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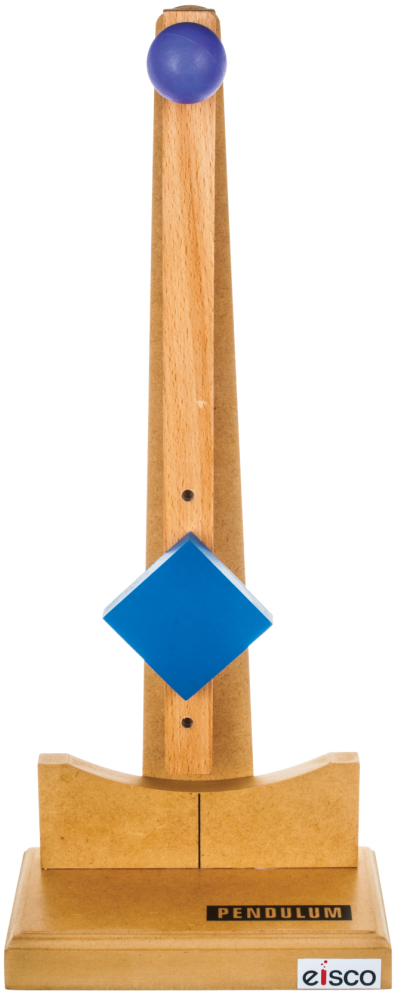
SIMPLE MACHINES
RIGID PENDULUM

CAT NO. WDSM13



Experiment Guide

GENERAL BACK GROUND OR THEORY ON THE EXPERIMENT:

PENDULUMS:

Pendulums are a body fixed at a point. When the body is displaced from that point it oscillates back and forth under the force of gravity. A simple pendulum consists of a mass on the end of a massless unstretchable string. The mass at the bottom of the string is called a bob.

This pendulum is a ridged body pendulum. The length of the pendulum is considered to be the distance from the pivot point to the center of mass of the object. In a ridged body pendulum, there is no string and the whole pendulum is considered to have mass.

Both simple pendulums and ridged body pendulums have a period that varies depending on the length from the pivot point to the center of mass.

Our pendulum's center of mass can be changed by moving the blue wooden block to any of the three positions drilled into the front of the ridged body pendulum.

Students can measure the period of this oscillation quite easily by timing how long it takes for twenty complete cycles of the pendulums motion, and then dividing their time by 20 to get the period. A complete cycle means the pendulum is released at an angle and swings to the lowest point, up to the highest point on the other side and then back through the lowest point to the beginning where it was released. It is a common mistake for students to count one cycle as the time it takes to move from the highest point back up to the highest point on the other side.

The angle that the pendulum is released from has very little effect on the period of the pendulum. The acceleration due to gravity also affects the period of the pendulum; however this cannot be changed in a typical classroom setting.

EVERYDAY PENDULUMS:

Old fashioned grandfather clocks have pendulums in them of a certain length to keep time. A metronome is very similar to an upside down ridged body pendulum, where changing the placement of the mass on the stick will change the period of oscillation. At the playground a child swing on a swing is a pendulum.

REQUIRED COMPONENTS (INCLUDED)

Name of Part	*Quantity*
Ridged body pendulum	1

REQUIRED COMPONENTS (NOT INCLUDED)

Name of Part	*Quantity*
Stopwatch	1

ACTIVITY : PENDULUM INVESTIGATION

TEACHER NOTES:

The study of a pendulum is a simple and easy to understand way to demonstrate to students how scientific inquiry is done. Students can discover interesting insights into how a pendulum behaves on their own with very little guidance from the teacher. Have the students work through the following worksheets and let them discover on their own what affects the period of a pendulum.

ACTIVITY 1: (OPTIONAL)

First have a large pendulum that the whole class can see easily in front of the classroom. This can be a drilled bowling ball with a hook suspended from supporting post in the ceiling if your administration will allow such a thing. Even a large 500g mass suspended from the ceiling will work. Make sure that all students will be able to see and time its motion from their seats. Pull back on the pendulum at some small angle and release it. Ask the students to make some observations. Any answer is acceptable here. They may say things like “There is a big bowling ball swinging on a string” or “The bowling ball is moving back and forth” Next introduce some vocabulary. Explain that the bowling ball or mass at the bottom is called a bob and the time it takes to go back and forth once is called the period. Have students use a stopwatch to time 10 back and forth motions of the pendulum and then divide this number by 10 to get the period.

Increasing precision:

To illustrate to students why it's helpful to time 10 cycles and not just one, have students time one cycle and then ask them to shout out their answers while you quickly write them on the board. Next have the students time 10 cycles and then shout those answers out. Move the decimal place over one for all of the 10 cycle times to show what the average of one cycle would be and compare the range of answers from timing one cycle to that of timing ten. There should be a much smaller range and therefore a greater degree of precision with the ten cycle values.

ACTIVITY 2 : WHAT AFFECTS THE PERIOD? GUIDED INQUIRY (TEACHER ANSWERS)

Ask the students to list everything that they can change about the pendulum. They can use the large pendulum in activity 1 to come up with ideas, or they can use the smaller apparatus.

What I observe about the pendulum	What I can change about the pendulum
• There is blue square attached to a post • The post is moving back and forth • The post does not return to its original height every time • There are three holes in the post for the blue square to be placed in. • There is a large purple ball on top of the post	• The position of the blue square • If the blue square is on the post or not • The angle the post is released from* • The speed of the post • How many times the post swings back and forth*

Then ask students to place a star next to everything they can measure about the pendulum.

Finally have students come up with an independent variable that they would like to test.

Depending on the level of your students you can either ask the students to develop their own question to test or come up with one as a class. The dependent variable in this case should be the period of the pendulum. The teacher may ask students to phrase the question like this: How does _____ affect the period of the pendulum?

The teacher may also come up with a question to investigate as a class, and help the students write the procedure. Make sure that students identify the dependent and independent variable before they write their procedure. Remind them that only one independent variable may be changed at a time and that all the other variables (the things listed in the last column) must stay the same. Students should put in their procedure specifically how these variables will be kept constant.

The information in the background section of this manual discusses some of the expected results from this experiment as well as how to graphically analyze those results to find the significance of the slope.

SAMPLE DATA:

Blue square in the top hole
Period = 17.2/20 = 0.86 seconds

Blue square in the middle hole
Period = 17.9/20 = 0.895 seconds

Blue square in the bottom hole
Period = 19.0/20 = 0.95 seconds

Students can find the center of mass of the ridged body by balancing it on the top of the curved surface as shown in diagram 1. The purple ball and pin pull out of the top of the pendulum in order to remove the ridged pendulum. By changing the position of the blue square and balancing the ridged body, we can find that the distance from the center of mass to the pivot point increases as the blue square is placed further away from the pivot point.

Diagram 1

Students should come up with the general relationship that as the distance between the pivot point and the blue square increases, the period increase. Also that the angle at which the ridged body is released from does not affect the period of the pendulum.

For a ridged body pendulum, the period is dependent upon the moment of inertia as well. Removing the blue square also changes the moment of inertia and therefore the period of the pendulum. Without the blue square the period is somewhere around 0.87 seconds, even though the distance from the center of mass to the pivot point is smaller than that for any of the values when the blue square is added.

NAME:_____ DATE:_____

ACTIVITY 2: WHAT AFFECTS THE PERIOD? GUIDED INQUIRY

1. In the chart below, list everything you can observe about the pendulum.

What I observe about the pendulum	What I can change about the pendulum

2. What can you change about this pendulum? List all these things in the second column. Be prepared to share your answers with the class and add your classmate's ideas to your list.

3. Place a star next to everything you can measure about the pendulum.

QUESTION TO INVESTIGATE:

How does _____ affect the period of the pendulum?

Write a procedure and record your data on a separate piece of paper and attach this to this sheet.

CONCLUSION:

Answer your question and provide supporting evidence to back up your claim in the space below.

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