5C Gravity and Falling Objects

How does gravity affect the motion of falling objects?

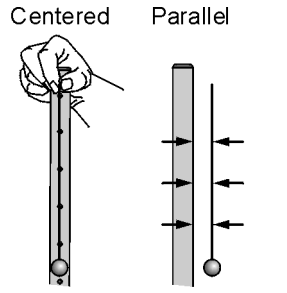
Gravity causes objects to accelerate as they fall. An object is in *free fall* if it is moving under the influence of only gravity. For example, when you drop a ball, it is in free fall from the time it leaves your hand until it hits the ground. In this investigation, you will compare the motion of objects with different masses that are in free fall.

Materials

- Data Collector and 2 photogates
- Physics stand
- Plastic ball and steel marbles
- Piece of string
- Tape

1 Setting up the experiment

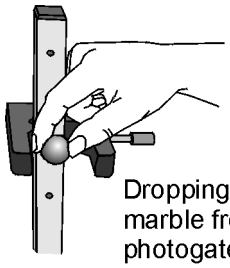
1. This investigation should be done with the physics stand on the floor and with the pole as perfectly vertical as you can make it. Tape the steel marble to a piece of string to make a plumb bob. Hold the string at the top of the physics stand and adjust the leveling feet until the string hangs down the center of the pole.
2. Attach photogate A near the top of the stand. The bottom of the "U" of the photogate should be against the pole.
3. Attach photogate B so it is 50 cm (10 holes) below photogate A.
4. Plug both photogates into the Data Collector.



When the pole is vertical, the string is centered and parallel

2 Collecting data

1. Examine the photogates and find the two small rectangular openings where the infrared light beam is emitted and detected. Hold the steel marble (without the string) so it is above the top photogate, centered just above the openings.
2. Carefully drop the marble without giving it a push. Allow it to fall to the bottom of the stand where one group member should catch it. The marble should fall straight through the center of the two photogates. This may take some practice!


Dropping the marble from photogate A

3. Record the time through photogate A (t_A), the time through photogate B (t_B), and the time from A to B (t_{AB}) in Table 1.
4. Repeat for a total of three trials with the steel marble.
5. Repeat with the plastic marble.

Table 1: Photogate data

Marble	t_A (s)	t_B (s)	t_{AB} (s)
steel			
steel			
steel			
plastic			
plastic			
plastic			

3 Calculating acceleration

1. Calculate the speed of the marble through each photogate. The distance a marble moves when passing through the photogate is its diameter, 0.019 meter.
2. Use the two speeds and the time A to B to calculate the acceleration for each trial.

Table 2: Speed and acceleration data

Marble	speed through A (m/s)	speed through B (m/s)	acceleration (m/s^2)
steel			
steel			
steel			
plastic			
plastic			
plastic			

4 Analyzing the data

a. Calculate the average acceleration for your three trials for the steel marble. Use the average from each group in your class to find the class average for the steel marble's acceleration.

b. Calculate your average and the class average for the plastic marble's acceleration.

c. How do the accelerations compare? Are they about the same, or are they very different?

d. Which marble has the greater weight, and is therefore pulled on by a stronger force of gravity?

e. Suppose you wanted to move the steel and plastic marbles across the floor with the same acceleration. Which would require more force to accelerate?

f. Use your answers from questions d and e to explain why the accelerations of the two marbles in free fall compared as they did.

g. Why was it important to drop the marbles straight through the center of the photogate beam?