Experiment: Total Mechanical Energy of a Pendulum

Purpose: To examine the conservation of energy in a simple pendulum

Materials:

- Pendulum apparatus with mass and hook
- Lab stand including clamps
- Photogate timer
- LabPro Interface
- Computer

Experimental Design:

A pendulum mass will be released from rest and the speed at the bottom of its swing can be measured using a photogate timer. The difference in height between the top and bottom of the swing can be measured and the changes in kinetic and potential energy can be analyzed. It is suggested that the photogate and pendulum mass be positioned such that the photogate beam intersects the center of the mass as close as possible.

Initial measurements:

1. Measure the "rest height" of the pendulum relative to the lab bench top. Record this height. Use appropriate units.

2. Determine the mass of the pendulum. Record this mass. Use appropriate units.

3. Use the Vernier callipers to determine the diameter of your pendulum. Use appropriate units.

Gathering Experimental Data

4. Raise the pendulum a height of 5 cm from its rest position.

5. Release the pendulum and swing it through the photogate timer.

6. Record the velocity of the pendulum as it passes through the photogate timer.

7. Repeat this trial 2 more times and record all four of your velocities.

8. Now in our second trial, you will change the release height of the pendulum. Repeat steps 4 – 7, using a release height of 10 cm. Record your 3 velocities.

9. Now in our third trial, you will once again change the release height of the pendulum. Repeat steps 4 – 7, using a release height of 15 cm. Record your 3 velocities.

10. Now in our fourth and final trial, you will change the mass of the pendulum. Double the mass of your pendulum and repeat steps 4 – 7, using a release height of 10 cm. Record your 3 velocities.

Total Mechanical Energy of a Pendulum

Using the Photogate Timer:

1. Connect the Photogate, LabPro interface and computer. Remember to use the transformer to power the LabPro as it requires a 110 V power supply.

2. Open the Logger Pro program (the program should automatically detect the photogate timer).

3. Click on the LabPro icon to open the sensor settings. If necessary, switch the DIG/SONIC 1 port to "Photogate".

4. Click on the "Photogate" icon in the DIG/SONIC window and scroll down to "Gate Timing".

5. Click on the "Photogate" icon and scroll down to "Set Distance and Length". Enter the diameter of the pendulum mass in the box highlighted.

6. Close the window to return to the data window. It will likely be a table along the left and two graphs on the right. When you are ready to begin collecting data click on the "Collect" icon. Click on "Stop" to stop data collection.

Data:

ITEM	RESULTS
Rest height of pendulum	
Mass of pendulum	
Diameter of pendulum	

Experimental Data

	Trial 1	Trial 2	Trial 3	Trial 4
Release height:				
Mass of Pendulum:				
Velocity in trial 1				
Velocity in trial 2				
Velocity in trial 3				

Total Mechanical Energy of a Pendulum

Sample Calculations:

(a) potential energy at the start (PE_i):

(b) kinetic energy at the start (KE_i):

(c) total mechanical energy at the start (TME_i):

(d) potential energy at the lowest point (PE_f):

(e) kinetic energy at the lowest point (KE_f):

(f) total mechanical energy at the lowest point (TME_f):

(g) Ratio of total mechanical energy (initial) to the total mechanical energy (final) = (TME_i/TME_f):

Table of Calculated Results:

Trial #	PE_i	KE_i	TME_i	KE_f	PE_f	TME_f	Ratio TME_i/TME_f
1-1							
1-2							
1-3							
2-1							
2-2							
2-3							
3-1							
3-2							
3-3							
4-1							
4-2							
4-3							

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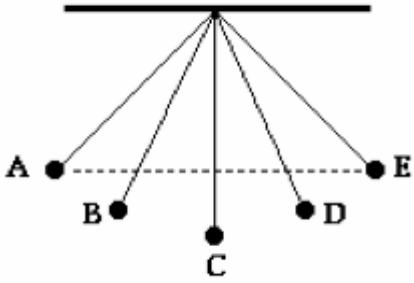
Analysis Questions:

1. Based on your data and calculated results, is the mechanical energy of the pendulum bob conserved? Support your answer by using actual data/results from your experiment.

2. Describe at least two sources of error in this experiment. Explain how you would fix these problems/errors.

3. Assuming that air resistance is negligible, would you expect the mechanical energy of the pendulum bob to be conserved as it swings from position A to position B to position C? Explain your answer.



4. In complete sentences, describe what happens to the amount of kinetic energy and the amount of potential energy as the pendulum bob moves from A to B to C to D to E. Be clear and specific.

5. If air resistance had a significant influence on the motion of the pendulum bob, then how would your answers to questions #1, #3, and #4 be different? Explain using complete sentences.