sound. Your teachers give you instructions with sound. These are only a few of the ways that sound is important to us.

Let's try a little experiment with sound. You will be given, by your teacher, a wire coat hanger and a piece of string. Tie both ends of the string to the ends of the coat hanger. Place the string on your head and with your fingers hold the string into your ears. Bend over so the coat hanger does not touch your body. Have your partner tap the coat hanger with a pencil. You may now have some questions, such as: What caused the sound? How did it get to my ears? Or why didn't my partner hear it? After you finish this mini-course, hopefully you will be able to answer these questions.

A. What is sound?

In this block you will study some of the features of waves. You will also be studying the two types of wave motion.

OBJECTIVES

At the end of this block, the student should be able to:

1. describe the difference between transverse and longitudinal waves;
2. identify the parts of a transverse wave;
3. identify the parts of a longitudinal wave;

4. state what each part of a wave is related to in sound;

5. explain how tonal quality makes it possible for us to tell the difference between two people or two instruments producing the same musical note.

ACTIVITIES

a. Do the Lab Exercise, "The Study of Wave Motion".

b. Complete Worksheet #1 from either a demonstration by your teacher or by using the reference material given to you by your teacher.

Lab Exercise

The Study of Wave Motion

Material: Slinky

Procedure: A. Place the Slinky on the floor and carefully stretch it to a length that has been okayed by your teacher. With your partner holding the other end, move your hand quickly to the right (12" - 18") and return it quickly to the starting position. When the Slinky comes to rest, repeat this motion to the left. Try again, this time moving your hand to the right followed immediately by motion to the left and then return to the starting position. Both motions should be about the same distance from the starting position. This is a longitudinal wave.

B. While the Slinky is lying still on the floor, reach out and pull about 3 to 4 feet of the Slinky back to you and hold the coils tightly together. While holding on to the last coil, release all of the other coils and observe the results. This is a transverse wave.

C. Try several other possibilities with your partner. For example, both you and your partner could make waves at the same time. Try matching both waves on the same side of the Slinky and also on opposite sides of the Slinky. Observe the results when the waves meet.

Interpretation: 1. Write a description of the difference between longitudinal and transverse waves from what you have observed in this experiment.

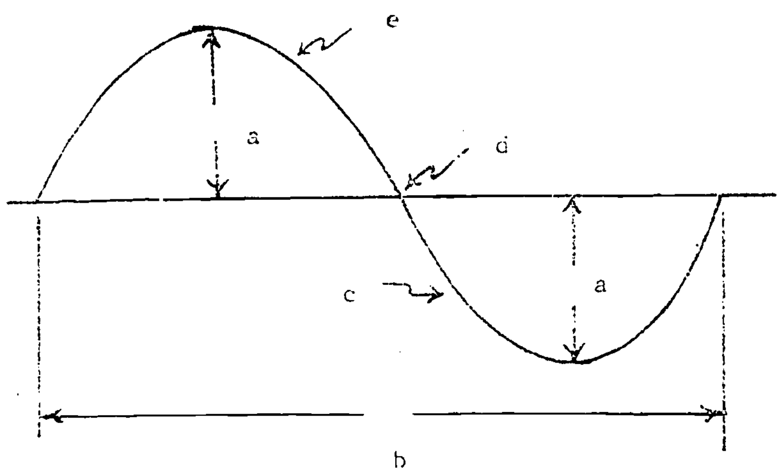
2. Make a sketch of a longitudinal wave and show the areas of compression (pushed together) and rarefaction (stretched apart).

3. Make a sketch or sketches of what you observed when the two waves met in procedure C. Do your best to explain what happened when the two waves met to produce the results you observed.

Worksheet #1

Wave Motion

1. Label the parts of the wave on the drawing.



a.

b.

c.

d.

e.

2. Tell how the wave motion is related to the pitch (high or low note) of the sound we hear.

3. How is the loudness of a sound related to wave motion?

4. What are overtones? How do they help us to tell people's voices apart?

B. How is sound produced?

In this block you are going to study some of the various ways sound can be produced.

OBJECTIVES

At the completion of this block, the student will be able to:

6. name some general materials needed for the production of sound;

7. list several different ways to produce sound;

8. explain how sound travels.

ACTIVITIES

a. Do the Lab Exercise, "Various Methods of Sound Production".

b. Do the Lab Exercise, Problem 8-11, "To Investigate Various Characteristics of Sound", found on page 256 of Lab Inquiry Text, Physical Science - Behavior of Light and Sound by Eisler and Shock.

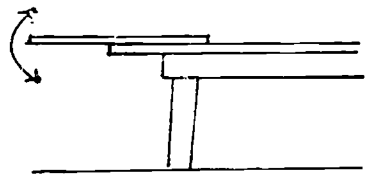
c. Do the Lab Exercise, "Sound in a Vacuum".

Lab Exercise

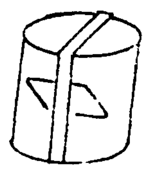
Various Methods of Sound Production

Materials: ruler, rubber band (2), whistle, tin can with both ends cut out, plastic wrap or plastic bag to fit the top of the can (2), tuning forks

Procedures: A. Place the ruler on the desk so that it hangs over the edge of the desk. Pluck the end of the ruler and observe the sound. Slide the ruler farther on and off the desk and pluck it. Observe how this affects the sound.

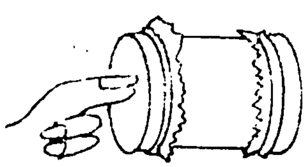


B. Stretch the rubber band over the tin can and pluck it. Try making the part of the rubber band you pluck looser or tighter by pushing up or pulling down the band on the sides of the can. How did this affect the sound?



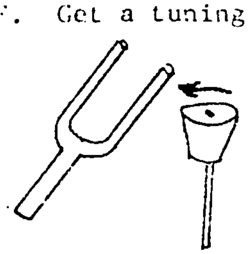
C. Cover one end of the can with a piece of plastic wrap and hold it tight with the rubber band. Make the plastic as tight as you can. Tap the plastic with your fingers and observe the results. Have your partner pull it tighter while you tap it. Does this change the sound that is produced?

D. Cover the other end of the can also with plastic as you did before. Push on one end of the can with your thumb and watch what happens on the other end.



E. Take the whistle provided by your teacher and blow through it. What do you observe to be the source of the sound?

F. Get a tuning fork from your teacher. Hit it against a <u>RUBBER</u> object. Do NOT hit it on the desk or any other hard object. Touch one of the prongs with your finger after you hit it. Write your observations on how the sound is made.



Interpretations: 1. From this experiment, describe three different methods of how sound can be made.

2. For any object to make a sound, what must it do?

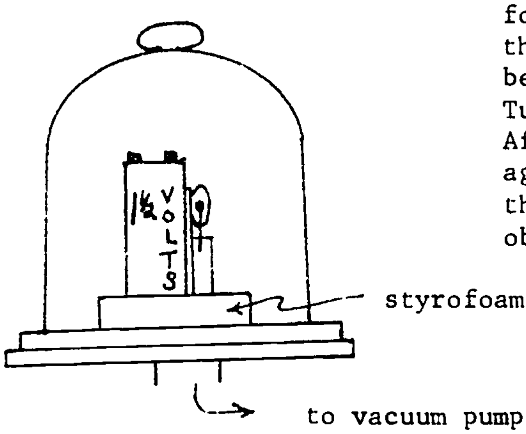
3. From what you observed in procedure D, how do you think sound travels?

Lab Exercise

Sound in a Vacuum

Materials: vacuum pump with plate, vacuum grease, bell jar, 6 volt battery, bell, block of stryofoam or foam rubber, rubber bands

Procedure: Attach the bell to the 6 volt battery. Place the battery and the foam on top of the vacuum pump. Hook the bell up so it rings. Cover it with the bell jar. Observe the loudness of the sound. Turn on the pump and listen to the sound. After about one minute turn off the pump, again listen to the loudness. Slowly allow the air to leak back in. Record your observations.



Interpretation: 1. From this experiment, what else do we need in order to have a sound?

2. Why do you think we can not hear the explosions on the sun?

C. What are some of sound's characteristics?

You have studied how sound is made and what it is. You will be using these ideas to study some of the characteristics of sound in this block.

OBJECTIVES

At the completion of this block, the student will be able to:

9. define frequency and pitch, and also be able to describe how they affect each other;

10. explain how forced vibrations happen;

11. explain how sympathetic vibration (resonance) happens;

12. explain how the length of the air column affects the frequency resonated;

13. compare the speed of sound in air with the speed of sound in a solid;

optional 14. calculate the frequency, period, wave length or speed of sound given the necessary information.

ACTIVITIES

a. Do the Lab Exercise, "Tuning Forks".

b. Do Lab Exercise, Problem 11-3, "How does the length of a column of vibrating air affect the pitch of a note produced?"

c. Do Worksheet #2, "Speed of Sound".

optional d. Do the Lab Exercise, "Speed of Sound in Air".

optional e. Do the Lab Exercise, "Speed of Sound in Metal".

optional f. Do problem sheet, "Calculations in Sound".

Lab Exercise

Tuning Forks and Forced Vibrations

Materials: tuning forks (several different frequencies), student desk or tote tray, rubber stopper hammer or rubber-soled shoe

Procedures:

A. Get a tuning fork and observe the frequency stamped on it. Hit it with the rubber stopper or hit it on the rubber heel of your shoe. DO NOT hit the tuning fork on the desk or any other hard object. After you have the fork vibrating hold it near your ear. Observe the loudness of the sound. Strike the tuning fork again and this time touch the handle or the desk top or the bottom of an up-side-down tote tray. Again observe the loudness of the sound. Try to touch the handle of the tuning fork to various parts of your head and see if you can hear anything (for example, behind your ear, forehead, etc.). DO NOT touch the vibrating prongs of the fork to your teeth, glasses, or any other object unless directed to do so by your teacher.

B. Get another tuning fork of a different frequency. Strike it and observe the pitch of the sound. Try this with several other tuning forks if they are available.

C. Have each member of your group get a different tuning fork. Strike them and touch them to the desk or tote try in groups of two or three. Describe the sound produced.

Interpretation:

1. The difference in loudness you hear when you held the tuning fork near your ear and then touched it to an object was due to forced vibration. Explain how this happened.

2. How does this idea of forced vibration explain how you heard the tuning fork when you touched it to your head.

3. Was the pitch of the second tuning fork higher or lower than the first? Did the second tuning fork vibrate at a higher or lower frequency than the first? How then are frequency and pitch related?

4. Why are different tones produced when two or more tuning forks are touched to the desk at the same time?

Problem 11-3: How does the length of a column of vibrating air affect the pitch of a note produced?

Purpose: To prepare a simple wind instrument and study the pitch of the notes produced by it

Materials: pop bottles, different sizes; facial tissue; alcohol, denatured; masking tape; pitch pipe

Procedure: Part One: Comparing Lengths of an Air Column to the Pitch of a Note

A. Disinfect the mouth of an empty soft-drink bottle with a tissue that has been dipped in denatured alcohol. Rinse the bottle with water after disinfecting.

B. Hold the mouth of the bottle to your lips and blow across it.

1. What was vibrating to produce the sound you heard?

C. Fill the bottle about one-quarter full of water and again blow over the mouth.

2. How is this sound different from the sound produced with the empty bottle?

D. When different lengths of air columns are caused to vibrate, different pitch sounds are produced. Now try blowing harder across the bottle containing the water.

3. How does the amount of air or speed of the air blowing across the mouth change the sound of the note produced?

E. Blowing more air across the mouth of the bottle changes the loudness of the sound but it does not change the frequency with which the column of air is vibrating. Discard the water in the bottle. Place a piece of masking tape along the entire length of the pop bottle. Write "top" on the end of the tape at the top of the bottle.

Your task now is to listen to some pitch or note which is known and to adjust the length of the air column in the bottle so the same note is produced when you blow across the mouth.

11-12 The line marked on the tape indicates the water level in the bottle. The letter indicates the note produced by blowing across the mouth of the bottle.

F. Blow over your empty bottle and compare the pitch to a note from a pitch pipe. Add small amounts of water until the pitch produced by blowing over the bottle is the same as some whole note from the pitch pipe.

G. Mark a line on the tape to indicate the water level in the bottle. Write the letter of the note produced next to the line on the tape. (See Figure 11-12) Now add more water until the next higher note on the scale is produced. You may have to pour out a little water if you raise the pitch above the next whole note. Mark the water level on the tape and identify the note produced.

H. Continue finding water levels which correspond to whole notes on the musical scale until you have produced at least eight consecutive whole notes in a scale. This final note should be the same note with which you started, only one octave higher in pitch. If your first note was G, then the note found exactly one octave higher could be labeled G' (read G Prime).

4. How does the spacing between notes at the bottom of the tape compare to the spacing between notes at the top of the tape?

I. To see how the scales on different kinds of bottles compare, match your tape scale with the tape scale from some other kind of bottle.

5. What similarities did you find between your scale and the scale produced by blowing across a different kind of bottle?

6. Based upon your experience, how could you predict what note an empty bottle would produce when air is blown over the mouth of the bottle?

J. Try your idea on some bottle which does not have any scale markings on it. Measure the length of air column needed to produce a pitch of C.

7. How many centimeters long was the air column needed to produce the note C? If you measured two different C pitches, include both lengths.

Special Note: It may be desirable to repeat all of Part One at home or somewhere else where a piano or other musical instrument is available, and where less interfering sounds are being produced. You would then need to bring to school only the tape or tapes labeled with notes and the kind of bottle used.

Part Two: Giving a "Pop" Concert

K. As a class activity, obtain eight or more bottles with scale markings on the sides. Fill each bottle to a level corresponding to a different note on the scale. Starting with the lowest note represented, blow each note in your scale. Correct any "sour notes" which you hear by adding or subtracting a small amount of water until the note has the correct pitch.

8. If a bottle gives a note which sounds too low (flat), should water be added to it or removed from it?

L. Compose a simple musical arrangement which can be blown on the wind instruments which you have. Something like "Twinkle, Twinkle Little Star" might become a hit if it is done with dignity and expression!

M. When all of the musician-blowers have memorized their music, a "pop" concert may be given for the rest of the class. You may wish to fill out the orchestra using some of the stringed instruments made in Problem 11-1.

One final note. Pitch is closely related to frequency, but the two are not identical. Pitch depends on a personal judgment. The loudness of a sound affects pitch. Also, the basic pitch for determining the musical scale has varied through history. For example, musicians today have set A above middle C as 440 vibrations per second. However, in the past it has been as low as 400 and as high as 462 vibrations per second.

Worksheet #2

Speed of Sound

Speed of sound in various medium at $0^\circ C$

medium	speed m/sec.
air	331.5
water	1450
iron	5100
glass	5500

1. From your experience, is air more or less dense than water?

2. If something is more dense, then would the molecules be closer together or farther apart than a less dense object?

3. How can this idea of density be used to explain why sound travels faster in water than in air?

Lab Exercise (Optional)

Speed of Sound in Air

Materials: track starter's pistol, stop watches, meter sticks or metric tape

Procedure: Separate the lab group into two parts. One group is made up of one student who will fire the pistol. The other group will contact the rest of the students who will time and record the data. The two groups are to be separated by as large a distance as possible (minimum of 90 to 100 m). The distance between the two groups must be measured. (This may have been done earlier for you by your teacher.)

When the timing group is ready, they should signal the shooter who will fire the pistol. The timers will time the difference between the time they see the smoke from the gun and the time they hear the sound. (This time will be less than one second unless the two groups are separated by more than 332 m.)

The data should be recorded in a table. The times for each trial averaged and the speed of sound calculated.

$$\text{speed of sound} = \frac{\text{distance between groups}}{\text{average time}}$$

Sample Data Table

Trial	Distance Between Groups	Time for Timer 1	Time for Timer 2	Time for Timer 3	Average Time	Speed of Sound

Interpretations:

1. How does the speed of sound you got compare to the standard value of 331.5 m/sec?

2. How would you explain any difference?

3. What suggestion would you give that would make the experiment more accurate?

Lab Exercise (Optional)

Speed of Sound in Metal

Materials: stop watches, meter sticks or measuring tape, railroad tracks or other metal rails with the ends touching. (If railroad tracks are used, be sure that no trains will be using the tracks while you are doing the experiment.)

Procedure: The lab group should divide themselves into two groups. These groups should then separate themselves as far apart as possible along the rails. The distance between the groups should then be measured. (It should be at least <u>1000</u> m.) While members of the timing group hold their ear against the rail, a member of the other group will hit the rail with a rock or piece of metal. The timer will record the time between the time he sees the rail being hit and the time he hears the sound. Record the data in a chart and calculate the speed of sound in metal.

Sample Data Table:

Trial	Distance	Time for Timer 1	Time for Timer 2	Average Time	Speed

$$\text{The speed of sound} = \frac{\text{Distance between groups}}{\text{Average time}}$$

Interpretation:

1. How does your value for the speed of sound compare to 5100 m/sec. which is the known value?

2. Can you explain any differences?

3. Why does sound travel faster in metal than in air?

Problem Sheet (Optional)

Calculations in Sound

Formulas:

$$\text{speed of sound} = \frac{\text{distance}}{\text{time}}$$

$$\text{frequency} = \frac{\text{speed}}{\text{wave length}}$$

$$\text{period} = \frac{1}{\text{frequency}}$$

1. A man in a submarine hears the sound of a depth charge explosion 3.5 seconds after it happens. If the depth charge was 4150 m. away, what is the speed of sound in water?

2. What is the period (time for one vibration) of a tuning fork that vibrates 250 times per second?

3. What would be the frequency of a note which has a wave length of 1 meter in air? (Speed of sound in air is 331.5 m/sec.)

4. How long would it take for the sound of the thunder to reach you from a thunderstorm 3000 meters away?

5. What is the speed of a sound wave that has a wave length of 2.5 m. and a frequency of 350 vibrations/second?

D. Other phenomena of sound

In this block we are going to look at some of the interesting things that happen with sound waves. Also, we will be studying things a person can do to change the pitch of a note obtained from vibrating string.

OBJECTIVES

At the end of this block, the student will be able to:

15. define beats and explain how they occur;

16. describe the Doppler effect and explain how it occurs;

17. explain the difference between music and noise;

18. list the things which affect the pitch of the sound produced by a string.

ACTIVITIES

a. Do the Lab Exercise, "Beats".

b. Do the Lab Exercise, "Doppler Effect".

c. Do Worksheet #3, "Music and Noise".

d. Do the Lab Exercise, "Laws of Strings".

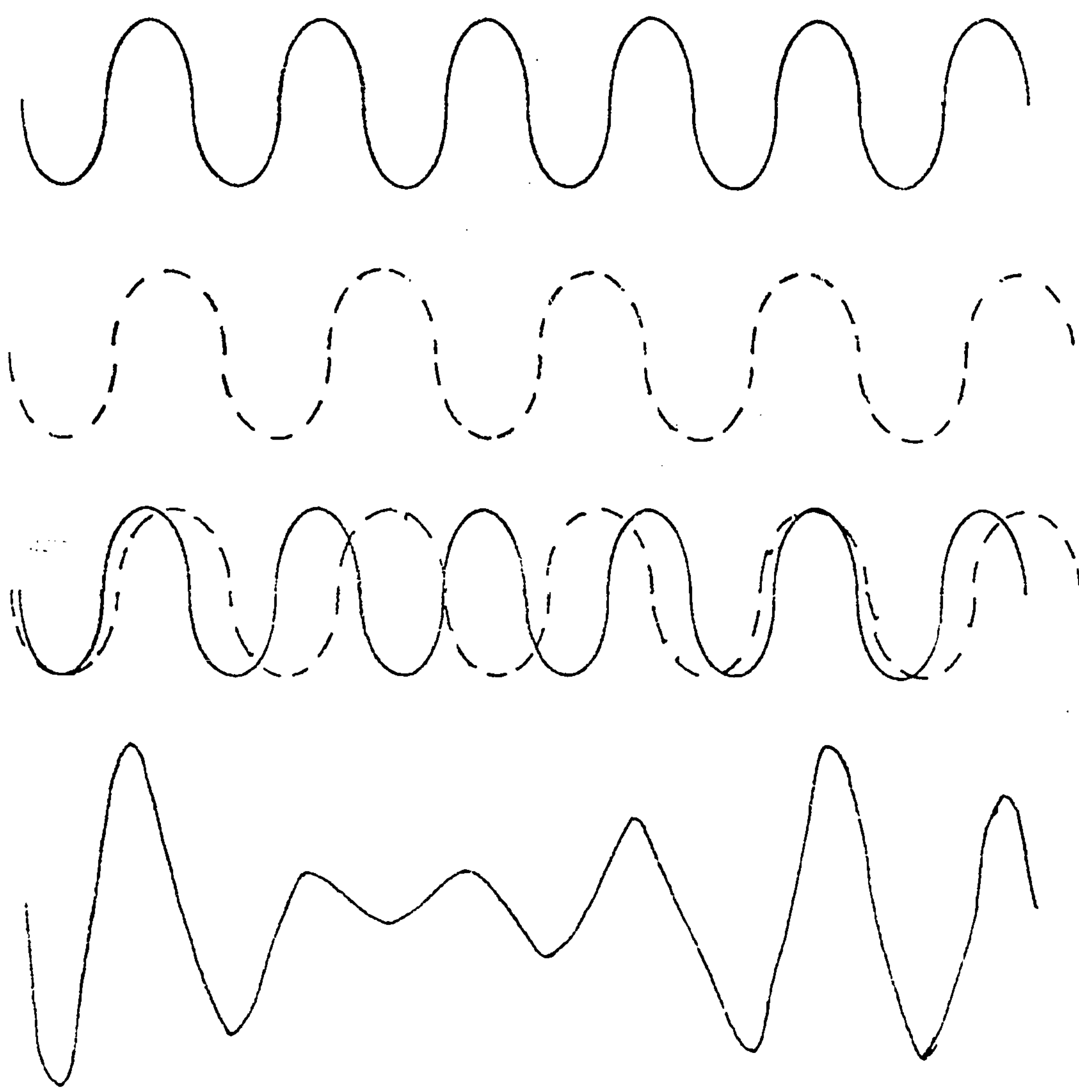
Lab Exercise

Beats

Materials: 2 tuning forks (same frequency), rubber bands

Procedure: A. Take one of the tuning forks and wrap 2 rubber bands around one of the prongs. Then, take the two tuning forks and strike them on a rubber surface. When they are both vibrating, touch the handles to the table top. You should notice the sound alternately getting louder and then softer. If this does not occur, then try moving the rubber bands up or down on the prong, or add additional rubber bands. This alternating volume change is called beats.

Interpretation: 1. Observe the following drawings and use them to explain beats.



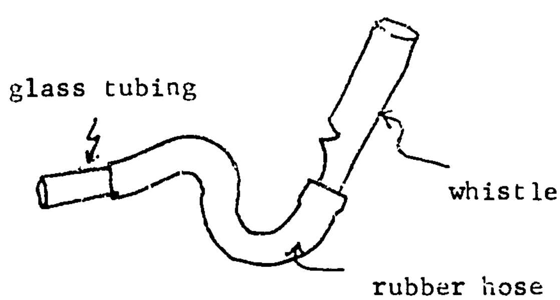
2. Why do you think that the rubber bands were placed on the tuning fork?

Lab Exercise

Doppler Effect

Materials: whistle, 3 foot section of rubber hose, 4 inch section of glass tubing to fit hose

Procedure Stick the glass tube into one end of the rubber hose and the whistle in the other end. Make sure the whistle is pushed far enough into the hose so that it will not come out easily. Then blow into the glass tube while you gently twirl the hose. (Be sure that when you spin the hose you don't point it at any-one.) Observe the sound produced while you spin the hose.



Interpretation: 1. Explain how the sounds you heard were produced.

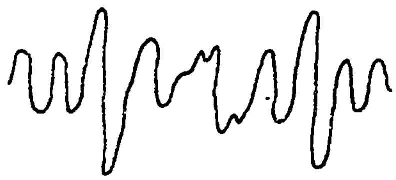
2. Give several examples where you have heard things like this before.

Worksheet #3

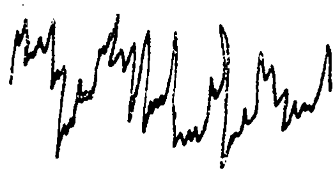
Music and Noise

Sound can be divided into two different areas. Science calls the two areas sound and noise. Sound is defined as any sound that is pleasing to the ear. If we would look at the sound waves on an oscilloscope, we would see that the waves are rounded and smooth with a repeating pattern. When pictured on an oscilloscope noise waves are jagged, irregular and do not repeat. Noise is defined as an unwanted, unpleasant sound.

Musical Tone



Noise



Even music can be unpleasant if it is too loud. We measure the loudness of a sound in a unit called decibels. Below is a chart which give some common sounds and their decibel readings.

Loudness of Sounds

Sound	Loudness (Decibels)
Whisper	20
Living room in a quiet home	40
Normal conversation	65-70
Street corner traffic	80
Niagara Falls	93
Rock band	95-110
Threshold of pain	120
Limit of endurance to ear	130
J-57 jet engine	160-170
12 in. cannon	225

Interpretation: 1. Give 3 examples of sounds that you would call music and 3 you would call noise.

2. When you are listening to the radio, of what you hear, what is music and what is noise?

3. Below is a table of allowable noise exposure. Compare these levels to the chart on loudness of sounds. Choose three sounds from the loudness chart and tell what you feel will happen if a person was exposed to four hours of that sound per day.

Allowable Noise Exposure

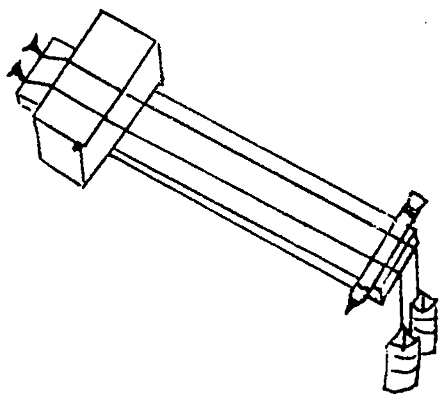
Sound level (decibels)	Time (per day)
90	8 hours
95	4 hours
100	2 hours
105	1 hour
115	15 minutes

Lab Exercise

Law of Strings

Materials: board with nails on end (approximately 20 x 100 cm), 4 wires ($1\frac{1}{2}$ meters long) - 2 different thickness; 2 same thickness but different material, box, 2 large tin cans with holes along rim, pencil

Procedure: A. Set up the equipment as shown in the drawing. Choose two wires which are of different thickness. Attach one end of the wire to the nail and the other end to the tin can. Fill the can approximately $\frac{1}{2}$ full with water unless directed to do otherwise by your teacher. Be sure both tin cans have the same amount of water in them. Pluck both wires and observe the sounds.



B. Move the pencil $\frac{1}{2}$ of the way up the board toward the box. With your finger, press down on the wire so that it is tight against the pencil. Pluck the wire. Try several other lengths of the wire. Record your observations.

C. Observe the sound of both wires when plucked; then fill the can 3/4 full of water. Pluck the strings and again observe the sounds.

D. Carefully remove the cans of water from the wires. Put two wires on the board which are of the same thickness but made of different materials. Replace the cans of water. Be sure they contain the same amount of water. Pluck the wires and observe the sound.

Interpretations: 1. List the four things which affect the pitch of the sound produced by a wire.

2. What was the purpose of the box in this set-up?

E. Optional reports

If you have time, or at the direction of your teacher, here are some topics which you may want to study further:

a. Write a report on what is hi-fidelity recording. This report may include a comparison of monophonic, stereophonic, quadrophonic recordings.

b. Obtain the pamphlet, "Noise Pollution" by the Addison Wesley Publishing Company and read through it. Prepare a report on noise pollution.

c. Write a report comparing the human voice mechanism to electronic methods of producing sound.

d. Write a report telling how the ear works. Compare this to electronic methods of detecting sound.

e. Choose a musical instrument and write a report telling about its history and how it works.

OR

Construct your own musical instrument. Tell how it is played and how it produces the music

f. Write a report on ultrasonics. Tell what it is and how it is used.

g. Write a report on acoustics. Discuss the sound absorbing properties of various materials. You may want to test the acoustics of a room and suggest if it needs any acoustical material to improve the acoustics.

OBJECTIVES

At the end of this mini-course, the student should be able to:

1. describe the difference between transverse and longitudinal waves;
2. identify the parts of a transverse wave;
3. identify the parts of a longitudinal wave;
4. state what each part of a wave is related to in sound;
5. explain how tonal quality makes it possible for us to tell the difference between two people or two instruments playing the same note;
6. name some general materials needed for the production of sound;
7. list several different ways to produce sound;
8. explain how sound travels;
9. define frequency and pitch and also be able to describe how they affect each other;
10. explain how forced vibrations happen;
11. explain how sympathic vibrations (resonance) happen;
12. explain how the length of the air column affects the frequency resonated;
13. compare the speed of sound in air with the speed of sound in a solid;
14. (onal) calculate the frequency, period, wave length or speed of sound given the necessary information;
15. define beats and explain how they occur;
16. describe the Doppler effect and explain how it happens;
17. explain the difference between music and noise;
18. list the things that affect the pitch of the sound produced by a string.

NOTES ON LAB EXERCISES

The Study of Wave Motion

This exercise may be done as a demonstration if you desire. The only problem you may have in this lab is that the students may stretch the slinky beyond its limit of elasticity.

Demonstration for Worksheet #1

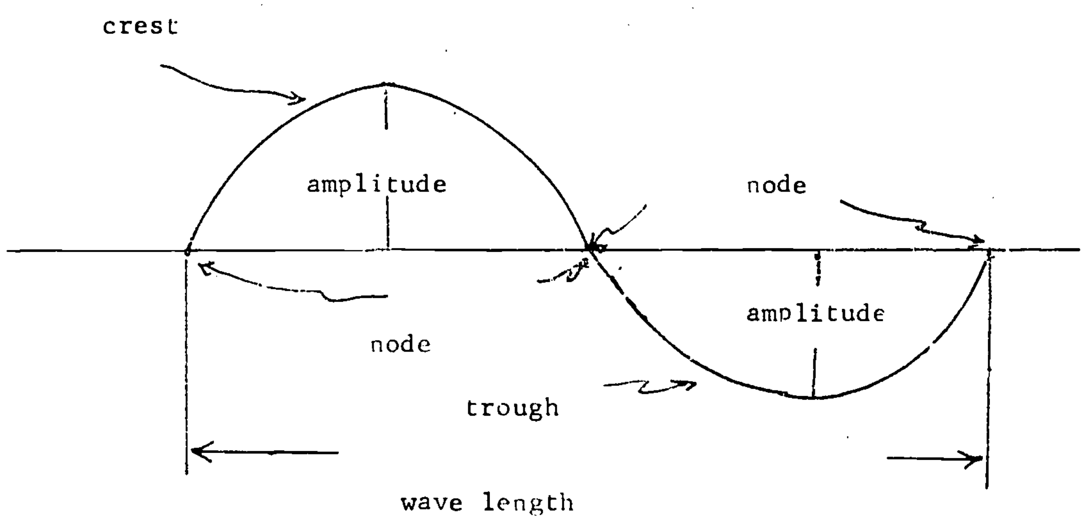
This demonstration is a high interest activity for the student. I would recommend that you do this activity rather than assign a reading assignment.

This demonstration requires the use of a signal generator, Wollensak tape recorder with mike and an oscilloscope. The wiring diagram is sketched at the end of this instruction.

Set up the equipment as shown in the diagram. Set the scope to the frequency range you plan to observe. Set the tape recorder on Record and move the Record Monitor switch to the right to on/P.A. Adjust the output of the signal generator, volume on the tape recorder and the gain on the scope so that the wave is visable on the screen. I would suggest that you set up and familiarize yourself with the equipment you have available.

The activities that you should do with your students are as follows:

a. Produce a standing wave and identify the parts for them. Also identify this as a transverse wave.



b. Turn up the frequency on the signal generator and show how the wave length decreases as the frequency increases. You may have to turn the volume down as you increase the frequency.

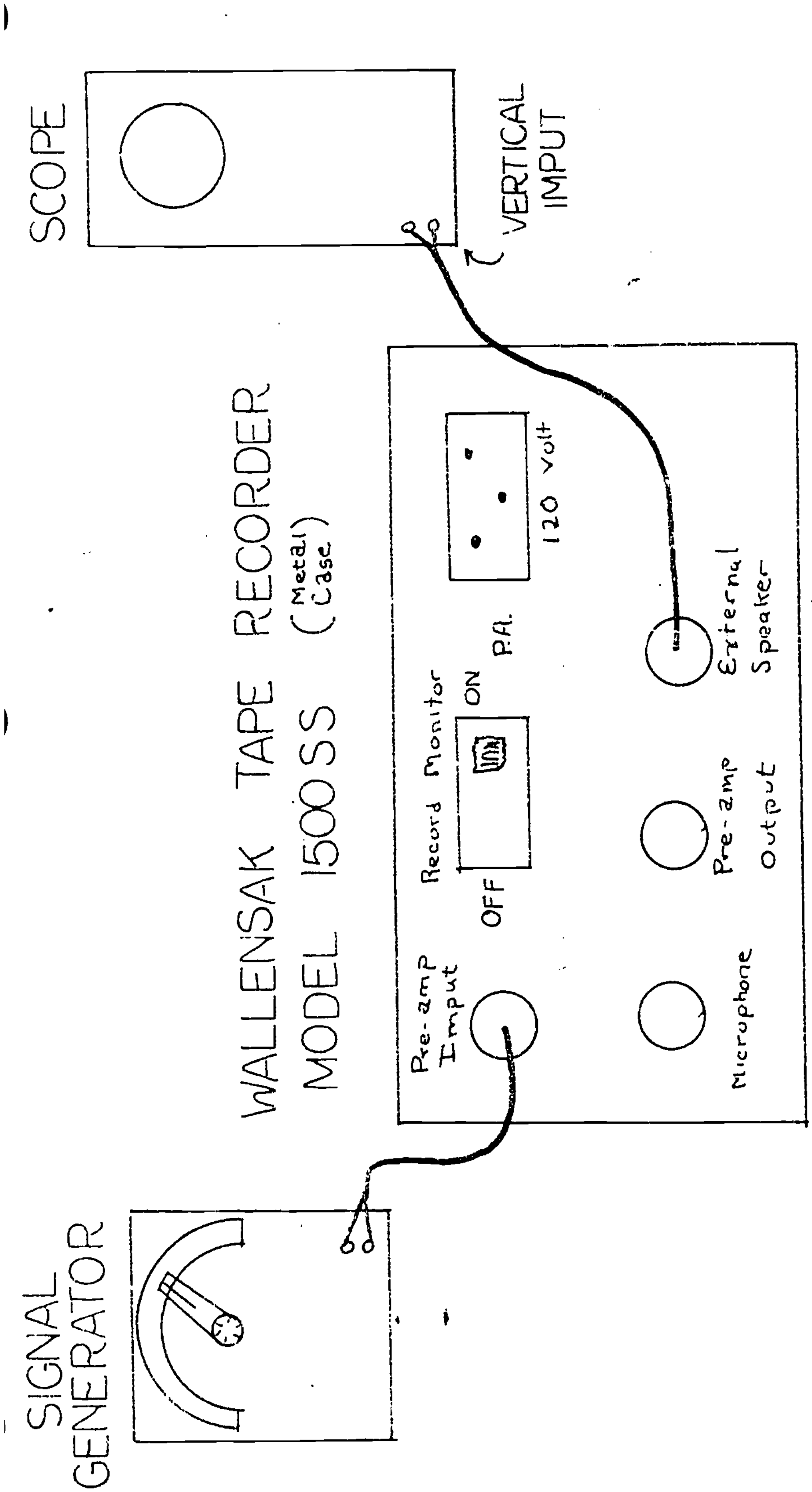
c. Turn the volume on the tape recorder up and down to show the relationship between loudness and amplitude.

d. While you have the signal generator hooked into the system, you may want to let the students see how high a pitch they can hear. You can do this by simply increasing the frequency on the signal generator and calling out the frequencies. You may want to point out this is not very accurate in the high frequency range (over 8 - 10,000) due to the limitations of the speaker.

e. Unplug the signal generator and plug in the microphone. Have several people speak into the mike saying the same thing. (i.e. vowels, one syllable words). Point out that the basic shape of the waves are the same but the overtones (harmonies) superimposed on top of the basic wave cause the difference of the voice quality. You could also show this by having several different instruments (or recording of several different instruments) playing the same note.

f. (optional) While the equipment is set up, you may want to play a tape of some musical selections and look at the wave patterns.

WIRING DIAGRAM FOR DEMONSTRATION



Sound in a Vacuum

This lab may be done as a demonstration.

Tuning Forks and Forced Vibrations

The student desk or tote tray are used as a sounding board. Any box or tray which has any volume to it can be used. You should also warn the students about touching the vibrating prongs of the tuning fork against something which will break.

Problem 11-3

Tuning forks may be substituted for the pitch pipe. If tuning forks are used, the tuning of the bottle can be checked by holding the vibrating fork above the bottle. If it is tuned properly, resonance will occur.

Speed of Sound in Air

The starters pistol has a plugged barrel. It produces a puff of smoke and a flash at the end of the cartridge cylinder. This pistol should be held over the shooter's head when fired. If there are any concerns with the use of the pistol, a pair of large cymbals can be substituted.

Calculations in Sound

1. $\text{speed} = d/t = \frac{4150 \text{ m}}{3.5 \text{ sec}} = 1185 \text{ m/sec}$

2. $\text{period} = \frac{1}{\text{freq}} = \frac{1}{250 \frac{\text{vib}}{\text{sec}}} = 0.004 \frac{\text{sec}}{\text{vib}}$

3. $\text{freq.} = \frac{\text{speed}}{\text{w. length}} = \frac{331.5 \text{ m/sec}}{1} = 331.5 \frac{\text{vib}}{\text{sec}}$

4. $\text{speed} = \frac{\text{distance}}{\text{time}}\ ; \quad t = \frac{d}{s} = \frac{3000 \text{ m}}{331.5 \text{ m/sec}} = 9.6 \text{ sec.}$

5. $\text{freq.} = \frac{\text{speed}}{\text{w. length}} \qquad s = f\ (\text{wl}) = (2.5\text{m})\ (350 \text{ vib/sec}) = 875 \text{ m/sec}$

Beats

You will want to check with the students to see if they are actually getting beats. You may have to help them adjust the rubber bands to produce a slight change in the frequency of the tuning fork.

Doppler Effect

Be careful that the students do not hit each other with the whistle. The whistle could be any kind of whistle; party favors may be the most accessible.

Law of Strings

The boards can be the speed tracks from IME. The box could be shoe boxes, pneumatic trough or any box of about that size. Any wire can be used (insulated, non-insulated, braided or single-stranded). Be careful if you use thin single-stranded copper wire because it will stretch and break if too much tension is applied.

Sound Cryptogram

T	R	A	N	V	E	R	S	E	A	Q	B	R	U	C	E	H	A	Y	D
U	A	C	S	A	D	C	B	C	T	T	R	S	S	E	N	D	U	O	L
N	F	G	M	B	G	T	H	C	B	O	B	D	E	E	S	F	C	G	A
I	I	M	U	U	C	A	V	F	O	A	S	U	V	E	Q	D	R	F	I
N	O	I	S	E	O	B	E	F	R	E	Q	U	E	N	C	Y	R	N	N
G	A	T	L	O	U	N	C	B	S	K	U	A	P	B	G	D	Y	F	D
F	W	X	C	Z	D	I	E	I	W	D	I	E	X	Y	Z	V	I	G	U
O	F	R	A	K	V	V	S	G	T	B	E	A	T	S	S	I	T	Q	T
R	E	S	O	N	A	N	C	E	D	H	T	U	R	G	F	B	F	H	I
K	F	B	U	W	J	M	K	O	F	G	S	U	G	H	I	R	J	K	G
D	R	E	T	H	U	V	P	I	J	D	T	E	O	L	R	A	E	O	N
A	B	T	R	C	D	P	I	L	E	D	I	C	K	G	M	T	N	P	O
S	W	H	A	L	P	I	T	G	I	N	S	K	P	F	N	I	G	E	L
T	H	W	X	L	T	Z	C	J	C	T	O	N	E	E	L	O	N	O	L
U	I	V	E	R	W	D	H	M	K	O	U	P	F	G	M	N	S	P	J
D	S	R	X	E	Y	R	E	F	H	N	N	D	I	L	N	T	K	M	A
Z	T	Y	C	C	D	U	Z	T	O	M	D	D	E	A	M	I	N	N	N
A	J	B	B	S	Y	M	P	A	T	H	E	T	I	C	T	T	R	O	E
D	E	L	A	E	Z	S	T	X	M	E	E	N	V	R	U	O	S	T	P
A	E	C	I	B	H	F	Y	G	G	H	W	V	O	I	C	E	R	Q	S

Find 24 words that were in this unit and match them to their definitions.

________ 1. Height of a wave
________ 2. Alternately loud and soft
________ 3. Pleasant sound
________ 4. Unpleasant sound
________ 5. Volume of sound
________ 6. High or low tone
________ 7. Human hearing device
________ 8. Sound made by humans
________ 9. No sound
________ 10. No material present
________ 11. Anything heard by ears
________ 12. A rhythm instrument
________ 13. What is player on a guitar
________ 14. A back and forth motion
________ 15. Used by a policeman
________ 16. Vibrations per sec.
________ 17. Change in pitch due to motion
________ 18. Vibrations at right angles to path of wave
________ 19. Vibrations is along path of wave
________ 20. A disturbance in water
________ 21. A particular pitch
________ 22. When a tube of air vibrates at the same frequency as a nearby tuning fork
________ 23. The action of one body vibrating naturally at the same frequency as another nearby body
________ 24. A device that vibrates at a fixed frequency

Vocabulary used in Cryptogram

transverse

longitudinal

wave

amplitude

tone

music

noise

vibration

tuning fork

loudness

vacuum

sound

drums

whistle

pitch

frequency

resonance

beats

Doppler Effect

sympathetic

ear

voice

quiet

strings

AUDIO-VISUAL AIDS

From Instructional Materials Center:

Filmstrip:

FS 530 Sound Encyclopedia Britannica

Records:

Rec 534 The Science of Sound
Rec 534 Sound Patterns

Study Prints:

S.P. 536 Heat, Light and Sound
S.P. 535 Light and Sound

Transparencies - Milliken Series:

Tr 530 Heat, Light and Sound
Tr 534 Light and Sound Energy

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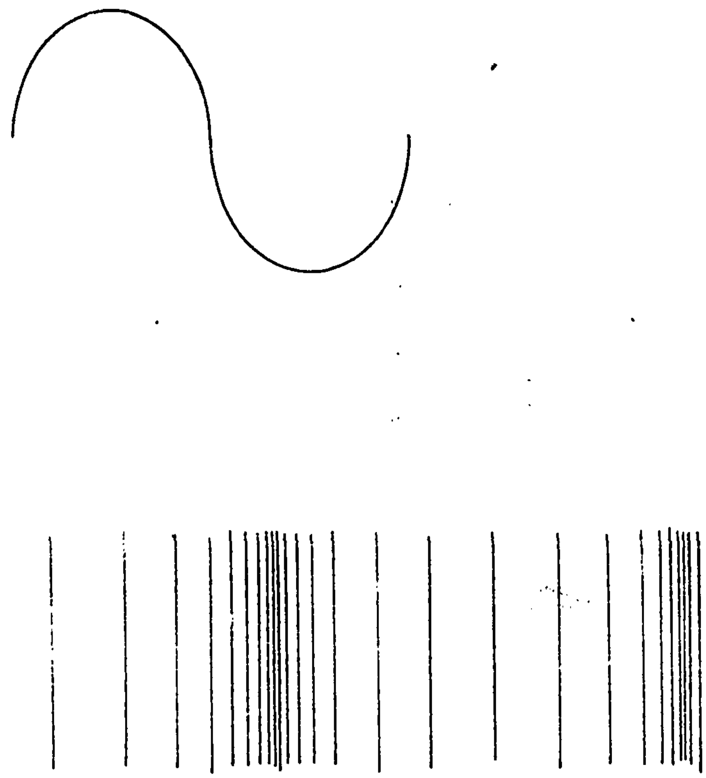
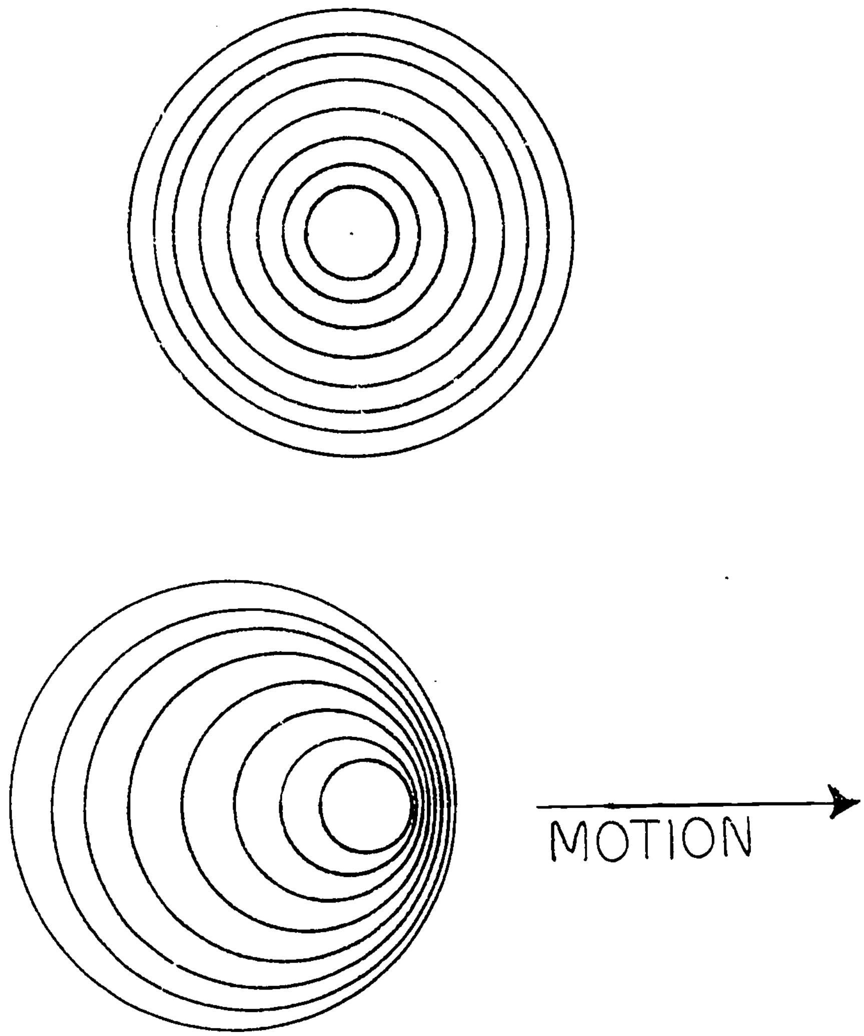
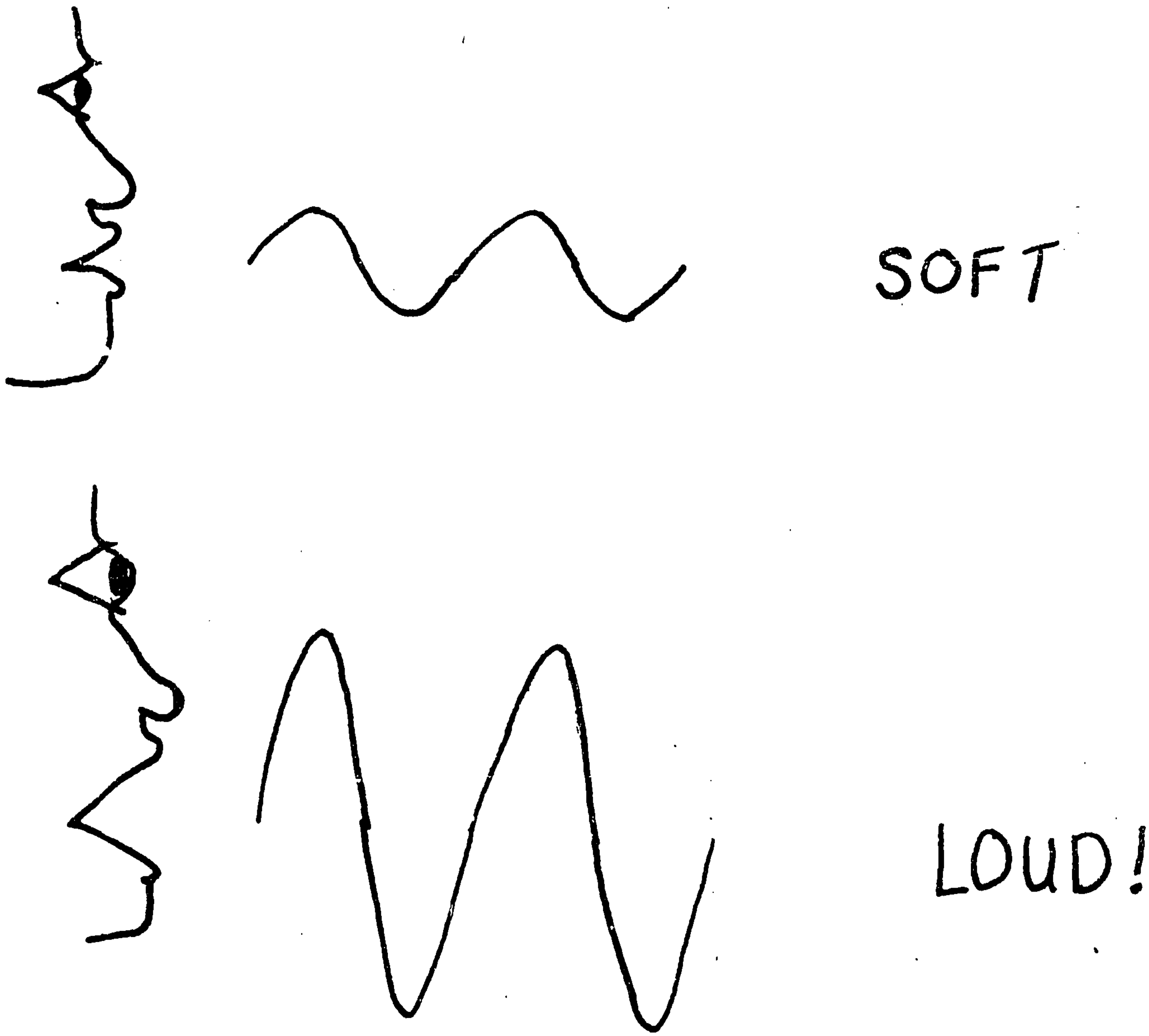


Transparency master for Longitudinal and Transverse Waves

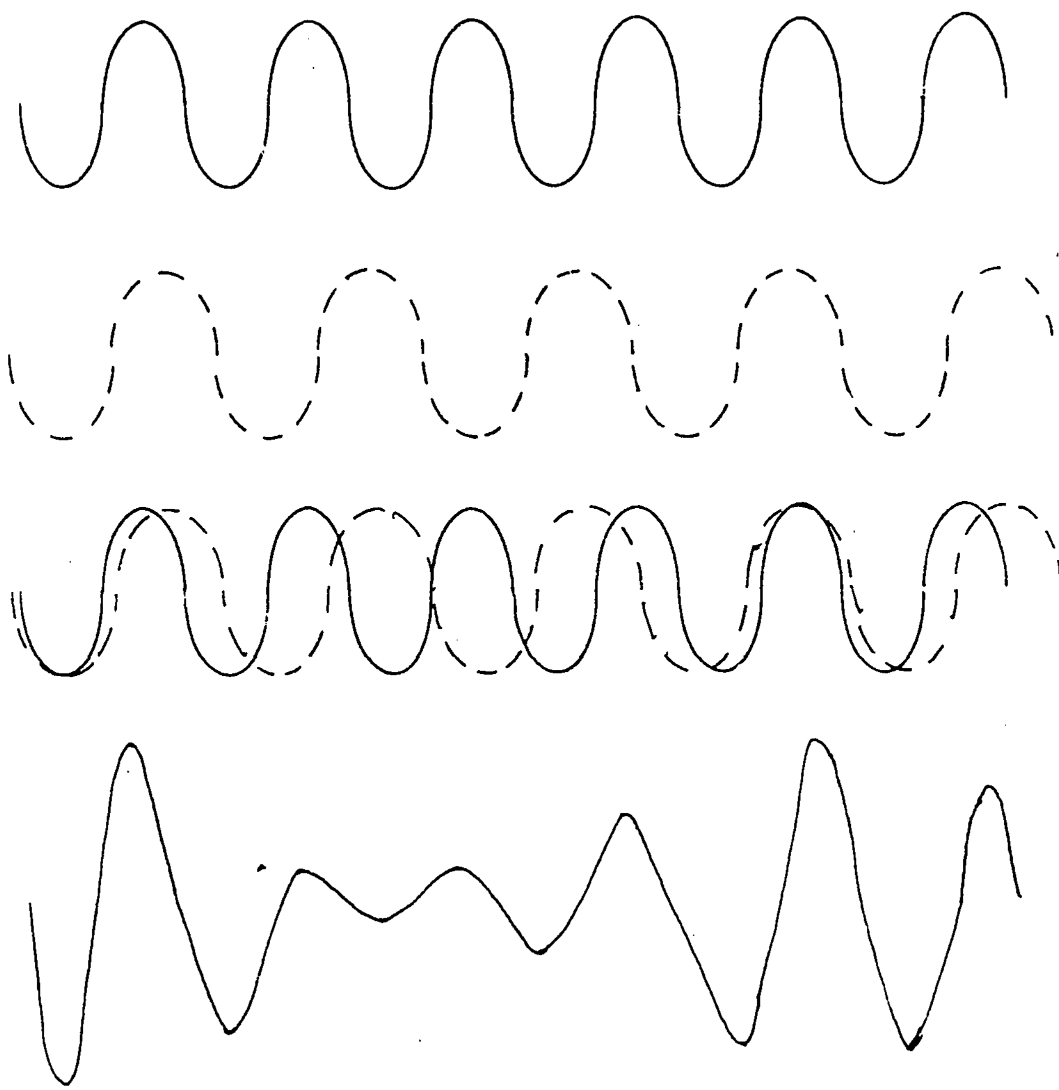
SOUND WAVES



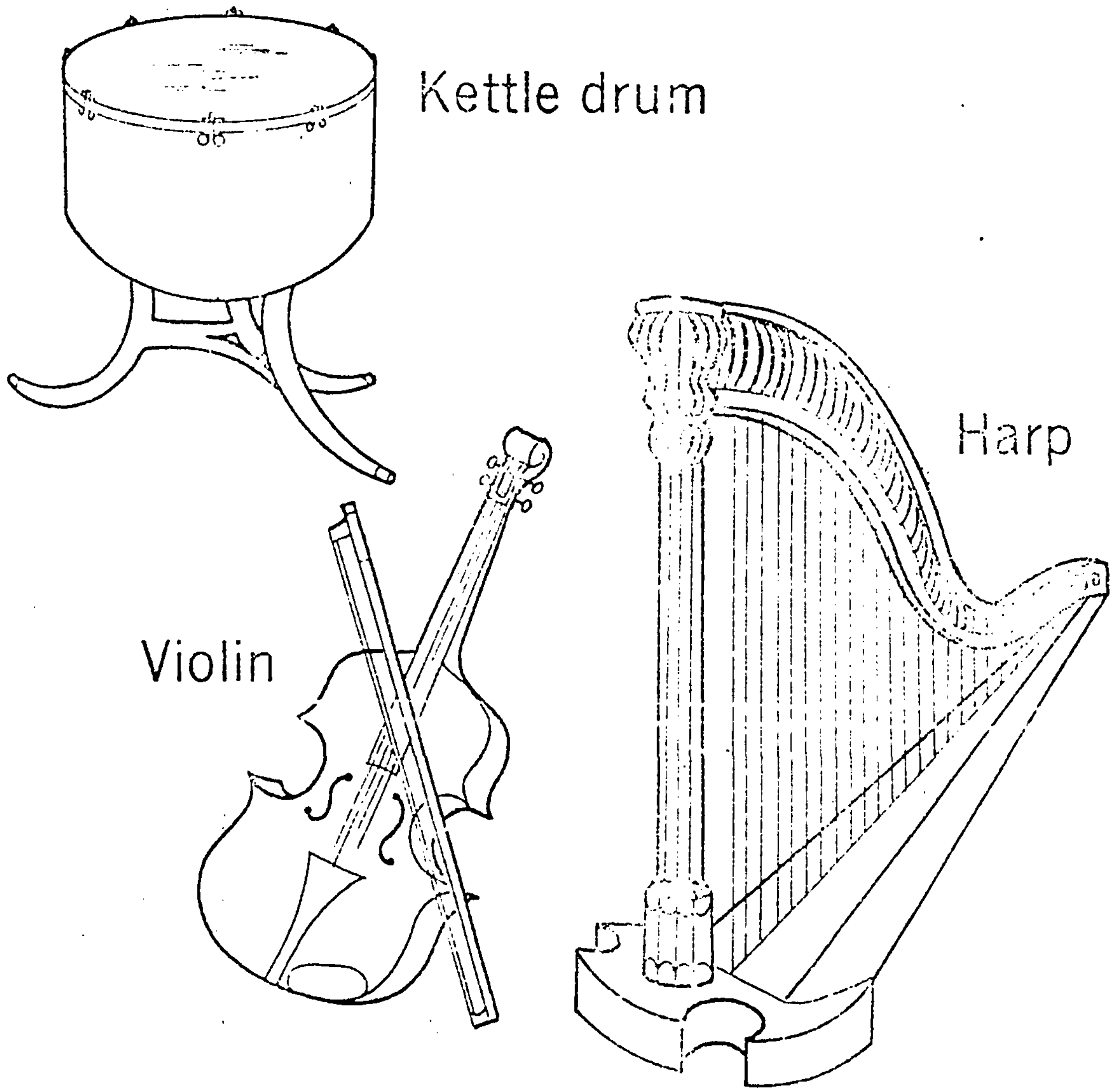
Transparency master for Doppler Effect



Transparency master on Amplitude and Loudness



Transparency master for Beats



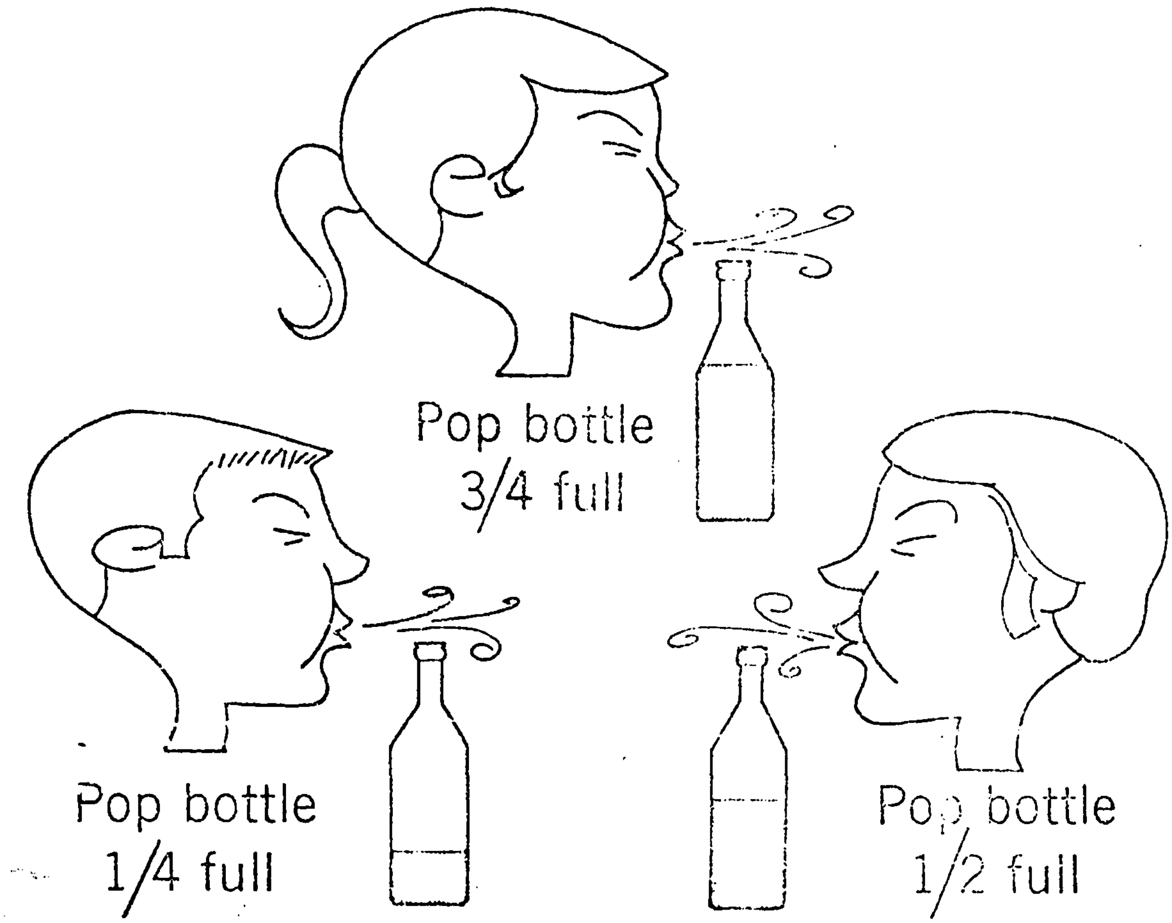
VIBRATION AND SOUND

(a) Which instruments depend upon vibrations to produce sound?

(b) Which instruments have resonating chamber? What does a resonating chamber do?

(c) If more tension is put on the string of the violin or the harp, what happens to the pitch?

(d) How could the pitch of the drum be changed?



A POP CONCERT

(a) Which bottle should produce the highest pitch note when air is blown across its mouth?

(b) What vibrates to produce sound in each bottle?

(c) Must a pop bottle be the same shape in order to produce the same pitch as another bottle? Explain.

Evaluation Form for Teachers

Name of mini-course ______________________________

Evaluation Questions	Yes	No	Comments
1. Did this unit accomplish its objectives with your students?			
2. Did you add any of your own activities? If so, please include with the return of this form.			
3. Did you add any films that other teachers would find useful? Please mention source.			
4. Were the student instructions clear?			
5. Was there enough information in the teacher's section?			
6. Do you plan to use this unit again?			

7. Which level of student used this unit? ______________________________

8. How did you use this unit - class, small group, individual? ________

____

PLEASE RETURN TO SCIENCE SUPERVISOR'S OFFICE AS SOON AS YOU COMPLETE THE COURSE.

SCIENCE MINI-COURSES

PHYSICAL SCIENCE	Prepared by
ELECTRICITY: Part 1 (Types of Generation of Electricity)	Marvin Blickenstaff
ELECTRICITY: Part 2 (The Control and Measurement of Electricity	Marvin Blickenstaff
ELECTRICITY: Part 3 (Applications for Electricity)	Marvin Blickenstaff
CAN YOU HEAR MY VIBES? (A Mini-course on Sound)	Charles Buffington
LENSES AND THEIR USES	Beverly Stonestreet
WHAT IS IT? Identification of an Unknown Chemical Substance	Jane Tritt
BIOLOGY	
A VERY COMPLEX MOLECULE: D.N.A.: The Substance that Carries Heredity	Paul Cook
Controlling the CODE OF LIFE	Paul Cook
Paleo Biology – BONES: Clues to Mankind's Past	Janet Owens
A Field Study in HUMAN ECOLOGY	Janet Owens
Basic Principles of GENETICS	Sharon Sheffield
HUMAN GENETICS – Mendel's Laws Applied to You	Sharon Sheffield
SCIENCE SURVEY	
WEATHER Instruments	John Fradiska
TOPOGRAPHIC Maps	John Geist and John Fradiska
CHEMISTRY	
WATER	Ross Foltz
PHYSICS	
PHYSICAL OPTICS	Walt Brilhart