Activity: Acceleration and Gravity

Objective

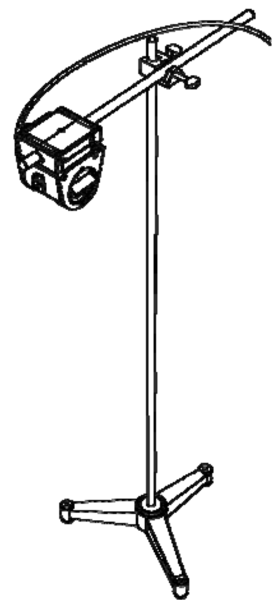
Analyze how gravity affects the motion of falling objects of different size and mass.

Materials and Equipment

- Data collection system
- Motion sensor
- Large base and support rod
- Right angle clamp
- Small rod
- Balance, 1-g resolution (1 per class)
- No-bounce pad
- Three objects of different size and similar mass
- Three objects of different mass and similar size
- Meter stick

Procedure – Similar Mass but Different Size

***NOTE**: Record all work, including tables, data, diagrams, and answers, into your notebook.*



☐ 1. Set up the motion sensor, rods, rod stand, and right angle clamp like the picture to the right. Slide the setup to the edge of your lab table with the motion sensor pointed toward the floor.

***NOTE:** The motion sensor should be as high above the floor as possible.*

☐ 2. Point the motion sensor straight down, toward the floor, and then place the no-bounce pad on the floor directly under the sensor.

☐ 3. Start a new experiment on the data collection system and connect the motion sensor to it. �(2.1) �(1.2)

☐ 4. Create a graph of velocity versus time �(7.1.1)

☐ 5. Set the switch on the top of the motion sensor to the stick figure (long range setting), and then set the data collection system to record 50 samples per second (50 Hz). �(5.1)

☐ 6. Copy Table 1 into your notebook and then measure the mass of the three objects of different size and similar mass. Record the values in the table in your notebook.

Table 1: Determine the velocity and acceleration caused by the force of gravity on objects of different size

Object	Mass (kg)	Initial Velocity (m/s)	Final Velocity (m/s)	Time of Fall (s)	Acceleration (m/s^2)
Large size					
Medium size					
Small size					

RECORD ALL DATA IN YOUR NOTEBOOK.

☐ 7. You will use your data to calculate the acceleration of each of the three objects with different size but similar mass in free fall, but before recording any data, predict (in your notebook) which object (large, medium, or small size) will have the greatest acceleration. Explain your prediction.

☐ 8. Hold the large object under the motion sensor so the bottom of the object is 40 cm below it. Begin recording a run of velocity versus time data just before you drop the object. �(6.2)

☐ 9. Stop recording data after the object hits the no-bounce pad. � (6.2)

***NOTE:** The object must hit the no-bounce pad on the floor. If the object misses the pad, slide the pad to the spot where the object landed and re-record a run of data.*

☐ 10. Repeat the same procedure for the medium and small objects.

☐ 11. Use your graph to determine the initial velocity (just before you dropped it), final velocity (just before it hit the ground), and time of fall (time from when it is dropped to when it hits the ground) for each different-sized object. Record the results in Table 1. � (9.1) (9.2)

Procedure – Similar Size but Different Mass

☐ 12. Next, you will drop the objects with similar size but different mass. Copy Table 2 into your notebook and then measure the mass of the three objects. Record the values in the table in your notebook.

Table 2: Determine the velocity and acceleration caused by the force of gravity on objects of different mass

Object	Mass (kg)	Initial Velocity (m/s)	Final Velocity (m/s)	Time of Fall (s)	Acceleration (m/s^2)
Large mass					
Medium mass					
Small mass					

RECORD ALL DATA IN YOUR NOTEBOOK.

☐ 13. You will use your data to determine the acceleration of each object, but before recording more data, predict (in your notebook) which object (large, medium, or small mass) will have the greatest acceleration. Explain your choice.

☐ 14. Hold the object with the greatest mass under the motion sensor so the bottom of the object is 40 cm below it and begin recording a run of velocity versus time data, in the same graph as the first three runs, just before you drop the object. �(6.2), (7.1.1)

☐ 15. Stop recording data after the object hits the no-bounce pad. � (6.2)

☐ 16. Repeat the same procedure for the medium and small mass objects.

☐ 17. Use your graph to determine the initial velocity (just before you dropped it), final velocity (just before it hit the ground), and time of fall (time from when it is dropped to when it hits the ground) for each object. Record the results into Table 2 in your notebook. � (9.1) (9.2)

Questions

***NOTE**: Record all work, including calculations and answers, into your notebook.*

1. If nobody was touching the object as it was falling in each trial, what was causing it to fall toward the ground?
2. After the object was dropped in each trial, did it change direction as it fell? Was it speeding up or slowing down? What evidence do you have to support your answers?
3. An object is accelerating when it is speeding up, slowing down, or changing direction. Based on your response to the previous question, was the object in each trial accelerating? Why or why not?
4. Acceleration describes the rate at which the velocity of an object changes. To calculate the acceleration of an object, you use the equation:

   $$\text{Acceleration} = \frac{\text{Final velocity} - \text{Initial velocity}}{\text{Time}}$$

   Use this equation to calculate the acceleration of each object in Table 1 and Table 2, and then enter the acceleration values into the last column of each table in your notebook.
5. Do the acceleration values support your predictions? Explain your answer.
6. Is it correct to say that falling objects accelerate the same no matter what size or mass the objects are? How does your data support or not support your answer?
7. Based on your answers to the previous question, do you think an apple and a bowling ball will hit the ground at the same time if they are dropped from the same height at the same time? Answer using complete sentences.
8. Complete the questions in the Challenge: Egg Drop handout for this activity.