

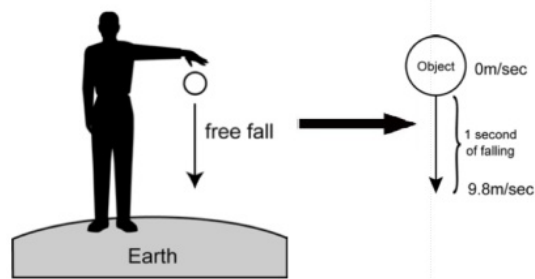
PHYSICS 2204
Unit 1: Kinematics
Worksheet 11 : Free Fall



STUDENT NAME: _____

The equations of kinematics for uniform acceleration also apply to the special case of an object that is accelerating near the earth's surface. Acceleration due to gravity is known to be 9.8 meters/second/second or 9.8 m/sec^2 and is represented by g . Three conditions must be met before we can use this acceleration:

- (1) the object must be in free fall
- (2) the object must have negligible air resistance
- (3) the object must be close to the surface of Earth.



There are a few unique features to solving freefall problems.

- a) acceleration is always constant at $g = -9.80 \text{ m/s}^2$ (the negative is very important)
- b) at the top of its flight, an object has $v = 0$. (since it must stop before starting to come down again)
- c) keeping your sign conventions for direction is very important...all velocity directed down must be negative, and all velocity directed up must be positive.

Example 1:

A cell phone is dropped from the edge of a building that is 441 m high. How long does it take for the object to hit the ground ?

Example 2:

A person throws a ball straight up from the ground. The ball leaves the person's hand at an initial velocity of 10.0 m/s up. The acceleration of the ball is 9.81 m/s^2 down. What is the velocity of the ball after 1.5s?

Example 3:

While standing on the edge of a 40 m cliff, Mr. Bishop throws a rock a rock vertically up at 31 m/s . How fast was it be moving when it hits the water?

Example 4:

A soccer ball is kicked vertically upward at 15 m/s from the ground.

- A) How long does it take to reach the maximum height?

- B) How long is the ball in the air (time of flight)?

Example 5:

A bottle is thrown straight upwards at 9.39 m/s. What is the maximum height reached by the bottle?

PART A: MULTIPLE CHOICE

Instructions: Shade the letter of the correct answer on the computer scorable answer sheet provided

- 1. Ignoring air resistance, an object falling toward the surface of the earth has a velocity that is:
 - (A) Acquired instantaneously
 - (B) Constant
 - (C) Decreasing
 - (D) Increasing

- 2. Ignoring air resistance, an object falling toward the surface of the earth has an acceleration that is
 - (A) Constant
 - (B) Decreasing
 - (C) Dependent on the weight of the object
 - (D) Increasing

- 3. Suppose an object is in free fall. Each second the object falls
 - (A) A larger distance than in the second before.
 - (B) The same distance as in the second before.
 - (C) With the same instantaneous speed.
 - (D) With the same average speed.

4. A ball tossed vertically upward rises, reaches its highest point, and then falls back to its starting point. During this time the acceleration of the ball is always
- (A) Directed downward
 - (B) Directed upward
 - (C) In the direction of motion
 - (D) Opposite its velocity

A ball is thrown straight up from point A, reaches a maximum height at point B, and then falls back to point C, as illustrated by the picture to the right. Use this for questions 5, 6, and 7.



5. Which of the following is true about the the ball's velocity and acceleration at point A?

(A) $v \downarrow \quad \uparrow a$	(B) $v \uparrow \quad \downarrow a$
(C) $v \downarrow \quad \downarrow a$	(D) $v \uparrow \quad \uparrow a$

6. Which of the following is true about the ball's velocity and acceleration the highest point B?

- (A) Its velocity and acceleration are both zero
- (B) Its velocity is down and non-zero constant and acceleration is zero
- (C) Its velocity is zero and acceleration is up and non-zero constant
- (D) Its velocity is zero and acceleration is down and non-zero constant

7. Which of the following is true about the the ball's velocity and acceleration at point C?

(A) $v \downarrow \quad \uparrow a$	(B) $v \uparrow \quad \downarrow a$
(C) $v \downarrow \quad \downarrow a$	(D) $v \uparrow \quad \uparrow a$

8. A heavy object and a light object are dropped at the same time from rest in a vacuum. The heavier object reaches the ground
- (A) At the same time as the lighter object.
 - (B) Later than the lighter object.
 - (C) Sooner than the lighter object.
 - (D) Unable to determine
9. An object is thrown downwards from the top of a tall bridge with an initial velocity of 12 m/s. What is the speed of the object when it has fallen 9.5 m?
- (A) 12 m/s
 - (B) 14 m/s
 - (C) 16 m/s
 - (D) 18 m/s
10. An object is thrown vertically upwards with an initial velocity of 6.8 m/s. How far does it travel in 0.60 s?
- (A) 1.1 m
 - (B) 2.3 m
 - (C) 4.1 m
 - (D) 5.8 m
11. A rock is thrown upwards from the second story window of an apartment building with an initial velocity of 6.80 m/s. What is the speed of the rock as it falls past the first story window located 3.25 m directly below the starting position?
- (A) 4.18 m/s
 - (B) 7.98 m/s
 - (C) 8.40 m/s
 - (D) 10.5 m/s
12. A ball is tossed straight up with an initial velocity of 5.0 m/s. What is the speed of the ball at its maximum height?
- (A) 0.0m/s
 - (B) 5.0 m/s
 - (C) 9.8 m/s
 - (D) 14.8 m/s
13. An iPod rests on a 1.2 m high table. How much time does it take to fall to the floor?
- (A) 0.24 s
 - (B) 0.49 s
 - (C) 1.9 s
 - (D) 3.7 s
14. Nicole throws a tennis ball vertically upward. The ball returns to the point of release after 3.5 s. What is the speed of the ball as it is released?
- (A) 0 m/s
 - (B) 14 m/s
 - (C) 17 m/s
 - (D) 34 m/s

15. A rock is dropped from a cliff. It takes 5.88 s for the rock to reach the bottom of the cliff. What is the height of the cliff?
- (A) 28.8 m
(B) 57.6 m
(C) 169 m
(D) 339 m
16. A cannonball is fired straight up at 50 m/s. Neglecting air resistance, when it returns to its starting point its speed
- (A) Is 50 m/s.
(B) Is more than 50 m/s.
(C) Is less than 50 m/s.
(D) Depends on how long it is in the air.

PART B: WRITTEN RESPONSE

1. A tourist drops a rock from rest from a guard rail overlooking a valley. What is the velocity of the rock at 4.0 s? What is the displacement of the rock at 4.0 s?
2. Suppose the tourist in question #1 instead threw the rock with an initial velocity of 8.0 m/s [down]. Determine the velocity and displacement of the rock at 4.0 s (Remember the v_i is down and must become a -8.0 m/s)
3. Suppose the tourist in question #1 instead threw the rock with an initial velocity of 8.0 m/s [up]. Determine the velocity and displacement of the rock at 4.0 s (Remember the v_i is up and must become a +8.0 m/s)
4. A college student wants to toss a textbook to his roommate who is leaning out of a window directly above him. He throws the book upwards with an initial velocity of 8.0 m/s. The roommate catches it while it is travelling at 3.0 m/s [up].
- a) How long was the book in the air?
b) How far vertically did the book travel?
c) Redo the problem, and have the roommate catch the book as it is travelling 3.0 m/s [down]. What is the time and displacement now? Do you notice anything?
5. A penny dropped into a wishing well reaches the bottom in 1.50 seconds. What was the velocity at impact?
6. A pitcher threw a baseball straight up at 35.8 meters per second. What was the ball's velocity after 2.50 seconds?
7. In a bizarre but harmless accident, Superman fell from the top of the Eiffel Tower. How fast was Superman traveling when he hit the ground 7.80 seconds after falling?
8. A stone tumbles into a mine shaft and strikes bottom after falling for 4.2 seconds. How deep is the mine shaft?

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9. A man is standing on the edge of a 20.0 m high cliff. He throws a rock vertically with an initial velocity of 10.0 m/s.

A) How high does the rock go?

B) How long does it take to reach its max height?

10. A boy threw a small bundle toward his girlfriend on a balcony 10.0 meters above him. The bundle stopped rising in 1.5 seconds. How high did the bundle travel? Was that high enough for her to catch it?

11. A rocket is launched vertically from the ground at a constant velocity of 41 m/s. After travelling at this velocity for 1.6 s, the rocket runs out of fuel. What is the maximum height the rocket reaches above the ground?

12. A water balloon was dropped from a high window and struck its target 1.1 seconds later. If the balloon left the person's hand at -5.0 m/sec, what was its velocity on impact?