

Free Fall

Free fall is when an object is moving only under the influence of _____.

Ignoring air resistance, all objects fall to the earth with the _____ acceleration due to gravity (g)

$$g = \frac{m}{s^2}$$

_____ object thrown up, down, or dropped has this _____.

Use the one-dimensional _____.

You drop a coin from the top of a hundred story building (1000 m). If you ignore air resistance, how fast will it be falling right before it hits the ground?

How long does it take to hit the ground?

A baseball is hit straight up into the air. If the initial velocity was 20 m/s, how high will the ball go?

How long will it be until the catcher catches the ball at the same height it was hit?

How fast is it going when catcher catches it?

Practice Work

1. What is the acceleration of a rock thrown straight upward on the way up? At the top of its flight? On the way down?
2. An object that is thrown straight up falls back to Earth. This is one-dimensional motion. (a) When is its velocity zero? (b) Does its velocity change direction? (c) Does the acceleration due to gravity have the same sign on the way up as on the way down?
3. A penny is dropped from rest from the top of the Willis (Sears) Tower in Chicago. Considering that the height of the building is 427 m and ignoring air resistance, find the speed with which the penny strikes the ground. (Cutnell 2.37) **91.5 m/s**
4. At the beginning of a basketball game, a referee tosses the ball straight up with a speed of 4.6 m/s. A player cannot touch the ball until after it reaches its maximum height and begins to fall down. What is the minimum time that a player must wait before touching the ball? (Cutnell 2.42) **0.47 s**
5. A basketball referee tosses the ball straight up for the starting tipoff. At what velocity must a basketball player leave the ground to rise 1.25 m above the floor in an attempt to get the ball? (OpenStax 2.43) **4.95 m/s**
6. A diver springs upward with an initial speed of 1.8 m/s from a 3.0-m board. (a) Find the velocity with which he strikes the water. (b) What is the highest point he reaches above the water? (Cutnell 2.44) **-7.9 m/s, 3.2 m**
7. (a) Calculate and graph the displacement at times of 0.500, 1.00, 1.50, 2.00, and 2.50 s for a rock thrown straight down with an initial velocity of 14.0 m/s from the Verrazano Narrows Bridge in New York City. The roadway of this bridge is 70.0 m above the water. (b) Repeat, but now calculate and graph the velocity. (OpenStax 2.42) **61.8 m, 51.1 m, 38.0 m, 22.4 m, 4.4 m; -18.9 m/s, -23.8 m/s, -28.7 m/s, -33.6 m/s, -38.5 m/s**
8. A rescue helicopter is hovering over a person whose boat has sunk. One of the rescuers throws a life preserver straight down to the victim with an initial velocity of 1.40 m/s and observes that it takes 1.8 s to reach the water. (a) List the knowns in this problem. (b) How high above the water was the preserver released? *Note that the downdraft of the helicopter reduces the effects of air resistance on the falling life preserver, so that an acceleration equal to that of gravity is reasonable.* (OpenStax 2.44) **18 m**
9. A dolphin in an aquatic show jumps straight up out of the water at a velocity of 13.0 m/s. (a) List the knowns in this problem. (b) How high does his body rise above the water? To solve this part, first note that the final velocity is now a known and identify its value. Then identify the unknown, and discuss how you chose the appropriate equation to solve for it. After choosing the equation, show your steps in solving for the unknown, checking units, and discuss whether the answer is reasonable. (c) How long is the dolphin in the air? Neglect any effects due to his size or orientation. (OpenStax 2.45) **8.62 m, 2.65 s**
10. A very strong, but inept, shot putter puts the shot straight up vertically with an initial velocity of 11.0 m/s. How long does he have to get out of the way if the shot was released at a height of 2.20 m, and he is 1.80 m tall? (OpenStax 2.48) **2.28 s**
11. You throw a ball straight up with an initial velocity of 15.0 m/s. It passes a tree branch on the way up at a height of 7.00 m. How much additional time will pass before the ball passes the tree branch on the way back down? (OpenStax 2.49) **1.91 s**