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Phys 20.01 Group homework 1

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2025 W35

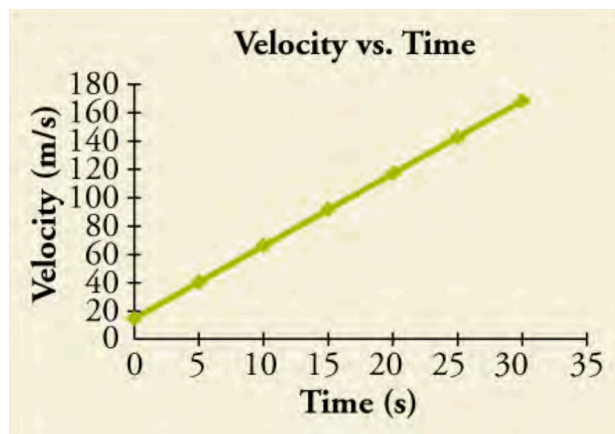
Instructions: For comprehension and conceptual questions, choose the best answer. For problem-solving questions, choose the best answer and show your solution and reasoning. Comprehension is 1 pt each, conceptual is 2 pt each, and problem-solving is 3 pt each.

1. Comprehension

- In the definition of velocity, what physical quantity is changing over time?
 - speed
 - distance
 - magnitude of displacement
 - position vector
- What does your car's odometer record?
 - displacement
 - distance
 - both distance and displacement
 - the sum of distance and displacement
- How can you use the definition of acceleration to explain the units in which acceleration is measured?
 - Acceleration is the rate of change of velocity. Therefore, its unit is m/s^2
 - Acceleration is the rate of change of displacement. Therefore, its unit is m/s
 - Acceleration is the rate of change of velocity. Therefore, its unit is m^2/s
 - Acceleration is the rate of change of displacement. Therefore, its unit is m^2/s
- What are the SI units of acceleration?
 - m^2/s
 - cm^2/s
 - m/s^2
 - cm/s^2
- Which of the following expressions correctly illustrates the SI units of each one of the variables in the formula?

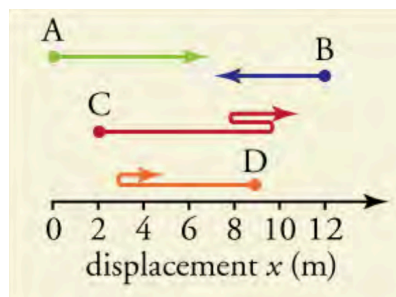
$$m\Delta v = F\Delta t$$
 - $\text{lb} \times \text{mph} = \text{ft} \times \text{lb} \times \text{s}$
 - $\text{lb} \times \text{km} = \text{N} \times \text{s}$
 - $\text{kg} \times \text{m/s} = \text{N} \times \text{s}$
 - $\text{g} \times \text{m/s} = \text{N} \times \text{s}$
- If a toy magnet is able to generate one centitesla, how many teslas would 10^8 magnets be able to generate?
 - 1 kT
 - 1 MT
 - 1 GT
 - 1 TT
- Which of the following best describes the relationship between instantaneous velocity and instantaneous speed?
 - Both instantaneous speed and instantaneous velocity are the same, even when there is a change in direction
 - Instantaneous speed and instantaneous velocity cannot be the same even if there is no change in direction of motion
 - Magnitude of instantaneous velocity is equal to instantaneous speed
 - Magnitude of instantaneous velocity is always greater than instantaneous speed
- A student calculated the final velocity of a train that decelerated from 30.5 m/s and got an answer of -43.34 m/s. Which of the following might indicate that he made a mistake in his calculation?
 - The sign of the final velocity is wrong
 - The magnitude of the answer is too small
 - There are too few significant digits in the answer
 - The units in the initial velocity are incorrect
- Why should you specify a reference frame when describing motion?
 - a description of motion depends on the reference frame
 - motion appears the same in all reference frames
 - reference frames affect the motion of an object
 - you can see motion better from certain reference frames
- Which of the following is true for the displacement of an object?
 - It is always equal to the distance the object moved between its initial and final positions
 - It is both the straight line distance the object moved as well as the direction of its motion
 - It is the direction the object moved between its initial and final positions
 - It is the straight line distance the object moved between its initial and final positions
- Which of the following statements explains why a racecar going around a curve is accelerating, even if the speed is constant?
 - The car is accelerating because the magnitude as well as the direction of velocity is changing
 - The car is accelerating because the magnitude of velocity is changing
 - The car is accelerating because the direction of velocity is changing

- d. The car is accelerating because neither the magnitude nor the direction of velocity is changing
12. A car is moving on a straight road at a constant speed in a single direction. Which of the following statements is true?
- Average velocity is zero
 - The magnitude of average velocity is equal to the average speed
 - The magnitude of average velocity is greater than the average speed
 - The magnitude of average velocity is less than the average speed
13. What is the slope of a straight line graph of position vs. time?
- Velocity
 - Displacement
 - Distance
 - Acceleration
14. What can you infer from the statement "Velocity of an object is zero?"
- Object is in linear motion with constant velocity
 - Object is moving at a constant speed
 - Object is either at rest or it returns to the initial point
 - Object is moving in a straight line without changing its direction
15. Which variable represents displacement?
- Δx
 - x
 - Δv
 - t
16. True or False: The vector for a negative acceleration points in the opposite direction when compared to the vector for a positive acceleration.
- True
 - False
17. Which of the following quantity is not a vector?
- velocity
 - force
 - displacement
 - distance
18. If a plot of displacement versus time is linear, what can be said about the acceleration?
- Acceleration is 0
 - Acceleration is a non-zero constant
 - Acceleration is positive
 - Acceleration is negative
19. In which example would you be correct in describing an object in motion while your friend would also be correct in describing that same object as being at rest?
- You are driving a car toward the east and your friend drives past you in the opposite direction with the same speed. In your frame of reference, you will be in motion. In your friend's frame of reference, you will be at rest
 - You are driving a car toward the east and your friend is standing at the bus stop. In your frame of reference, you will be in motion. In your friend's frame of reference, you will be at rest
 - You are driving a car toward the east and your friend is standing at the bus stop. In your frame of reference, your friend will be moving toward the west. In your friend's frame of reference, he will be at rest
 - You are driving a car toward the east and your friend is standing at the bus stop. In your frame of reference, your friend will be moving toward the east. In your friend's frame of reference, he will be at rest
20. True or False: The figure shows a velocity vs. time graph for a jet car. If you take the slope at any point on the graph, the jet car's acceleration will be 5.0 m/s^2 .
- True
 - False



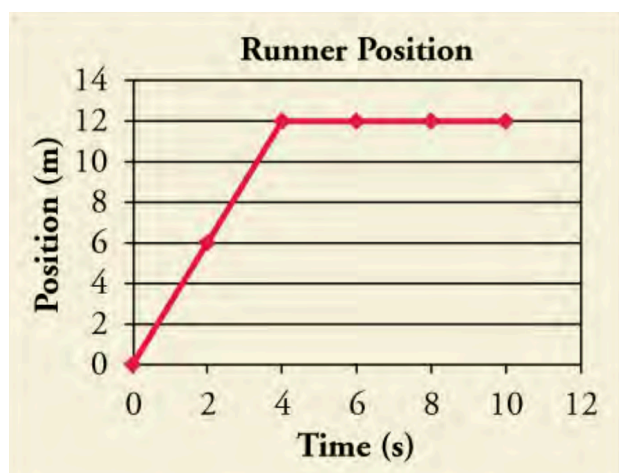
2. Conceptual

1. Find the distance traveled from the starting point for each path. Which path has the maximum distance?
- A
 - B
 - C
 - D

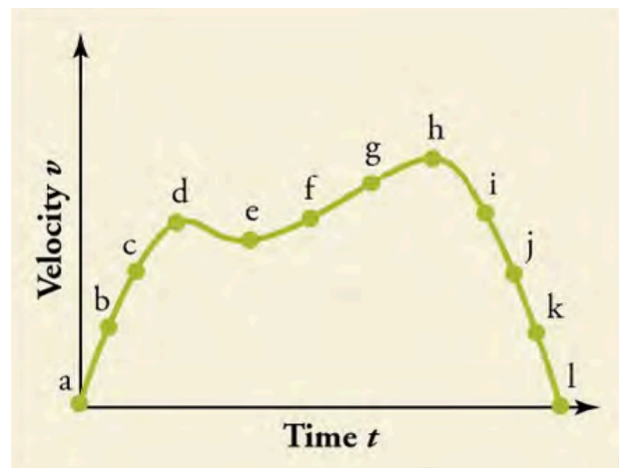


2. If a car decelerates from 20 m/s to 15 m/s in 5 s , what is Δv ?
- -5 m/s
 - -1 m/s
 - 1 m/s
 - 5 m/s

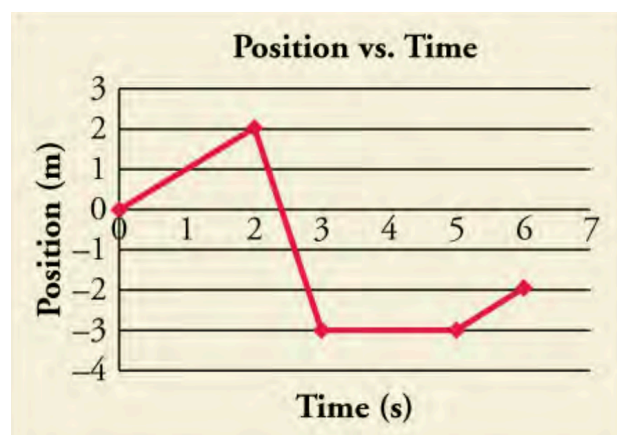
3. If a velocity increases from 0 to 20 m/s in 10 s, what is the average acceleration?
 - a. 0.5 m/s^2
 - b. 2 m/s^2
 - c. 10 m/s^2
 - d. 30 m/s^2
4. If a biker rides west for 50 miles from his starting position, then turns and bikes back east 80 miles. What is his net displacement?
 - a. 130 miles
 - b. 30 miles east
 - c. 30 miles west
 - d. Cannot be determined from the information given
5. Four bicyclists travel different distances and times along a straight path. Which cyclist traveled with the greatest average speed?
 - a. Cyclist 1 travels 95 m in 27 s
 - b. Cyclist 2 travels 87 m in 22 s
 - c. Cyclist 3 travels 106 m in 26 s
 - d. Cyclist 4 travels 108 m in 24 s
6. When is a plot of velocity versus time a straight line and when is it a curved line?
 - a. It is a straight line when acceleration is changing and is a curved line when acceleration is constant
 - b. It is a straight line when acceleration is constant and is a curved line when acceleration is changing
 - c. It is a straight line when velocity is constant and is a curved line when velocity is changing
 - d. It is a straight line when velocity is changing and is a curved line when velocity is constant
7. Use the graph to describe what the runner's motion looks like. How are average velocity for only the first four seconds and instantaneous velocity related? What is the runner's net displacement over the time shown?
 - a. The net displacement is 12 m and average velocity is equal to the instantaneous velocity
 - b. The net displacement is 12 m and average velocity is two times the instantaneous velocity
 - c. The net displacement is $10 + 12 = 22 \text{ m}$ and average velocity is equal to the instantaneous velocity
 - d. The net displacement is $10 + 12 = 22 \text{ m}$ and average velocity is two times the instantaneous velocity
8. 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?
 - a. 0.574 s
 - b. 0.956 s
 - c. 1.53 s
 - d. 1.91 s
9. A position vs. time graph of a frog swimming across a pond has two distinct straight-line sections. The slope of the first section is 1 m/s. The slope of the second section is 0 m/s. If each section lasts 1 s, then what is the frog's total average velocity?
 - a. 0 m/s
 - b. 2 m/s
 - c. 0.5 m/s
 - d. 1 m/s
10. A man walks three blocks (30 m) east, and then another five blocks (50 m) north to the drugstore (point B). What is the magnitude of his final displacement from his original location (point A)?
 - a. 20 m
 - b. 40 m
 - c. 60 m
 - d. 3400 m
11. A submarine sends out a sonar signal (sound wave) in a direction directly downward. It takes 2.3 s for the sound wave to travel from the submarine to the ocean bottom, and back to the submarine. How high up from the ocean floor is the submarine? The speed of sound in water is 1489 m/s.
 - a. 1700 m
 - b. 3000 m
 - c. 5000 m
 - d. cannot be determined
12. A car is traveling at 40 km/hr and the driver puts on the brakes, bringing the car to rest in a time of 6 s. What's the magnitude of the average acceleration of the car in units of km/hr^2 ?
 - a. 240 km/hr^2
 - b. 12000 km/hr^2
 - c. 24000 km/hr^2
 - d. 30000 km/hr^2
13. If an object is released 19.6 m above the ground, how long does it take the object to reach the ground?
 - a. 1 s
 - b. 2 s
 - c. 4 s
 - d. 10 s
14. At a place where g is 9.8 m/s^2 , an object is thrown vertically downward with a speed of 10 m/s while a different object is thrown vertically upward with a speed of 20 m/s. Which object undergoes a greater change in speed in a time of 2 s?



- a. The first object because the speed vector points in the same direction as the acceleration due to gravity
 b. The second object because it has a higher velocity
 c. Both objects undergo the same change in speed
 d. Cannot be determined from the information given
15. Billy drops a ball from a height of 1 m. The ball bounces back to a height of 0.8 m, then bounces again to a height of 0.5 m, and bounces once more to a height of 0.2 m. Up is the positive direction. What are the total displacement of the ball and the total distance traveled by the ball?
- a. The displacement is equal to -4 m and the distance is equal to 4 m
 b. The displacement is equal to 4 m and the distance is equal to 1 m
 c. The displacement is equal to 1 m and the distance is equal to 4 m
 d. The displacement is equal to -1 m and the distance is equal to 4 m
16. **Bonus.** A base jumper runs off a cliff, with a speed of 3 m/s. What is its overall velocity after 5 s?
- a. 3 m/s
 b. -5 m/s
 c. 5 m/s
 d. 10 m/s
17. You sit in a car that is moving at an average speed of 86.4 km/h. During the 3.3 s that you glance out the window, how far has the car traveled?
- a. 7.27 m
 b. 79 m
 c. 285 km
 d. 1026 m
18. A car accelerates from rest at a stop sign at a rate of 3.0 m/s^2 to a speed of 21.0 m/s, and then immediately begins to decelerate to a stop at the next stop sign at a rate of 4.0 m/s^2 . How long did it take the car to travel from the first stop sign to the second stop sign?
- a. 1.7 s
 b. 5.3 s
 c. 7.0 s
 d. 12 s
19. Consider the motion of the object whose velocity is charted in the graph. During which points is the object slowing down and speeding up?



20. What is the average velocity for the whole time period shown in the graph?
- a. $-\frac{1}{3}$ m/s
 b. $-\frac{3}{4}$ m/s
 c. $\frac{1}{3}$ m/s
 d. $\frac{3}{4}$ m/s



3. Problem solving

1. **Airbag injuries.** During an auto accident, the vehicle's airbags deploy and slow down the passengers more gently than if they had hit the windshield or steering wheel. According to safety standards, airbags produce a maximum acceleration of $60g$ that lasts for only 36 ms (or less). How far (in meters) does a person travel in coming to a complete stop in 36 ms at a constant acceleration of $60g$?
2. A typical male sprinter can maintain his maximum acceleration for 2.0 s, and his maximum speed is 10 m/s. After he reaches this maximum speed, his acceleration becomes zero, and then he runs at constant speed. Assume that his acceleration is constant during the first 2.0 s of the race, that he starts from rest, and that he runs in a straight line.
- a. How far has the sprinter run when he reaches his maximum speed?
 b. What is the magnitude of his average velocity for a race of these lengths: 50.0 m, 100.0 m, 200.0 m?