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. If the acceleration of a car is zero, must its velocity be zero? If the velocity of a car is zero must its acceleration be zero? Explain your answers.

3. An accelerating body must at all times

   (a) have positive velocity.

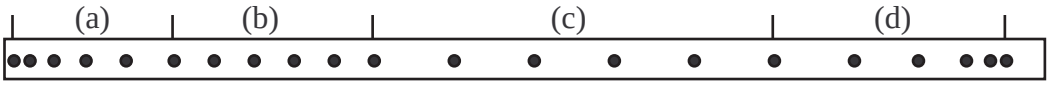
   (b) have an increasing speed.

   (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.

4. The diagram below shows a piece of a ticker tape which passed through a vibrating marker which vibrated at a constant rate of 20 s^{-1}



   In which region was the average speed the greatest? In which region was average acceleration the 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.

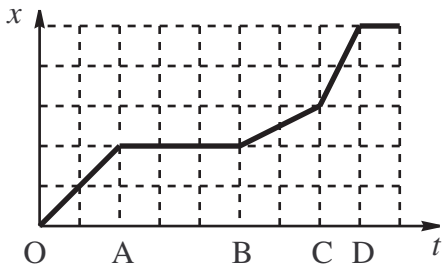
   (c) the accelerations are the same.

   (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.

Part II

1. The motion of a particle is described by the position-time graph shown below. During which interval is the *instantaneous* velocity of the particle greatest?



(a) OA (b) AB (c) BC (d) CD

Answer (d): Instantaneous velocity is the slope of the position time graph.

2. For the above position-time graph during which interval is the *average* velocity greatest.

(a) OA (b) OB (c) OC (d) OD

Answer (a): During this interval $\Delta x/\Delta t$ is largest.

3. Given an example of an object that has

(a) high velocity and low acceleration.
A plane cruising at full speed

(b) low velocity and high acceleration.
A race car at the very start of a race. A badminton birdie being hit by a racket.

(c) an unchanging speed but high acceleration.
anything moving at constant speed around a small circle.

4. Two stones are released from rest at a certain height, one slightly after the other. Answer the following questions regarding their motion as they fall through the air, with explanations.

   (a) will the difference in their speeds increase, decrease, or stay the same?
   The difference in their speeds will remain constant since the acceleration is constant, so their velocities increase by the same amount each second.)

   (b) will their distance between them increase, decrease, or stay the same?
   There distance apart will increase because the first stone is traveling faster than the second.

   (c) will the time interval between the instants at which they hit the ground be smaller than, equal to, or larger than the time interval between the instants of their release?
   The time interval will be equal to the initial time interval. Although the balls are further apart than at the beginning they are also traveling faster.

5. 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?
   $\bar{v} = \dfrac{\Delta x}{\Delta t} = \dfrac{100}{9.8} = 10.2 \text{ m/s}$

6. The following graphs show the motion of a toy car along a straight track. For each situation describe the motion and complete and sketch the missing graph.