

Free-Fall Problems in 1-dimension
Honors Physics

Name _____

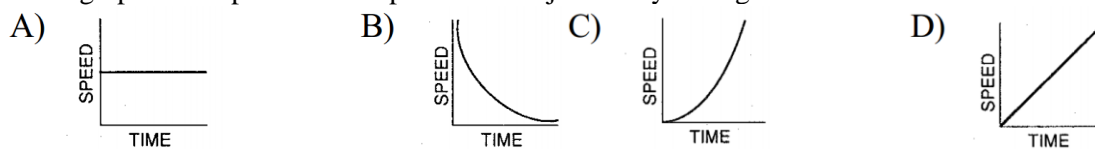
Good techniques and habits for solving problems

- Draw a picture to help you visualize what's going on.
- Label the picture with given information (numbers and/or words).
- Write down what you know with variables (e.g., $d = 5\text{ m}$ $t = 2\text{ s}$)
- Write down what you are looking for with a variable (e.g., $a = ???$)
- Choose an appropriate formula that will allow you to solve for the unknown. Write it down.
- Mathematically solve the problem (either plug in numbers and solve OR rearrange algebraically and then plug in)

Free-Fall Problems

- Free-fall is when an object is only acted on by gravity. The acceleration of the object is -9.8 m/s^2 for an object near the surface of the Earth. The negative sign simply indicates this acceleration is always downward.
- If an object is dropped, then its initial velocity is 0 m/s .
- If an object is projected upwards with an initial velocity, then its velocity will decrease on the way up until its velocity is 0 m/s at the top of its path.
- For all of these problems, disregard air resistance.

1. An object is dropped from rest and falls freely 20. meters to Earth. When is the speed of the object 9.8 meters per second? (this is a multiple choice concept question)
 - a) during the entire first second of its fall
 - b) at the end of its first second of fall
 - c) during its entire time of fall
 - d) after it has fallen 9.8 meters
2. You drop a stone down off a bridge. You are able to count to 4.0 seconds when it finally hits the water. How high is the bridge?
3. Niagara Falls is 51 meters high. If you dropped a ball off the ledge, how much time would it take it to hit the water?
4. If you dropped your cell phone from a height of 1.20 m above the ground, with what speed would it strike the ground?
5. An astronaut drops a rock on planet X from a height of 0.72 m above the ground. If it takes 0.63 seconds for the rock to strike the ground, what is the acceleration on planet X?
6. Which graph best represents the speed of an object freely falling downward near the Earth's surface?



7. An 8.0 kg bowling ball is dropped from a height of 20.0 meters above the ground. Which graph below best represents the relationship between magnitude of the acceleration (a) and time (t) for the object?
 - A) B) C) D)
8. A ball is thrown vertically upward with an initial velocity of 29.4 meters per second. What is the maximum height reached by the ball?
9. You fire a paintball from a paintball gun straight up into the air at 25.0 m/s.
 - a) What is the instantaneous velocity at the top of its flight? (*no calculation required*)
 - b) What is the acceleration at the top of its flight? (*no calculation required*)
 - c) What is the maximum height the paintball will reach?
10. A Nerf gun is shot straight up from the ground with an initial velocity of 14.0 m/s. What is the total time the projectile is in the air?

2) 78.4 m	3) 3.23 s	4) 4.85 m/s	5) -3.6 m/s^2	8) 44.1 m	9) c) 31.9 m	10) 2.86 s
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11. What are the conditions for a freely falling object?
12. What is the gain in velocity per second for a freely falling object?
13. The acceleration of free fall is about 10 m/s^2 . Why is the second squared?
14. What is the velocity acquired by a freely falling object 5.0 seconds after being dropped from a rest position? What is it after 6.0 seconds?
15. What is the displacement of a freely falling object 5.00 seconds after being dropped from a rest position? What is it after 6.00 seconds?
16. If a friend claims that in a standing jump he can remain off the ground for 1.0 second then how high can he jump? For 2.0 seconds? Are either of these claims likely to be true?
17. Suppose that a freely falling object were somehow equipped with a speedometer. By how much would its speed reading increase with each second of fall?
18. Suppose that the same freely falling object were also equipped with an odometer. Would the readings of distance fallen indicate equal or different falling distances for successive seconds?
19. For a freely falling object dropped from rest, what is the acceleration at the end of the 5th second of fall? The 10th second? Defend your answer.
20. When a ball player throws a ball straight up, by how much does the speed of the ball decrease each second while ascending? By how much does it increase while descending? How much time is required for rising as compared to falling?
21. A small object is dropped (a) What is its velocity after it falls freely for 4.80 s? (b) What is its displacement from the initial position?
22. A pitcher throws a baseball straight up, with an initial speed of 24.5 m/s. (a) How long does it take to reach the highest point? (b) How high does the ball rise above its release point? (c) How much total time will it take for the ball to return to its release point?
23. Someone standing at the edge of a cliff throws a ball nearly straight up at 29.4 m/s past the edge. (a) How long (time) will it take for the ball to reach the top of its flight? (b) How high will the ball travel? (c) If the cliff is 90 m high, how much total time (from when it is initially thrown) will it take for the ball to reach the ground below?

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|-----------------------------------|------------------------|------------------------------|----------------------------------|-------------|
| 12) 9.8 m/s | 14) -49 m/s; -58.8 m/s | 15) -122.5 m; -176.4 m | 16) 1.23 m; 4.9 m | 17) 9.8 m/s |
| 19) -9.8 m/s ² | 20) 9.8 m/s; same | 21) (a) -47 m/s (b) -112.9 m | 22) (a) 2.5 s (b) 30.6 m (c) 5 s | |
| 23) (a) 3 s (b) 44.1 m (c) 8.23 s | | | | |