Part I

1. An object goes from one point in space to another. After it arrives at its destination

   (a) its displacement is the same as its distance traveled.

   (b) its displacement is always greater than its distance traveled.

   (c) its displacement is always smaller than its distance traveled.

   (d) its displacement is never larger than its distance traveled.

   Answer: (d). Displacement is always the distance between the initial position and the final position. The distance depends on the path taken so can be longer but not shorter.

2. An accelerating body must at all times

   (a) have positive velocity.

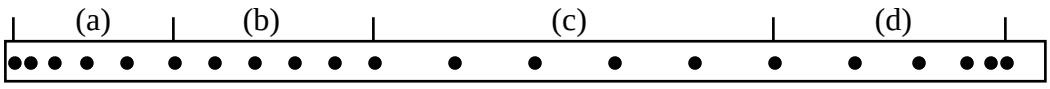
   (b) have an increasing speed.

   (c) have a changing direction.

   (d) have a changing velocity.

   Answer (d). Acceleration means that the velocity is changing. An object can have constant speed and accelerate provided its direction is changing. An accelerating object can have constant direction provided its speed is changing.

3. The diagram below shows a piece of tape which passed through a vibrating marker which makes a mark every 0.05 sec.



   Which region shows where the average velocity was greatest?

   Answer (c). The object covers the greatest distance in the same time interval.

4. Again referring to the ticker tape above, which region shows where the magnitude of the acceleration was greatest?

   Answer (d). The change in velocity is greatest in this interval.

5. A ball is thrown straight up from height H while a second is thrown straight down. Neglect air resistance. After the balls have been released

   (a) the one thrown up has the greater acceleration.

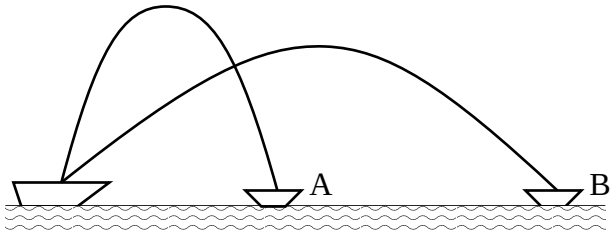
   (b) the one thrown down has the greater acceleration.

   (c) the accelerations are the same.

   (d) neither ball accelerates after it has been released.

   Answer (c): When an object is acted on by gravity alone the acceleration is always constant and directed downward.

6. A ship simultaneously tosses two water balloons at enemy boats. If the balloons follow the parabolic trajectories shown, which boat gets hit first?



   (a) A; (b) B; (c) both at the same time; (d) need more information.

   Answer: (b). Balloon A travels higher and therefore is in the air longer.

7. A projectile is launched at an angle above the horizontal and follows a parabolic trajectory reaching a maximum height at point P. If air friction is negligible which of the following statements about point P is correct?

   (a) The horizontal component of both velocity and acceleration are zero.

   (b) The vertical component of both velocity and acceleration are zero.

   (c) The horizontal component of velocity and the vertical component of acceleration are zero.

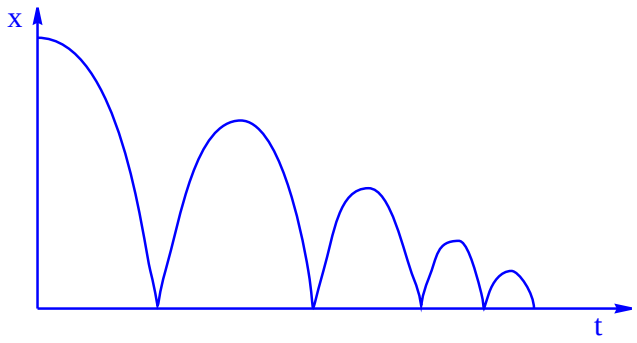
   (d) The vertical component of velocity and the horizontal component of acceleration are zero.

   Answer: (d). The horizontal component of acceleration is zero since gravity acts in the vertical direction only. The horizontal component of velocity is constant and not zero, but at the maximum height the vertical component of velocity changes from up to down and so is momentarily zero.

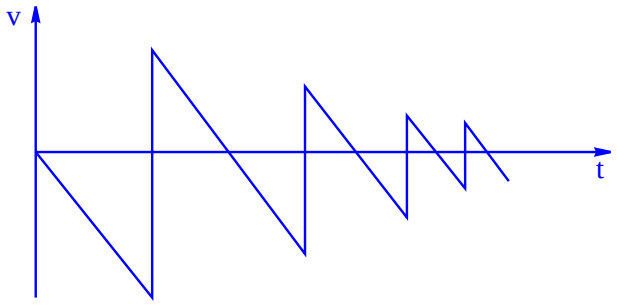
Part II

1. A ball is dropped from above the ground and bounces several times before coming to rest. Assuming the ground is the origin and the positive direction is upwards sketch graphs of

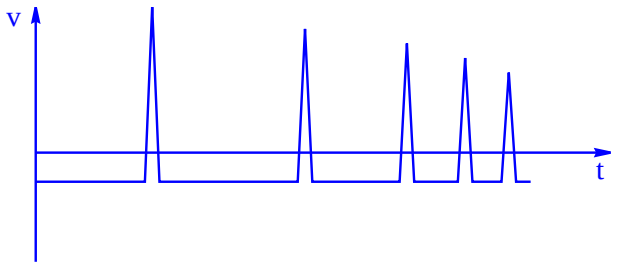
   (a) position vs. time



   (b) velocity vs. time



   (c) acceleration vs. time



2. The phrases "slows down" and "decreases velocity" do not have identical physical meaning. Describe each of the following physical situations using the appropriate phrase. When both are appropriate indicate this, when neither are appropriate indicate this also.

   (a) An object increasing its speed traveling in the negative direction "decreases velocity"

   (b) An object decreasing its speed traveling in the positive direction "slows down" and "decreases velocity"

   (c) An object increasing its speed traveling in the positive direction neither phrase

   (d) An object decreasing its speed traveling in the negative direction. "slows down"

3. A sprinter in a 100 dash accelerates uniformly from rest reaching a top speed of 14.7 m/s after 6.00 seconds. He then runs at constant speed for the remainder of the race.

   (a) What is his rate of acceleration during the initial phase of the race?

   $a = \dfrac{\Delta v}{\Delta t} = (14.7 - 0)/6.0 = 2.45 \text{ m/s}^2$

   (b) How far did he travel in the first phase of the race?

   The distance covered is $\Delta x = \frac{1}{2}at^2 = \frac{1}{2}(2.45)(6)^2 = 44.1$ m

   (c) What was his time in the race?

   For the first part of the race $t_1 = 6.00$ s.

   For the second part $t_2 = \dfrac{\Delta x}{v} = \dfrac{100 - 44.1}{14.7} = 3.80$ s so total time is $t = 9.80$ s

   (d) What was his average acceleration over the entire race?

   $\bar{a} = \dfrac{\Delta v}{\Delta t} = \dfrac{14.7 - 0}{9.80} = 1.50 \text{ m/s}^2$

   (e) What was his average speed over the entire race?

   $\bar{v} = \dfrac{\Delta x}{\Delta t} = \dfrac{100}{9.8} = 10.2$ m/s

4. A physics text book is dropped from a height of 1.0 m onto a stationary cockroach.

   (a) How long does it take for the book to reach the ground?

   $\Delta y = \frac{1}{2}at^2 \;\Rightarrow\; -1.0 = \frac{1}{2}(-9.8)t^2 \;\Rightarrow\; t^2 = 1.0/4.9 \;\Rightarrow t = 0.45$ s

   (b) What will the velocity of the book be when it reaches the ground?

   $v = at = -9.8 \times 0.45 = -4.4$ m/s (ie 4.4 m/s downwards)

   (c) The cockroach sees the book the moment it is released and must move 10 cm to get out of the way. How fast must the cockroach move to avoid a sticky finish.

   $v = \Delta x/t = 0.1/45 = 0.22$ m/s