One Dimensional Kinematics
Concept Questions

Question 1 You are throwing a ball straight up in the air. At the highest point, the ball's

1. velocity and acceleration are zero
2. velocity is nonzero but its acceleration is zero
3. acceleration is nonzero, but its velocity is zero
4. velocity and acceleration are both nonzero.

Answer 3. The ball reaches its highest point when its velocity is zero; the acceleration of gravity is never zero (it is always 9.8 m/s^2 downward).

Question 2 An object goes from one point in space to another. After it arrives at its destination, the distance it traveled is:

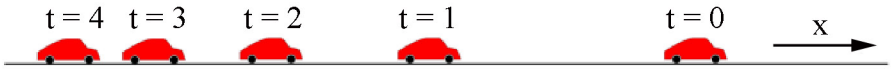
1. either greater than or equal to
2. always greater than
3. always equal to
4. either smaller than or equal to
5. always smaller than
6. either smaller or larger than

the magnitude of the displacement.

Answer 1. The magnitude of the displacement is equal to the magnitude of the length of the straight line connecting the initial point to the final point. The distance is the length of the path traveled between the two points. The distance traveled is always greater or equal to the magnitude of the displacement since the actual path traveled between the two points need not be the straight-line path.

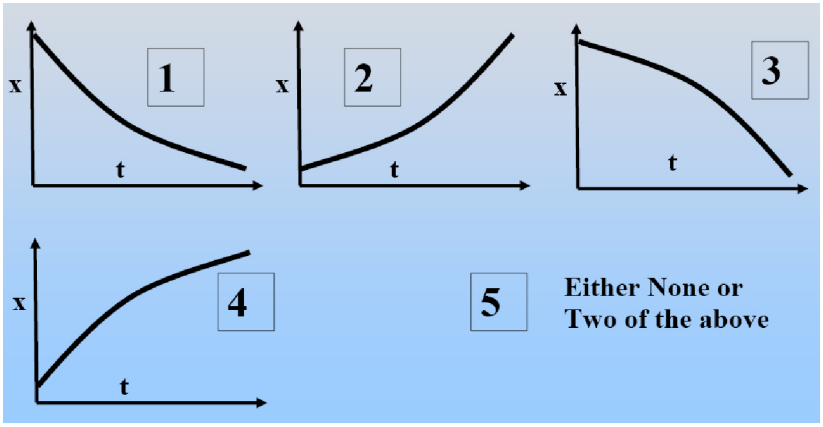
Question 3 Strobe Representation 1

The strobe picture shows the position of the object at t = 0, t = 1s, t = 2s, t = 3s, and t = 4s.



Position of car at 5 succesive time (stroboscopic representation)

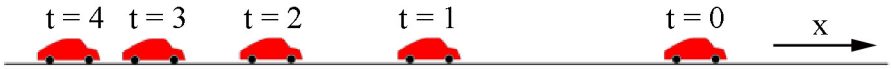
Which of the graphs below is a possible graph of the position, x(t)?



Answer 1. The strobe picture shows the position of the object at t = 0, t = 1s, t = 2s, t = 3s, and t = 4s. The object is moving to the left and hence in the negative x-direction so the position function x(t) must be decreasing. The magnitude of the displacement for each time interval of one second is steadily decreasing so graph 1 represents such a possible case.

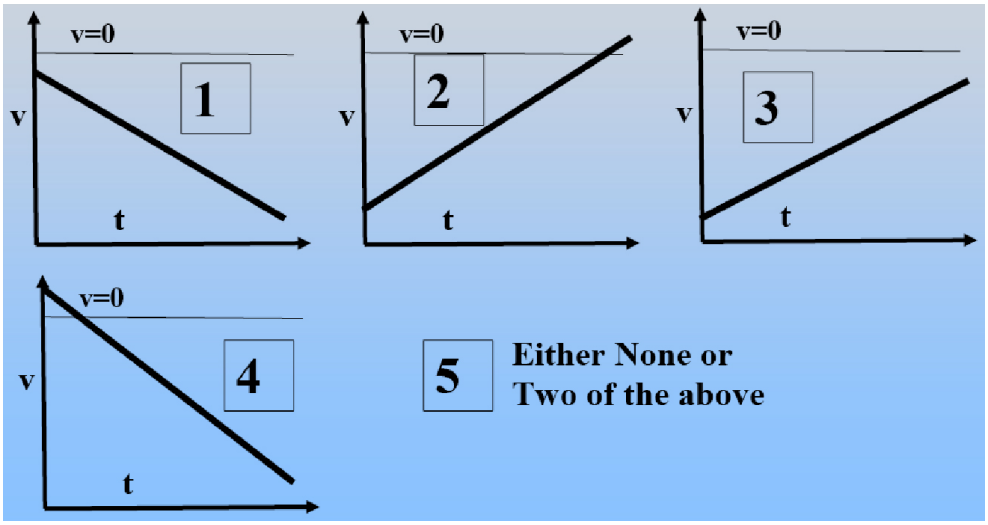
Question 4 Strobe Representation 2

The strobe picture shows the position of the object at t = 0, t = 1s, t = 2s, t = 3s, and t = 4s.



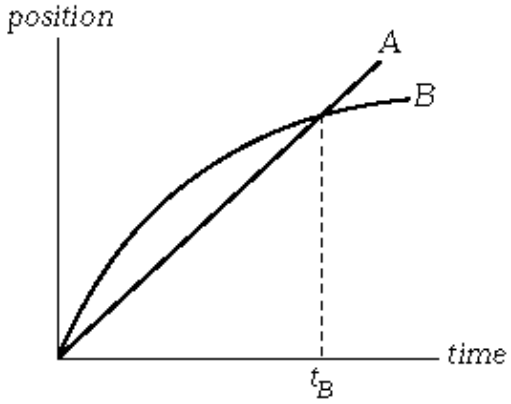
Position of car at 5 succesive time (stroboscopic representation)

Which of the graphs below is a possible graph of the x-component of velocity?



Answer 2 and 3. Once again the object is moving in the negative x-direction and so for the interval $0 < t < 4$s the x-component of the velocity is negative. From the strobe picture the magnitude of the displacement decreases for each subsequent time interval of one second so the x-component of the velocity is negative and steadily increasing i.e. getting smaller in magnitude. Upon closer inspection it appears that the x-component of the velocity is increasing linearly. There is some ambiguity to the graphs since there are no markings for the time axis. If we assume that the graph only represents the time interval between 0 and 4s, then graph 2 indicates that at the end of this interval the x-component of the velocity is positive which is not true. So only graph 3 is correct. However if the time axis extends beyond 4s, then it is possible to infer that the object will steadily slow down , reverse direction, move in the positive x-direction with a positive x-component of the velocity. Then graphs 2 and 3 would both describe the motion.

Question 5 The graph shows position as a function of time for two trains running on parallel tracks. For times greater than $t = 0$, which is true:



1. At time t_B, both trains have the same velocity.
2. Both trains speed up all the time.
3. Both trains have the same velocity at some time earlier than t_B.
4. Somewhere on the graph, both trains have the same acceleration.

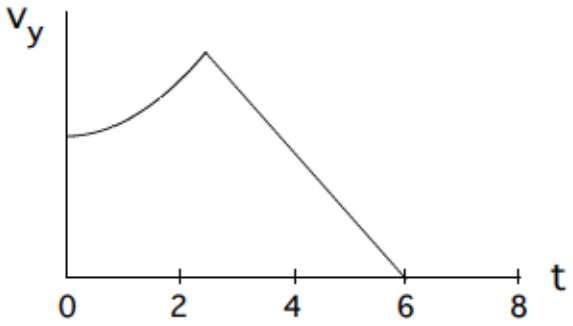
Answer 3. The slope of curve *B* is parallel to line *A* at some point $t < t_B$.

Question 6 A person standing at the edge of a cliff throws one ball straight up and another ball straight down, each at the same initial speed. Neglecting air resistance, which ball hits the ground below the cliff with the greater speed:

1. ball initially thrown upward;
2. ball initially thrown downward;
3. neither; they both hit at the same speed.

Answer 3. (Coordinate system: positive *x*-axis upwards.) Upon its descent, the velocity of an object thrown straight up with an initial *x*-component of velocity $v_{x,0} > 0$ has velocity $v_x = -v_{x,0} < 0$ when it passes the point at which it was first released. This is exactly the same *x*-component of velocity as the ball that was thrown downward, so both balls will hit the ground with the same *x*-component of velocity. Let t_f denote the time interval that the ball thrown downwards takes to hit the ground, then the *x*-component of the velocity of both balls when they hit the ground is given by $v_x(t_f) = v_{x,0} - gt_f$.

Question 7



The graph above represents the y-component of the velocity of an object as a function of time. Which of the following could be a reasonable description of its motion?

1. The object accelerates upward at a constant rate and then accelerates downward until it hits the ground at t = 6 s.

2. The object accelerates upward at a constant rate and then accelerates downward until it reaches it highest point at t = 6 s.

3. The object accelerates upward at a non-constant rate and then accelerates downward until it hits the ground at t = 6 s.

4. The object accelerates upward at a non-constant rate and then accelerates downward until it reaches it highest point at t = 6 s.

5. None of the above.

Answer 4 Inspection of the graph indicates that in the first interval dv/dt = a is not constant. This excludes 1) and 2). The area under the velocity verses time graph is positive and non-zero. Thus there is a positive total displacement which excludes 1) and 3). The velocity goes to zero at the end of the second interval. At that point the displacement has stopped changing. This is consistent with 2) and 4).