

The Pendulum

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INTRODUCTION

A *pendulum* is a string or stick with a weight or bob on the end. The pendulum follows the law of falling objects[—an invisible force, gravity, pulls the pendulum toward Earth. The period of time it takes a pendulum to complete one full swing is simply called the period. Three *variables* affect the period: the length of the pendulum, the size of the *arc* it makes, and the *mass* of the bob. In this activity, you'll discover what happens if you change one or more of the variables. Do you think the period will change?

TIME NEEDED

Preparation: 40 min.

Completion: 1 hr.

WHAT YOU NEED

- various weights, with hooks or handles to attach to string
- string
- stopwatch
- ringstand or fixed hook on wall
- calculator
- metric ruler
- pencil
- a friend or family member



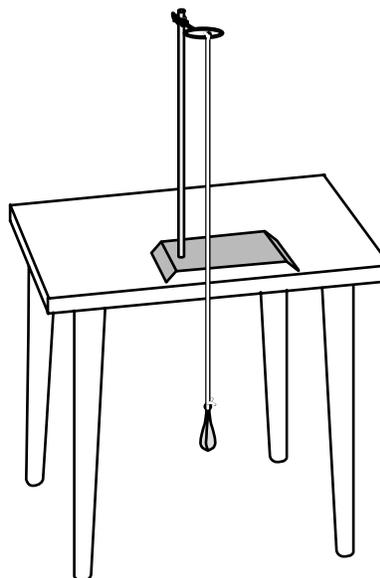
Safety Precautions

Keep your face away from swinging weights. Also, please click on the checkmark to view the safety guidelines.

WHAT YOU DO

1. **Tie** a weight to one end of string and **attach** other end of string

to ringstand or hook so that length of string between ring/hook and weight is 1 meter.



2. **Pull back** weight let go of weight so it swings freely back and forth, not in a loop. Practice this a few times.
3. **Pull back** weight and ask friend/family member to say “go.” **Start** stopwatch as you let go of weight.
4. **Start** counting number of complete swings until timer says “stop” at last swing. Now you have two values: number of complete swings, and number of seconds to make them.
5. **Calculate** period of pendulum. **Divide** number of swings by number of seconds. For example, if 12 swings take 25.71 seconds, the period is 2.1425—rounded off to 2.14 seconds.
6. **Record** results on Data Table A.

Data Table A: Weight Variable

WEIGHT USED	SWINGS	TIME	PERIOD	AVERAGE
Size_____ Trial 1 Trial 2 Trial 3				
Size_____ Trial 1 Trial 2 Trial 3				
Size_____ Trial 1 Trial 2 Trial 3				

7. **Repeat** steps 3–6 two more times with same weight to find average period.
8. **Repeat** steps 3–6 with each weight of different mass three times to find average period and **record** all results on data table A.
9. **Repeat** steps 3–6 with each weight again but **change** arc by changing how far back you pull weight before releasing it. **Record** all results on Data Table B.

Data Table B: Arc Size Variable

WEIGHT USED	SWINGS	TIME	PERIOD	AVERAGE
Size_____ Trial 1 Trial 2 Trial 3				
Size_____ Trial 1 Trial 2 Trial 3				
Size_____ Trial 1 Trial 2 Trial 3				

10. **Repeat** steps 3–6 with each weight again but **change** length of string—cut to make 75 cm, 50 cm, and 25 cm. **Record** all results on Data Table C.

Data Table C: String Length Variable

WEIGHT USED	SWINGS	TIME	PERIOD	AVERAGE
Size_____ Trial 1 Trial 2 Trial 3				
Size_____ Trial 1 Trial 2 Trial 3				
Size_____ Trial 1 Trial 2 Trial 3				



OBSERVATIONS

1. How did changing the mass of the bob on the end of the string affect the period of the pendulum?
2. How did changing the arc of the swing affect the period?

3. How did changing the length of the string affect the period?

 **OUR FINDINGS**

Click on the above link to see what we found.

Follow-Up

Play a pendulum bowling game with friends. Tie one end of a 5-foot string to a tennis ball, and tie the other end to a tree branch. Stick pencils in the holes of empty thread spools to create bowling pins. Place a big piece of cardboard on the ground to make a flat place to set up the pins. Take turns. Pull back the tennis-ball pendulum, aim, and let go. How many pins did you get down with just one swing of the pendulum? Just like bowling, you get two swings to try to knock down all the pins.

Words To Know

arc — a curved line

mass — resistance to movement of matter, with gravity it's known as weight

pendulum — an object hung from a fixed point from which it can swing freely

variable — part that can be changed or isolated in an experiment

Our Findings

3. PHYSICAL SCIENCES

3.31 THE PENDULUM

1. Pendulums follow the law of falling objects. An invisible force, gravity, pulls objects toward Earth at the same speed no matter what their mass. So the different weights affected the period very slightly, if at all.
2. It hardly changed it.
3. The period of the pendulum got faster as the string got shorter, so the shortest string had the fastest period.

SAFETY GUIDELINES

Special Safety Note To Experimenters

Some activities in this book have special safety rules to follow. The special rules are on the page with that activity. But even if every safety rule in the world is not listed with an experiment, you have to know how to be safe when doing science projects. So it's very important that you read, copy, and follow the Everyday Safety Rules that follow.

Sometimes science experiments can be dangerous. Things can spill, break, or even catch fire. You have to know what to do. . . fast. So be prepared. Read the directions for each experiment carefully, and follow any special safety rules listed with it, then be careful.

Always follow common-sense safety rules like NEVER RUN WITH SCISSORS IN YOUR HAND or BE CAREFUL WITH HOT THINGS! You already know a lot of common-sense safety rules ...so remember to follow them, and have fun!

Everyday Safety Rules

PREPARE

- Clear off your work space.
- Read all directions.
- Know what problems might happen, and be prepared.

PROTECT YOURSELF

- Follow directions step-by-step.
- Do just one experiment at a time.
- Locate exits, fire extinguisher, eye wash, and first-aid kit before you start. Ask an adult to show you how to use a fire extinguisher.
- Be sure there's fresh air in the room.
- Wear an apron and safety goggles.
- Don't wear contact lenses, have bare feet, or wear very loose clothing.
- Keep work space and floor clean.
- Clean up spills immediately,
- Don't drink or eat around the experiment work space.
- Don't eat or drink any stuff tested, unless a grown-up says it's OK.

USE EQUIPMENT CAREFULLY

- Don't set up equipment too near the edge of your work space.

- Be cautious when using pointed or sharp instruments, like scissors, screwdrivers, or knives.
- Unplug any electric device by pulling out the plug, not pulling on the cord.
- Use only low voltage batteries, like those used in flashlights or smaller.
- Be careful when using chairs or step-stools.

USING CHEMICALS

- Have an adult help you with all experiments requiring chemicals.
- Don't inhale or taste chemicals.
- Read all labels carefully.
- Label all chemicals.
- Wear goggles, apron, and gloves so chemicals don't touch your skin.
- Wash hands before and after using solutions.
- Wipe up spills thoroughly.

HEATING THINGS

- Wear goggles, apron, and gloves when boiling water.
- Use safety tongs and heat-resistant mitten or hot pads.
- Never leave heated things unattended.
- Turn off hot plates and oven burners when you're finished.
- Keep flammable things away from heat and flames.
- Have a fire extinguisher ready.

IN THE FIELD

- Never go on a field trip alone: follow the Buddy System.
- Tell a responsible grown-up where you're going.
- Know the area and be aware of dangers, like poisonous plants and deep water.
- Dress for the weather conditions.
- Bring along a first-aid kit.
- Don't drink water or eat plants in the wild, unless the grown-up you're with says it's OK.

FINISHING UP

- Clean up the equipment and your work space.
- Return chemicals to the proper containers.
- Don't throw stuff down the drain unless instructed to.
- Wash your hands.
- To protect the environment, get rid of chemicals according to local, state, and federal laws.