STEM Sound Investigation
Singing To Your Own Tune
Student Inquiry Sheet

Center for the Advancement of STEM Education

Science Center of Inquiry

Name________________________________Class______________ Date___________________

1: Swinging Pendulums

In this investigation, you are going to build a pendulum. A pendulum is anything that is suspended so that it can swing or move back and forth.

Cut a piece of string 30 cm long. Tie a paperclip to the end your string. Bend it to look like a fishhook so that you can hang washers on it. Tape the free end of the string to something like the edge of a table so that your pendulum can freely swing back and forth. Hang one washer on your pendulum's hook. Pull it back so that the washer rises 4 cm above the table and release it. The time it takes a pendulum to swing over and back one time is called the pendulum's period.

A. **Find the period of the 30 cm pendulum with 1 washer pulled up 4 cm** by measuring the time it takes to swing back and forth 10 times. Then divide the time of 10 swings by 10 to get the time of one swing or period. Do at least 2 tests to ensure accuracy. Record your results below:

Pendulum Length	Time of 10 swings	Period of Pendulum

B. Find the period of the 30 cm pendulum with 1 washer pulled up 2 cm .

Pendulum Length	Time of 10 swings	Period of Pendulum

C. Find the period of a 30 cm long pendulum with 2 washers pulled up 2 cm.

Pendulum Length	Time of 10 swings	Period of Pendulum

D. Find the period of a 15 cm long pendulum with 1 washer pulled up 2 cm.

Pendulum Length	Time of 10 swings	Period of Pendulum

E. Working together with other students, use your data to write some rules that describe how your pendulum works. Be prepared to present, share, and debate your rules.

Rule 1: How raising the pendulum from 4 cm to 2 cm changes the period of the pendulum:

Rule 2: How changing the weight of the washers from 1 to 2 washers changes the period of the pendulum:

Rule 3: How changing the length from 15 cm to 30 cm changes the period of the pendulum:

Check Point

Part 2: Pendulum Interactions

A. Now you're going to build a side-by-side double pendulum. Attach the end of a 15 cm string to a table with tape. Attach the other end to the table so that the middle of the string hangs down about 2 cm. Hang two 30 cm pendulums each with 1 washer from the string attached to the table. Keep the pendulums about 5 cm apart. Lift one pendulum 2 cm and release it. Carefully observe and describe what happens. Record your results below:

A. Try this investigation again but <u>hang two pendulums of significantly different lengths</u> 5 cm apart. (30 cm and 15 cm). Record your results below.

E. Working together with other students, use your data write some rules that describe the motion of the side-by-side pendulums. Be prepared to present, share, and debate your rules.

Rule 1: How side-by-side pendulums of equal lengths impact their motion.

Rule 2: How changing the length of side-by-side pendulum impacts their motion.

Wonderings

In June, 2013, Nik Wallenda walked across the Grand Canyon on a steel cable. Look at the picture of the walk and see if you can find side by side pendulums on the cable: http://popwatch.ew.com/2013/06/24/nik-wallenda-grand-canyon-walk-skywire/ What purpose do you think these pendulums serve?

Check Point

Part 3: Tuning Forks — Transferring Motion And Energy

In this investigation, you're going to use tuning forks to explore vibrations and compare them to pendulum motions.

A. Does changing the length of a tuning fork change the frequency (high and low sounds)? How does length (or height) affect the sound of the tuning fork? How is this like a pendulum?

B. Can side-by-side tuning forks pass motion like side-by-side pendulums pass motion? Try the following experiments. Using two tuning forks of the same frequency, make one fork vibrate. Hold it as close as possible to the non-vibrating fork making sure the forks do not touch. Do this for about 5 seconds. Hold the fork that was not originally vibrating next to your ear. Is it now vibrating and making a sound? How do your findings compare with the motion of a side-by-side pendulum?

B. Try the tuning fork experiment again. This time hold two tuning forks of different frequencies close to each other. Were there any differences as to how well the frequencies passed? How do your findings compare with the motion of the side-by-pendulums of different lengths?

C. Fill a glass or a beaker 1/4 full of water then **gently** tap on the glass with a hard object such as a key to create sound from the glass. As you are tapping, slowly add more water to the glass. How does the sound change as you fill the glass? How is this like a pendulum or a tuning fork?

D. Fill a glass about 1/2 full of water. Dip your finger in the water and then move your wet finger around the top rim of the glass in a steady but slow motion. Does your glass "sing"? If it does, then change the level of water in the glass and create the sound again. Does the pitch or frequency of the sound change as the water level changes? How is this like the pendulums?

The explorations of pendulums and tuning forks help us notice that matter exhibits a natural ability for motion based upon the type of material, the shape, components and/or structure. The natural motion of an object is called **resonance.**

Check Point

Create Your Own Resonance Band

do re me fa so la ti do

In this inquiry, you will explore the backbone of music, the musical scale by using Palm Pipes to make the notes. Palm Pipes are short lengths of 1/2 inch PVC pipe. They make sounds (notes) when you tap them into the palm of your hand.

The first "do" is a root frequency and is the long pipe. The last "do" is twice the root frequency. This represents an octave. (8: like an octopus)

To create a musical scale you need to select six frequencies between the root frequency and twice the root frequency. This creates seven intervals in the eight-step octave. The length of the pipe determines the frequency of the sound waves.

A pipe cut 24 cm long is the music note "F". This will be our root frequency. As the pipes are cut shorter the frequency increases. When we get to 12 cm the frequency has doubled and we have an octave. The chart shows the lengths of pipe needed and the notes they make to play “Twinkle, Twinkle Little Star”:

Music Note	Scheme "R" cm
F	24.0
G	21.4
A	19.0
Bb	18.0
C	16.0
D	14.3
E	12.7
F'	12.0

Twin	-	kle,	twin	-	kle	lit	-tle	star,	How	I	won	-	der	what	you	are
F		F	C		C	D	D	C	Bb	Bb	A		A	G	G	F
Up	a	-	bove	the	world	so	high,	Like	a	dia	-	mond	in	the	sky,	
C	C		Bb	Bb	A	A	G	C	C	Bb		Bb	A	A	G	

Design your own music and share it with other students. Invite students who play different musical instruments to visit and show how they make different sounds.