1. An object is traveling at 20 m/sec to the left. What is its speed and velocity?

2. Which has the greater speed and velocity: object A with a velocity of -20 m/sec or object B with a velocity of -10 m/sec?

3. A billiard ball is hit and travels in a straight line. If x centimeters is the distance of the ball from its initial position at t seconds, then $x(t) = 5t^2 - 4t$. If the ball hits a cushion that is 12 cm from its initial position, at what velocity does it hit the cushion?

4. If a particle moves along a line according to the equation $s(t) = t^5 - 5t^4$ for all real numbers, t, then how many times does the particle reverse its direction?

5. The position in meters of a particle moving on the x-axis is given by $x(t) = 2t^3 - 2t + 1$ at all times t, $t > 0$. Find the acceleration when the velocity is 4 m/sec.

6. If $x(t) = \dfrac{t}{t^2 + 5}$ is the position function of a moving particle for $t > 0$, at what instant of time will the particle start to reverse its direction of motion, and where is it at that instant?

7. The position function of a particle moving on a coordinate line is given by: $x(t) = 2t^3 - 21t^2 + 60t + 3$, where x is in feet and t is in seconds.

a) When is the particle at rest?

b) When does the particle reverse direction?

c) What is the velocity when the acceleration is zero?

d) What is the speed when the acceleration is 6 ft/sec?

e) What is the displacement from $t = 1$ to $t = 3$?

f) What is the total distance moved from $t = 1$ to $t = 3$?

8. If $v(t) = (t - 5)(t - 3)^2(t - 1)$ represents the velocity of a particle moving along a line,
   a) When will the particle be at rest?
   b) When will the particle move to the left?
   c) When will the particle change direction?

9. A ball is thrown vertically upwards from the edge at the top of a building 160 ft tall with an initial velocity of 24 ft/sec. If the height of the ball (measured from the ground) is given by the function: $h(t) = -16t^2 + bt + c$,
a) Find the values of b and c.

b) How long does it take the ball to reach its maximum height?

c) What is the maximum height of the ball?

d) How long before the ball passes the top of the building on the way down?

e) How long does it take for the ball to hit the ground?

f) What is the speed of the ball when it hits the ground?

g) What is the speed of the ball at $t = 1$ second?

1. An object is traveling at 20 m/sec to the left. What is its speed and velocity?

$$\text{speed} = 20 \, m/s$$
$$\text{velocity} = -20 \, m/s$$

2. Which has the greater speed and velocity: object A with a velocity of -20 m/sec or object B with a velocity of -10 m/sec?

$$\text{greater velocity} \to \text{object } B \, (-10 \, m/s)$$

$$\text{greater speed: object } A \, (20 \, m/s)$$

3. A billiard ball is hit and travels in a straight line. If x centimeters is the distance of the ball from its initial position at t seconds, then $x(t) = 5t^2 - 4t$. If the ball hits a cushion that is 12 cm from its initial position, at what velocity does it hit the cushion?

$$12 = x(t)$$
$$12 = 5t^2 - 4t$$
$$5t^2 - 4t - 12 = 0$$
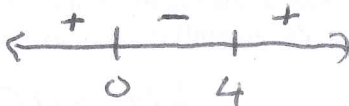$$(5t + 6)(t - 2) = 0 \quad t = -6/5, 2$$

$$v(t) = 10t - 4$$
$$v(2) = 10(2) - 4 = 16 \, cm/s$$

4. If a particle moves along a line according to the equation $s(t) = t^5 - 5t^4$ for all real numbers, t, then how many times does the particle reverse its direction?

$$v(t) = 5t^4 - 20t^3$$
$$0 = 5t^3(t - 4)$$
$$t = 0, 4$$

twice, at $t = 0, t = 4s$

5. The position in meters of a particle moving on the x-axis is given by $x(t) = 2t^3 - 2t + 1$ at all times t, $t > 0$. Find the acceleration when the velocity is 4 m/sec.

$$v(t) = 6t^2 - 2$$
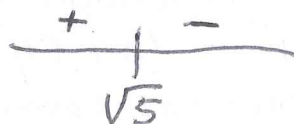$$a(t) = 12t$$

$$4 = 6t^2 - 2$$
$$6 = 6t^2$$
$$t = 1$$

$$a(1) = 12(1) \quad \boxed{12 \, m/s^2}$$

6. If $x(t) = \dfrac{t}{t^2 + 5}$ is the position function of a moving particle for $t > 0$, at what instant of time will the particle start to reverse its direction of motion, and where is it at that instant?

$$v(t) = \frac{1(t^2 + 5) - t(2t)}{(t^2 + 5)^2}$$

$$= \frac{t^2 + 5 - 2t^2}{(t^2 + 5)^2} = \frac{5 - t^2}{(t^2 + 5)^2} = 0 \quad \boxed{t = \sqrt{5}}$$

7. The position function of a particle moving on a coordinate line is given by: $x(t) = 2t^3 - 21t^2 + 60t + 3$, where x is in feet and t is in seconds.
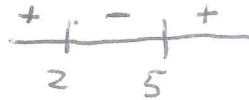
$v(t) = 6t^2 - 42t + 60 = 6(t^2 - 7t + 10)$

a) When is the particle at rest?

$0 = 6(t-5)(t-2)$

$t = 5, 2$ secs.

b) When does the particle reverse direction?

$\xcancel{}$ + | − | +
  2   5

$t = 2, 5$ secs.

c) What is the velocity when the acceleration is zero?

$a(t) = 12t - 42$
$a(t) = 6(2t-7)$
$t = \frac{7}{2}$

$\left| v(\frac{7}{2}) = -13.5 \text{ ft/s} \right.$

d) What is the speed when the acceleration is 6 ft/sec?

$6 = 6(2t-7)$
$1 = 2t-7$
$2t = 8 \quad t = 4$

$\left| v(4) = -12 \right.$
Speed $= 12$ ft/s

e) What is the displacement from $t = 1$ to $t = 3$?

$x(1) = 44$
$x(3) = 48$

$48 - 44 = 4$ ft

f) What is the total distance moved from $t = 1$ to $t = 3$?

$x(1) = 44 \rangle 11$
$x(2) = 55$
$x(3) = 48 \rangle 7$

$11 + 7 = 18$ ft

8. If $v(t) = (t-5)(t-3)^2(t-1)$ represents the velocity of a particle moving along a line,
   a) When will the particle be at rest?
   b) When will the particle move to the left?
   c) When will the particle change direction?

a) $t = 5, 3, 1$

$\longleftarrow$ + | − | − | + $\longrightarrow$
         1   3   5

b) $(1,3) \cup (3,5)$

c) $t = 1, 5$ sec.

g)

9. A ball is thrown vertically upwards from the edge at the top of a building 160 ft tall with an initial velocity of 24 ft/sec. If the height of the ball (measured from the ground) is given by the function: $h(t) = -16t^2 + bt + c$,
a) Find the values of b and c.

$b = 24$ ft/s $c = 160$

$h(t) = -16t^2 + 24t + 160$
$= -8(2t^2 - 3t - 20)$
$-8(2t + 5)(t - 4)$

b) How long does it take the ball to reach its maximum height?

$v(t) = -32t + 24.$ $0 = -32t + 24$ $t = \frac{3}{4}$ sec.

c) What is the maximum height of the ball?

$h(\frac{3}{4}) = 169$ ft.

d) How long before the ball passes the top of the building on the way down?

$\cancel{160} = -16t^2 + 24t + \cancel{160}$ $0 = -8t(2t - 3)$ $t = \frac{3}{2}$ sec.

e) How long does it take for the ball to hit the ground?

$h(t) = -8(2t + 5)(t - 4)$ $t = 4$ sec.

f) What is the speed of the ball when it hits the ground?

$v(4) = -104$ 104 ft/s

g) What is the speed of the ball at $t = 1$ second?

$v(1) = -8$ 8 ft/s