PENDULUM LAB

ENERGY CONVERSION

MONROE

Time Frame:	Standards:
45 minutes	Idaho Standard 2.2, 2.3, 2.4

Objectives:

Pendulums swing with a very regular motion. This motion converts energy from gravitational potential energy to kinetic energy, and back again. This motion can be looked upon as a wave, or a cycle. We will examine this cycle, or wave, as part of the phenomenon of a pendulum.

Terms:

Bob ~ this is the weight at the end of a pendulum
Cycle ~ a cycle the movement of a pendulum bob, such that the position of the bob is the same, and the direction of the bob is the same. Usually, this is from where the bob was replaced, to the top of the swinging motion on the opposite side, and back to the point of beginning. Displacement is zero.
Frequency ~ this is the number of cycles completed per second. This is cycles per sec.
String length ~ this is the distance from the pendulum support, to the center of the bob.
Distance pulled back ~ this is the distance, in meters, from the rest position of the bob, to the release point. This is measured against the table.

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Background Information:

FORMS OF ENERGY

All forms of energy fall under two categories

POTENTIAL

Potential energy is stored energy and the energy of position (gravitational).

CHEMICAL ENERGY

Chemical energy is the energy stored in the bonds of atoms and molecules. Biomass, petroleum, natural gas, propane and coal are examples of stored chemical energy.

NUCLEAR ENERGY

Nuclear energy is the energy stored in the nucleus of an atom. It is the energy that holds the nucleus together. The nucleus of a uranium atom is an example of nuclear energy.

STORED MECHANICAL ENERGY

Stored mechanical energy is energy stored in objects or substances by the application of a force. Compressed metal springs and stretched rubber bands are examples of stored mechanical energy.

GRAVITATIONAL ENERGY

Gravitational energy is the energy of place or position. Water held in a reservoir behind a hydropower dam is an example of potential gravitational energy. When the water in the reservoir is released to spin the turbines, it becomes motion energy.

KINETIC

Kinetic energy is motion. It is the motion of waves, electrons, atoms, molecules and substances.

RADIANT ENERGY

Radiant energy is electromagnetic energy that travels in transverse waves. Radiant energy includes visible light, x-rays, gamma rays and radio waves. Solar energy is an example of radiant energy.

THERMAL ENERGY

Thermal energy (or heat) is the internal energy in substances. It is the vibration and movement of atoms and molecules within substances. Geothermal energy is an example of thermal energy.

MOTION

The movement of objects or substances from one place to another is motion. Wind is an example of motion energy.

SOUND

Sound is the movement of energy through objects or substances in longitudinal (compression/rarefaction) waves.

ELECTRICAL ENERGY

Electrical energy is the movement of electrons. Lightning and electricity are examples of electrical energy.

Materials:

1. Fishing Line (string works, but 3 lb. fishing line works best)
2. Weights of various sizes (any size or weight will work, as long as mass is known)
3. Meter sticks or metric rulers
4. Stop watches
5. A bar from which a pendulum can easily swing

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Variables:

You will need to complete six more trials. Change only one of the variables at a time, keeping the other two the same as the control run, but change the variable twice. Your teacher will show you an example. There are three variables, but remember to only change one at a time.

Complete a control run of the pendulum. Everyone will do the same control run. Everyone will use a string length of .33 meters, and a bob mass of .25-kg, pulled back .15 meters. You will calculate the frequency.

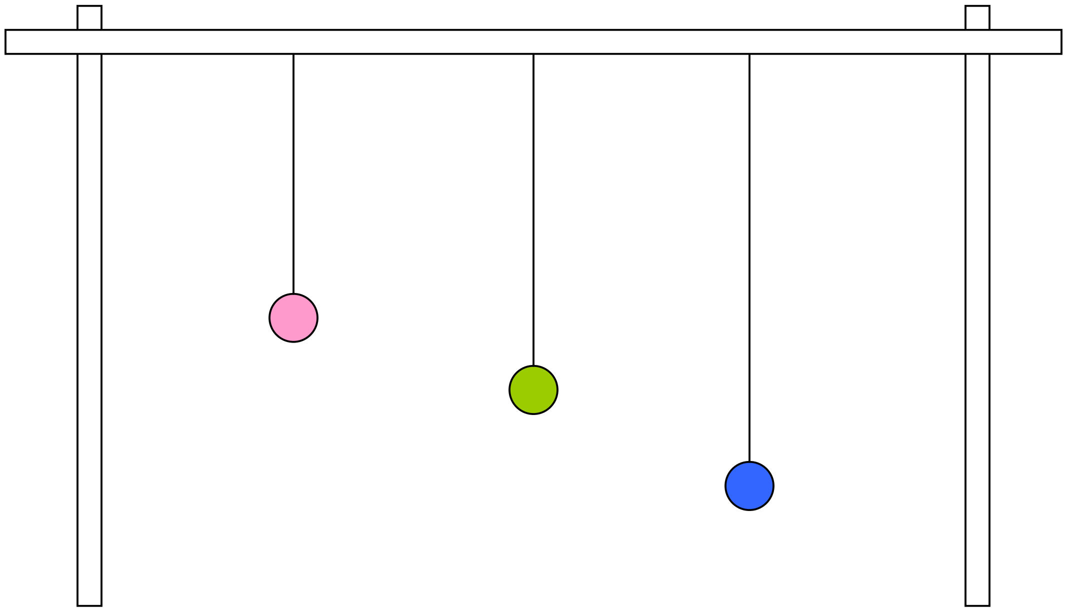
Analysis:

By examining your data, be able to prove to yourself which of the three variables, or combinations, will change how fast a pendulum swings. Answer the questions on the following pages.

Procedure:

1. In some way the string should be attached or wound around the suspension bar so that the string length can be changed and measured. It will be different for individual cases
2. Pull the bob back, measuring against the table, by a known distance.
3. Release the bob and time the swing of the pendulum for a number of cycles. Back and forth is a single cycle.
4. Fill out the data sheet.
5. The ONLY thing that will matter is the length of the string. Students will understand this by the end of the lab. They should also understand that the amount of kinetic energy in the system is rising and falling in a manner exactly opposite that of the potential energy so that the sum of the two does not change.

Diagram of bobs:



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Data Chart:

String Length	Bob Mass	Distance Pulled back	Cycles Counted	Seconds Counted	Frequency (cycle/sec)
.33m	**.25-kg**	**.15 m**	**10 cycles**		
	.25-kg	.15 m			
	.25-kg	.15 m			
.33m	.25-kg				
.33m	.25-kg				
.33m		.15m			
.33m		.15m			

Assessment:

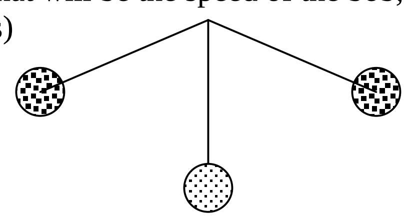
According to your data, what is the factor that most influences the frequency of the swing of the pendulum? (1 point)

Explain why you think so. (1 point)

Describe the energy conversion in the pendulum's swing, between kinetic and potential energy. You need to show an understanding of the energy conversion, and may need to review your science text book. (2 points)

Your principle walks in, and requests that you make a pendulum swing with a frequency of *.25 cycles* per second. How would explain to your principle how this would be done, or else explain why it could **not** be done. (1 point)

Examine the pendulum shown at the right. What will be the speed of the bob, at the lowest point of the pendulum? (2 **extra** points)



Bob has a mass of 2.5 kilogram
String length is 4 meters
Bob height at release point is 2.5 meters
GPE = mass • height
KE = ½(mass) • velocity^2
Law of conservation of energy says, "energy moved but not made or destroyed"

Answers to questions in assessment piece.

The only variable that will influence the swing of the pendulum is the length of the string, unless the pendulum is forced to swing in an unreasonable pattern.

On the data chart, the data probably shows that there was no change in the frequency of the system during the last four trials, even though the mass of the bob and the distance pulled back were altered.

As the pendulum rose, the kinetic energy will fall to zero at the top of the swing. At that point the potential energy is at its peak.

The principle could not see a frequency of .25 cycles per second, because the length of the string would never be long enough, unless you are doing the experiment in a gymnasium.

GPE (at top of swing) = KE (at bottom of swing)

GPE = 2.5 kilograms x 2.5 meters x 9.8 meters / second / second = 61.25 Joules

KE = ½ mass x velocity^2

61.25 J = 1.25 kilograms x velocity^2

61.25 J / 1.25 kg = velocity^2

49 = velocity^2

Take the square root of both sides

The fastest speed is 7 meters per second