

Free Fall Motion

An object that is free falling is only under the influence of gravity. In free-fall motion, we will neglect air resistance because we are assuming only the effects of gravity and nothing else. Gravity always causes objects to accelerate downwards at a rate of 9.8 m/s/s. So if an object is dropped from a given height, it will accelerate at a rate of 9.8 m/s². To accelerate at 9.8 m/s² means to change the velocity 9.8 m/s every second.

$$a = \frac{\Delta v}{t}$$

Therefore, with a change in velocity of 9.8 m/s every second you can expect a pattern similar to the one below:

Time (s)	Velocity
0	0
1	-9.8
2	-19.6
3	-29.4

*Note the negative values are due to the fact that the objects are following a downward trajectory.

Let's give it a try with the following lab: *Look Out Below!*

Materials:

- Find any 5 objects you choose. Try to choose objects of varying size and weight.
- Tape measure
- Stopwatch
- Sheet of paper or the data sheet below
- Calculator

Procedure:

1. Go to highest place that you can safely release your objects, start watch when release, stop when it hits the ground.
2. Place your objects in the order that you think they will fall, from the fastest to the slowest
3. Determine at what height you are dropping your objects from using your tape measure
4. Hold you first object in one hand and the stopwatch in the other hand; The moment you release the object, start the stopwatch. As soon as that object hits the ground, stop the

watch and record your answers on the chart below. Be sure to drop each object from the same height, the higher the better.

5. Repeat at least 3 times for each object so that you can take the average.

Trial #	Object	Time - sec	Velocity (Distance/time)

The terminal velocity is the fastest velocity at which an object can fall when in free-fall motion. Some objects reach their terminal velocity faster than others and will fall all the way to the ground at the same constant velocity.

To determine the velocity of each object, record the height at which you dropped each object:

Height (ft) = _____

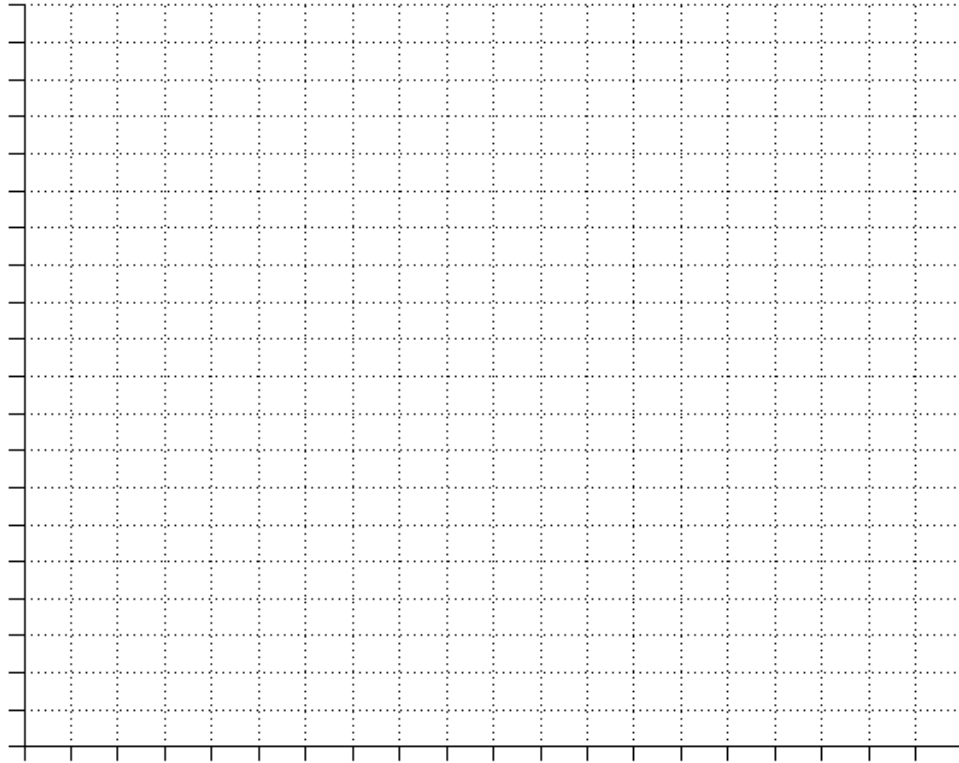
Velocity = distance/time

Example: 6 feet/3 seconds = 2 ft/sec.

6. Determine the velocity of each of the objects you dropped and record in the table above.

Graph:

Now that you have calculated the velocity of each object; graph the velocity vs the time in seconds for each object.



1. What similarities do you notice with each object?

2. Use the formula for velocity and determine how long it would take each of your objects to fall 75 feet.
 - a. Object 1: _____
 - b. Object 2: _____
 - c. Object 3: _____
 - d. Object 4: _____
 - e. Object 5: _____

Calculations:

Work the problems using the following equations and don't forget to show all steps of your work. Draw a box around your answers.

$$g = 9.8 \text{ m/s}^2$$

$$v_f = g t$$

$$y = \frac{1}{2} g t^2$$

1. I drop a penny from the top of the tower at the University of Texas and it takes 1.85 seconds to hit the ground. Calculate the velocity at impact in m/s.
2. If I drop a watermelon from the top of one of the tower dorms at UT, and it takes 3.34 seconds to hit the ground, calculate how tall the building is in meters and then convert into feet.
3. You are walking in Paris alongside the Eiffel Tower and suddenly a croissant smacks you on the head and knocks you to the ground. From your handy dandy tourist guidebook you find that the height of the Eiffel Tower is 300.5 m. If you neglect air resistance, calculate how many seconds the croissant dropped before it tagged you on the head.
4. During the latter part of your European vacation, you are hanging out at the beach at the gold coast of Spain. As you are laying in your chaise lounge soaking up the warm Mediterranean sun, a large glob of seagull poop hits you in the face. Since you got an "A" in physics you are able to estimate the impact velocity at 98.5 m/s. How much time was the poop in the air from?
5. If you were to throw a large log over the edge of the Grand Canyon and it took 5.65 seconds to hit the ground, calculate the velocity and calculate the distance the log fell in meters.

6. The John Hancock Center in Chicago is the tallest building in the United States in which there are residential apartments. The Hancock Center is 343 m tall. Suppose a resident accidentally causes a chunk of ice to fall from the roof. What would be the velocity of the ice as it hits the ground?

7. The Sears Tower in Chicago is 443 m tall. Suppose a book is dropped from the top of the building. What would be the book's velocity at a as it hits the ground?

Solutions:

Work the problems using the following equations and don't forget to show all steps of your work. Draw a box around your answers.

$$g = 9.8 \text{ m/s}^2$$

$$v_f = g t$$

$$y = \frac{1}{2} g t^2$$

1. I drop a penny from the top of the tower at the University of Texas and it takes 1.85 seconds to hit the ground. Calculate the velocity at impact in m/s.
18.13 m/s
2. If I drop a watermelon from the top of one of the tower dorms at UT, and it takes 3.34 seconds to hit the ground, calculate how tall the building is in meters and then convert into feet.
54.66 m or 177.65 ft
3. You are walking in Paris alongside the Eiffel Tower and suddenly a croissant smacks you on the head and knocks you to the ground. From your handy dandy tourist guidebook you find that the height of the Eiffel Tower is 300.5 m. If you neglect air resistance, calculate how many seconds the croissant dropped before it tagged you on the head.
7.83 s
4. During the latter part of your European vacation, you are hanging out at the beach at the gold coast of Spain. As you are laying in your chaise lounge soaking up the warm Mediterranean sun, a large glob of seagull poop hits you in the face. Since you got an "A" in physics you are able to estimate the impact velocity at 98.5 m/s. How much time was the poop in the air from?
10.05 s
5. If you were to throw a large log over the edge of the Grand Canyon and it took 5.65 seconds to hit the ground, calculate the velocity and calculate the distance the log fell in meters.
55.37 m/s & 156.42 m
6. The John Hancock Center in Chicago is the tallest building in the United States in which there are residential apartments. The Hancock Center is 343 m tall. Suppose a resident accidentally causes a chunk of ice to fall from the roof. What would be the velocity of the ice as it hits the ground?
82 m/s
7. The Sears Tower in Chicago is 443 m tall. Suppose a book is dropped from the top of the building. What would be the book's velocity at a as it hits the ground?
93.2 m/s