**FREE FALL CONCEPTUAL QUESTIONS**

1. Two identical bowling balls A and B are each dropped from rest from the top of a tall tower as shown in the diagram below. Ball A is dropped 1.0 s before ball B is dropped, but both balls fall for some time before ball A strikes the ground. After ball B is dropped, but before ball A strikes the ground, which of the following is true?
2. The distance between the two balls decreases.
3. The velocity of ball A increases with respect to ball B.
4. The velocity of ball A decreases with respect to ball B.
5. The distance between the two balls remains constant.
6. The distance between the two balls increases.
7. Which of the following is true for an object falling freely in a vacuum near the surface of the earth?
8. Its velocity cannot exceed 10 m/s.
9. Its terminal velocity will be greater than when dropped in air.
10. Its velocity will increase but its acceleration will be zero.
11. Its acceleration will constantly increase.
12. Its acceleration will remain constant.
13. In the absence of air resistance, if an object were to fall freely near the surface of the moon
14. its velocity could never exceed 10 m/s
15. its acceleration would gradually decrease until the object moves with a terminal velocity
16. the acceleration is constant
17. it will fall with a constant speed
18. the acceleration is zero
19. A rocket near the surface of the Earth is accelerating vertically upward at 10 m/s2. The rocket releases an instrument package. Immediately after release the acceleration of the instrument package is
20. 20 m/s2 up
21. 10 m/s2 up
22. 0
23. 10 m/s2 down
24. 20 m/s2 down
25. An object is thrown upwards with a velocity of 30 m/s near the surface of the earth. After 2 s, what would be the direction of the displacement, velocity, and acceleration?

 Displacement Velocity Acceleration

1. up up up
2. up up down
3. up down down
4. up down up
5. down down down
6. At a particular point in time, a freely falling object is moving downward with a speed of 27 m/s. If it continues to fall, 1 s later the object would be moving downward with a speed closest to
7. 270 m/s
8. 37 m/s
9. 27 m/s
10. 17 m/s
11. 10 m/s
12. At a certain time, an object in free fall has velocity 4.0 m/s in the upward direction. What is the approximate velocity of the object one second later?
13. 14 m/s up
14. 10 m/s up
15. 4.0 m/s up
16. 6.0 m/s down
17. 10 m/s down
18. A freely falling object is found to be moving downward at 18 m/s. If it continues to fall, 2 s later the object would be moving with a speed of
19. 8.0 m/s
20. 10 m/s
21. 18 m/s
22. 38 m/s
23. 180 m/s

**FREE FALL KINEMATICS EQUATIONS**

1. An object is released from rest on a planet that has no atmosphere. The object falls freely for 3.0 m in the first second. What is the magnitude of the acceleration due to gravity on the planet?
2. 1.5 m/s2
3. 3.0 m/s2
4. 6.0 m/s2
5. 10.0 m/s2
6. 12.0 m/s2
7. An object is dropped from rest from the top of a 400 m cliff on Earth. What is the distance the object travels during the first 6 s of its fall?
8. 30 m
9. 60 m
10. 120 m
11. 180 m
12. 360 m
13. From the top of a tall building, a rock is thrown straight downward with a speed of 20 m/s. It strikes the ground 3.0 s later. Approximately how tall is the building?
14. 45 m
15. 60 m
16. 90 m
17. 105 m
18. 120 m
19. A ball is thrown off a high cliff with no horizontal velocity. It lands 6.0 s later with a speed of 40 m/s. What was the initial velocity of the ball?
20. 100 m/s up
21. 20 m/s up
22. 0
23. 20 m/s down
24. 100 m/s down
25. A ball that is dropped from the top of a building strikes the ground with a speed of 30 m/s. The height of the building is approximately
26. 15 m
27. 30 m
28. 45 m
29. 75 m
30. 90 m
31. A pebble is dropped from a high vertical cliff. The collision of the pebble with the ground below is seen 1.5 s after the pebble is dropped. With what speed did the pebble hit the ground?
32. 10 m/s
33. 15 m/s
34. 48.6 m/s
35. 100.4 m/s
36. 343 m/s
37. Three students are arguing about the height of a parking garage. One student suggested that to determine the height of the garage, they simply had to drop tennis balls from the top and time the fall of the tennis balls. If the time for the ball to fall was 1.4 s, approximately how tall is the parking garage?
38. 4.9 m
39. 7.0 m
40. 9.8 m
41. 13.8 m
42. 19.6 m
43. A person standing on the edge of a fire escape simultaneously launches two apples, one straight up with a speed of 7 m/s and the other straight down at the same speed. How far apart are the two apples 2 s after they are thrown, assuming that neither has hit the ground?
44. 14 m
45. 20 m
46. 28 m
47. 34 m
48. 56 m
49. A model rocket, launched from rest on the ground, accelerates upward at 50 m/s2 for 2.0 s before its engine burns out, leaving it to coast upward. To what approximate maximum height does the rocket rise?
50. 100 m
51. 500 m
52. 600 m
53. 1000 m
54. 1200 m

**FREE FALL KINEMATICS RELATIONS**

1. An object is released from rest and falls a distance *h* during the first second of time. How far will it fall during the next second of time?
2. *h*
3. 2*h*
4. 3*h*
5. 4*h*
6. *h*2
7. A baseball is thrown vertically into the air with a velocity *v*, and reaches a maximum height *h*. At what height was the baseball moving with one-half its original velocity?
8. 0.25*h*
9. 0.33*h*
10. 0.50*h*
11. 0.67*h*
12. 0.75*h*
13. Two objects are released from rest at the same time. Object 1 falls freely for 5.0 s, and object 2 falls freely for 10.0 s. Compared to object 1, object 2 falls
14. twice as far
15. three times as far
16. four times as far
17. eight times as far
18. sixteen times as far
19. If a ball is thrown directly upwards with twice the initial speed of another, how much higher will it be at its apex?
20. 8 times
21. 4 times
22.  times
23. 2 times
24.  times

**FREE FALL GRAPHS**

A perfectly ideal rubber ball is dropped from a height of 2 m. It hits the floor and rebounds to its original height.

1. Which of the following graphs best represents the distance above the floor vs. time for the rubber ball?
2. (B) (C) (D) (E)



1. Which of the following graphs best represents acceleration vs. time for the rubber ball?
2. (B) (C) (D) (E)



**AIR RESISTANCE**

1. A whiffle ball is tossed straight upward. Which of the following statements are true?

I. The ball’s speed is zero at the highest point.

II. The ball’s acceleration is zero at the highest point.

III. The time it takes the ball to go up is equal to the time it takes the ball to come down.

1. I only
2. II only
3. I & II only
4. I & III only
5. I, II, & III
6. A large beach ball is dropped from the ceiling of a school gymnasium to the floor about 10 m below. Which of the following graphs would best represent its velocity as a function of time? Do not neglect air resistance.
7. (B) (C) (D) (E)



1. When a falling object reaches terminal velocity, it
2. is no longer subject to the resistance of air
3. moves downward with a constant velocity
4. has an acceleration of approximately 10 m/s2
5. has no downward velocity
6. has an upward acceleration