Chapter 5 Drill

The answers and explanations can be found in Chapter 17.

Section I: Multiple Choice

1. An object that's moving with constant speed travels once around a circular path. Which of the following is/are true concerning this motion?

   I. The displacement is zero.
   II. The average speed is zero.
   III. The acceleration is zero.

   (A) I only
   (B) I and II only
   (C) I and III only
   (D) III only
   (E) II and III only

2. At time $t = t_1$, an object's velocity is given by the vector $\mathbf{v}_1$ shown below:

   A short time later, at $t = t_2$, the object's velocity is the vector $\mathbf{v}_2$:

   If $v_2 = v_1$, which one of the following vectors best illustrates the object's average acceleration between $t = t_1$ and $t = t_2$?

   (A) 
   (B) 
   (C) 
   (D) 
   (E) 

3. A rock is thrown off a 30 m cliff at a 45° angle above the horizontal. Which is the following is true regarding the acceleration of the rock?

   (A) The acceleration will be of magnitude g and have both horizontal and vertical components.
   (B) At the peak of the rock's path, the magnitude of acceleration will be half of what it was when the rock was initially thrown.
   (C) The acceleration will be of magnitude g and in a downward direction.
   (D) The acceleration will be downward during the rock's ascent and upward during the rock's descent.
   (E) The acceleration will increase throughout the rock's flight.

4. A baseball is thrown straight upward. What is the ball's acceleration at its highest point?

   (A) 0
   (B) $\frac{1}{2}g$, downward
   (C) g, downward
   (D) $\frac{1}{2}g$, upward
   (E) g, upward

5. An object's location, in meters, after t seconds have passed is given by the equation

   $$\mathbf{x}(t) = -3t^3 + t^2 + 6t$$

   What is the maximum velocity of the object?

   (A) 0.11 m/s
   (B) 2.73 m/s
   (C) 6.11 m/s
   (D) 7.39 m/s
   (E) 9.81 m/s

6. A rock is dropped off a cliff and strikes the ground with an impact speed of 30 m/s. How high was the cliff?

   (A) 15 m
   (B) 20 m
   (C) 30 m
   (D) 45 m
   (E) 60 m

7. A stone is thrown horizontally with an initial speed of 10 m/s from a bridge. If air resistance could be ignored, how long would it take the stone to strike the water 80 m below the bridge?

   (A) 1 s
   (B) 2 s
   (C) 4 s
   (D) 6 s
   (E) 8 s

8. A soccer ball, at rest on the ground, is kicked with an initial velocity of 10 m/s at a launch angle of 30°. Calculate its total flight time, assuming that air resistance is negligible.

   (A) 0.5 s
   (B) 1 s
   (C) 1.7 s
   (D) 2 s
   (E) 4 s

9. A stone is thrown horizontally with an initial speed of 30 m/s from a bridge. Find the stone's total speed when it enters the water 4 seconds later. (Ignore air resistance.)

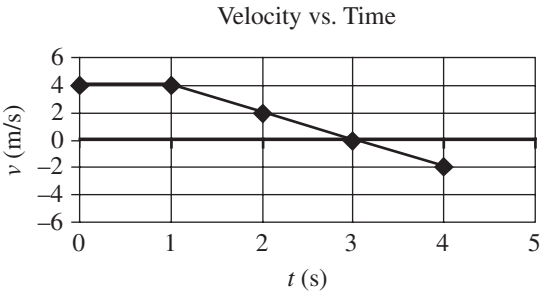
   (A) 30 m/s
   (B) 40 m/s
   (C) 50 m/s
   (D) 60 m/s
   (E) 70 m/s

10. Which one of the following statements is true concerning the motion of an ideal projectile launched at an angle of 45° to the horizontal?

    (A) The acceleration vector points opposite to the velocity vector on the way up and in the same direction as the velocity vector on the way down.
    (B) The speed at the top of the trajectory is zero.
    (C) The object's total speed remains constant during the entire flight.
    (D) The horizontal speed decreases on the way up and increases on the way down.
    (E) The vertical speed decreases on the way up and increases on the way down.

11. An object is going to be launched from the ground with an initial velocity of **v**. It starts a distance d away from a wall of height h. Assume that the wall is close enough that any angle $\theta < 45$ would not make it over the wall. Which of the following equations could be solved to find the angle θ that would maximize the horizontal distance the object travels while still ensuring it passes over the wall?

    (A) $h = d\tan\theta - \frac{1}{2}\left(\frac{gd^2}{v^2\cos^2\theta}\right)$
    (B) $h = d^2\cos\theta - \frac{1}{2}\left(\frac{gd^2}{v^2\cos^2\theta}\right)$
    (C) $h = d\tan\theta - \frac{1}{2}\left(\frac{gd^2}{v\cos\theta}\right)$
    (D) $h = d\sin\theta - \frac{1}{2}\left(\frac{gd^2}{v^2\cos^2\theta}\right)$
    (E) $h = d\sin\theta - \frac{1}{2}\left(\frac{gd^2}{v^2\cos\theta}\right)$

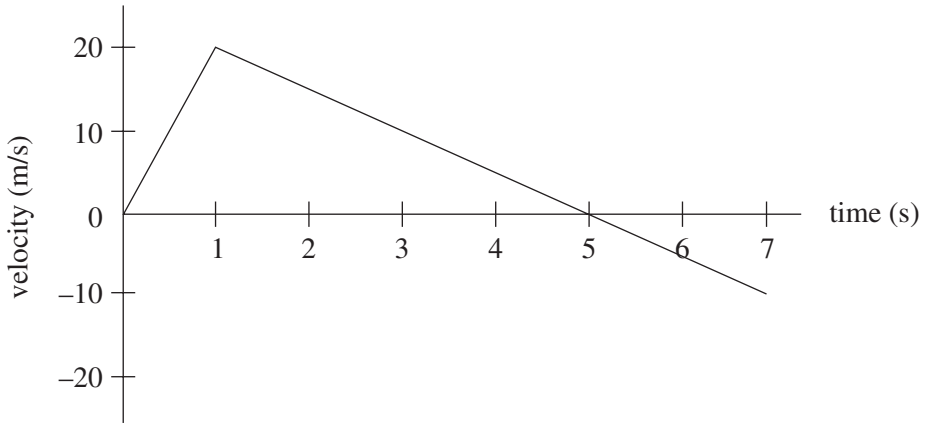


12. The velocity of an object moving in a straight line is graphed above. If $x = 3.0$ m at $t = 0$ s, what is the position of the particle at $t = 3.0$ s?

    (A) 6 m
    (B) 10 m
    (C) 8 m
    (D) 11 m
    (E) –5 m

Section II: Free Response

1. This question concerns the motion of a car on a straight track; the car's velocity as a function of time is plotted below.



   (a) Describe what happened to the car at time $t = 1$ s.

   (b) How does the car's average velocity between time $t = 0$ and $t = 1$ s compare to its average velocity between times $t = 1$ s and $t = 5$ s?

   (c) What is the displacement of the car from time $t = 0$ to time $t = 7$ s?

   (d) Plot the car's acceleration during this interval as a function of time.

   (e) Plot the object's position during this interval as a function of time. Assume that the car begins at $s = 0$.

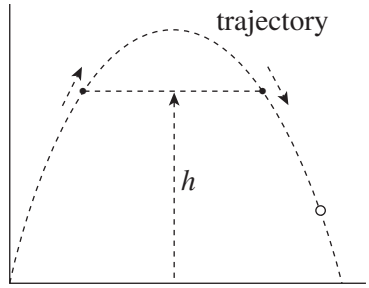
2. Consider a projectile moving in a parabolic trajectory under constant gravitational acceleration. Its initial velocity has magnitude v_0, and its launch angle (with the horizontal) is θ_0. Solve the following in terms of given quantities and the acceleration of gravity, g.

   (a) Calculate the maximum height, H, of the projectile.

   (b) Calculate the (horizontal) range, R, of the projectile.

   (c) For what valueof θ_0 will the range be maximized?

   (d) If $0 < h < H$, compute the time that elapses between passing through the horizontal line of height h in both directions (ascending and descending); that is, compute the time required for the projectile to pass through the two points shown in this figure:



3. A cannonball is shot with an initial speed of 50 m/s at a launch angle of 40° toward a castle wall 220 m away. The height of the wall is 30 m. Assume that effects due to the air are negligible. (For this problem, use $g = 9.8$ m/s^2.)

   (a) How long will it take the cannonball to reach the vertical plane of the wall?

   (b) Will the cannonball strike the wall? If the cannonball strikes the wall, how far below the top of the wall does it strike? If the cannonball does not strike the wall, how much does it clear the wall by?

4. A particle moves along a straight axis in such a way that its acceleration at time t is given by the equation $a(t) = 6t$ (m/s^2). If the particle's initial velocity is 2 m/s and its initial position is $x = 4$ m, determine

   (a) The time at which the particle's velocity is 14 m/s

   (b) The particle's position at time $t = 3$ s