

1.E: Kinematics (Exercise)

Conceptual Questions

2.1: Displacement

1. Give an example in which there are clear distinctions among distance traveled, displacement, and magnitude of displacement. Specifically identify each quantity in your example.
2. Under what circumstances does distance traveled equal magnitude of displacement? What is the only case in which magnitude of displacement and displacement are exactly the same?
3. Bacteria move back and forth by using their flagella (structures that look like little tails). Speeds of up to $50 \mu\text{m/s}$ ($50 \times 10^{-6} \text{ m/s}$) have been observed. The total distance traveled by a bacterium is large for its size, while its displacement is small. Why is this?

2.2: Vectors, Scalars, and Coordinate Systems

4. A student writes, “A bird that is diving for prey has a speed of -10 m/s .” What is wrong with the student’s statement? What has the student actually described? Explain.
5. What is the speed of the bird in [Exercise 2.2.4](#)?
6. Acceleration is the change in velocity over time. Given this information, is acceleration a vector or a scalar quantity? Explain.
7. A weather forecast states that the temperature is predicted to be -5°C the following day. Is this temperature a vector or a scalar quantity? Explain.

2.3: Time, Velocity, and Speed

8. Give an example (but not one from the text) of a device used to measure time and identify what change in that device indicates a change in time.
9. There is a distinction between average speed and the magnitude of average velocity. Give an example that illustrates the difference between these two quantities.
10. Does a car’s odometer measure position or displacement? Does its speedometer measure speed or velocity?
11. If you divide the total distance traveled on a car trip (as determined by the odometer) by the time for the trip, are you calculating the average speed or the magnitude of the average velocity? Under what circumstances are these two quantities the same?
12. How are instantaneous velocity and instantaneous speed related to one another? How do they differ?

2.4: Acceleration

13. Is it possible for speed to be constant while acceleration is not zero? Give an example of such a situation.
14. Is it possible for velocity to be constant while acceleration is not zero? Explain.
15. Give an example in which velocity is zero yet acceleration is not.
16. If a subway train is moving to the left (has a negative velocity) and then comes to a stop, what is the direction of its acceleration? Is the acceleration positive or negative?
17. Plus and minus signs are used in one-dimensional motion to indicate direction. What is the sign of an acceleration that reduces the magnitude of a negative velocity? Of a positive velocity?

2.5: Motion Equations for Constant Acceleration in One Dimension

18. In a constant-acceleration motion, how does the position change? How does the velocity change?
19. Describe the relationship between the position and the velocity in a constant-acceleration motion.
20. Describe the relationship between the velocity and the acceleration in a constant-acceleration motion.

21. In a constant-acceleration motion starting from rest, how does the distance traveled change with the duration of motion? If the motion continues for double the time (total), how much does the distance traveled increase (total)?

2.6: Falling Objects

22. What is the acceleration of a rock thrown straight upward on the way up? At the top of its flight? On the way down?
23. 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?
24. Suppose you throw a rock nearly straight up at a coconut in a palm tree, and the rock misses on the way up but hits the coconut on the way down. Neglecting air resistance, how does the speed of the rock when it hits the coconut on the way down compare with what it would have been if it had hit the coconut on the way up? Is it more likely to dislodge the coconut on the way up or down? Explain.
25. If an object is thrown straight up and air resistance is negligible, then its speed when it returns to the starting point is the same as when it was released. If air resistance were not negligible, how would its speed upon return compare with its initial speed? How would the maximum height to which it rises be affected?
26. The severity of a fall depends on your speed when you strike the ground. All factors but the acceleration due to gravity being the same, how many times higher could a safe fall on the Moon be than on Earth (gravitational acceleration on the Moon is about $1/6$ that of the Earth)?
27. How many times higher could an astronaut jump on the Moon than on Earth if his takeoff speed is the same in both locations (gravitational acceleration on the Moon is about $1/6$ of g on Earth)?

2.7: Projectile Motion

28. Answer the following questions for projectile motion on level ground assuming negligible air resistance (the initial angle being neither 0° nor 90°): (a) Is the velocity ever zero? (b) When is the velocity a minimum? A maximum? (c) Can the velocity ever be the same as the initial velocity at a time other than at $t = 0$? (d) Can the speed ever be the same as the initial speed at a time other than at $t = 0$?
29. Answer the following questions for projectile motion on level ground assuming negligible air resistance (the initial angle being neither 0° nor 90°): (a) Is the acceleration ever zero? (b) Is the acceleration ever in the same direction as a component of velocity? (c) Is the acceleration ever opposite in direction to a component of velocity?
30. For a fixed initial speed, the range of a projectile is determined by the angle at which it is fired. For all but the maximum, there are two angles that give the same range. Considering factors that might affect the ability of an archer to hit a target, such as wind, explain why the smaller angle (closer to the horizontal) is preferable. When would it be necessary for the archer to use the larger angle? Why does the punter in a football game use the higher trajectory?
31. During a lecture demonstration, a professor places two coins on the edge of a table. She then flicks one of the coins horizontally off the table, simultaneously nudging the other over the edge. Describe the subsequent motion of the two coins, in particular discussing whether they hit the floor at the same time.

2.8: Centripetal Acceleration

32. Give examples of centripetal acceleration from everyday experience.
33. A satellite in a circular orbit around the Earth is undergoing a centripetal acceleration. Explain how this description is consistent with the description that the satellite is in free-fall.
34. Can centripetal acceleration change the speed of circular motion? Explain.

Problems & Exercises

2.1: Displacement

- 35.

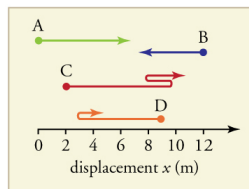


Figure 1.E. 1

Find the following for path A in Figure 1.E. 1: (a) The distance traveled. (b) The magnitude of the displacement from start to finish. (c) The displacement from start to finish.

Answer

(a) 7 m

(b) 7 m

(c) +7 m

36. Find the following for path B in Figure 1.E. 1: (a) The distance traveled. (b) The magnitude of the displacement from start to finish. (c) The displacement from start to finish.

37. Find the following for path C in Figure 1.E. 1: (a) The distance traveled. (b) The magnitude of the displacement from start to finish. (c) The displacement from start to finish.

Answer

(a) 13 m

(b) 9 m

(c) +9 m

38. Find the following for path D in Figure 1.E. 1: (a) The distance traveled. (b) The magnitude of the displacement from start to finish. (c) The displacement from start to finish.

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