



## SWINGING PENDULUMS: HOW DOES ENERGY CHANGE?

All objects have energy. Raindrops have energy, paper airplanes have energy, and even a book sitting on a table has energy. The total energy of a system is kinetic energy (KE) plus potential energy (PE). Objects in motion have kinetic energy (KE) while objects at rest have potential energy (PE). How does kinetic energy and potential energy change in a swinging pendulum?

### Objectives:

Construct a pendulum, explain how a pendulum behaves, and describe and calculate potential energy and kinetic energy of a system.

### Question & Hypothesis:

How does kinetic energy and potential energy change in a swinging pendulum?

Write a hypothesis in response to the question above. Use an "If \_\_\_\_\_, then \_\_\_\_\_, because \_\_\_\_\_" statement.

### Materials:

Large metal sinker  
Small metal sinker  
Ring stand  
Ring clamp  
String (at least 30 cm long)  
Metric ruler  
Protractor  
Stopwatch  
Electronic balance

### Procedures:

1. Set up the ring stand and ring clamp. Use the metric ruler to adjust the ring to a height of 25 cm above the table or desk.
2. Mass the large and small metal sinkers. Record these measurements in your science notebook.
3. Securely tie the string to the small sinker. Measure 15 cm along the string. Tie the string at this point to the ring clamp (the sinker should hang 15 cm below the ring clamp).
4. Allow the pendulum to hang at rest. Record your observations of the pendulum's energy – potential, kinetic, or both. Remember, potential energy is *relative*.
5. Hold the pendulum above the table to form a 60° angle with the ring stand. Record your observations about the pendulum's energy relative to the lowest point in the pendulum's swing.
6. From the 60° position, release the pendulum and allow it to swing for exactly one minute. Count the number of full swings (back and forth equals one swing) during the one minute. Record this information in data table shown.
7. Run two more trials of 1-minute each and record the information in the data table.
8. Repeat steps 3-7 using the large sinker. Record your measurements.

### Data Table:

Pendulum		Number of swings in 2 minutes		
String length (cm)	Sinker Size	Trial 1	Trial 2	Trial 3
15	small			
15	large			

### Analysis:

Answer the following questions in complete sentences in your science notebook or show all the work for your mathematics.

1. Calculate the average number of swings using each sinker.
2. What type of energy does the pendulum have when it is hanging straight down? Explain.
3. What type of energy does the pendulum have when it is resting at a 60° angle from vertical? Explain.
4. What force acted on the pendulum when it was released from its raised position?

5. Which sinker size caused the pendulum to swing more in two minutes? Include supporting data in your answer. Give an explanation for this data.
  6. Answer the following questions using the **large sinker**.
    - a. Calculate the potential energy of the sinker if it were resting at an angle  $90^\circ$  from vertical. Carefully think about the height of the sinker at this angle relative to the lowest point in the pendulum's swing (the height is not from the top of the table).
    - b. What is the kinetic energy of the sinker if it were resting at a  $90^\circ$  from vertical?
    - c. What is the kinetic energy of the sinker when swinging as it reaches its lowest vertical point from the ring clamp?
    - d. What is the velocity of the sinker (neglecting air resistance) as it swings through its lowest vertical point? *Hint: You must use the equation for kinetic energy to solve for velocity.*
  7. Answer the following questions using the **small sinker**.
    - a. Calculate the potential energy of the sinker if it were resting at an angle  $90^\circ$  from vertical. Carefully think about the height of the sinker at this angle (it's not the height from the top of the table).
    - b. What is the kinetic energy of the sinker if it were resting at a  $90^\circ$  from vertical?
    - c. What is the kinetic energy of the sinker when swinging as it reaches its lowest vertical point from the ring clamp?
    - d. What is the velocity of the sinker (neglecting air resistance) as it swings through its lowest vertical point? *Hint: You must use the equation for kinetic energy to solve for velocity.*
  8. The figure below is sketch of the pendulum experiment you just did. Identify both the amount of potential energy and kinetic energy at each position below using the calculation from question #7. Include a labeled sketch in your notebook.
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**Conclusion:**

Write a conclusion to this lab based on the original question asked. Be sure to state whether you proved or disproved your hypothesis. Be sure to include supporting data.