QUIZ: MOTION-I

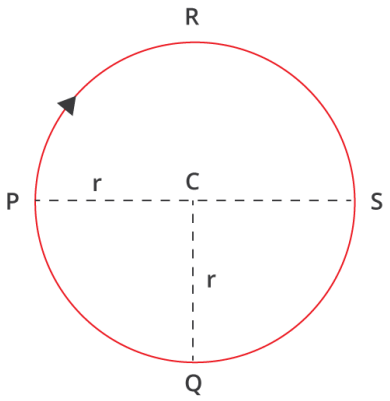
1. A ball A is thrown vertically upward from the roof of a building. Another identical ball B is thrown vertically down from the same point with the same speed. Both balls finally touch the ground. Which of the following statements is correct?

(a) Displacement of A is more than the displacement of B.
(b) Displacement of A is equal to the displacement of B.
(c) Average speed of A is equal to the average speed of B.
(d) Average velocity of A is equal to the average velocity of B.

2. A ball is thrown vertically upward. Take upward as positive y direction. During the upward motion of the ball, its

(a) Velocity and acceleration both are upwards.
(b) Velocity and acceleration both are downwards.
(c) Velocity is upward but acceleration is downward.
(d) Velocity is downward but acceleration is upward.

3. An object moves clockwise along a circular path of radius r. It starts from point P. When the object reaches point Q, the ratio of magnitude of its displacement to distance is



(a) 1
(b) $\frac{1}{3}$

(c) $\frac{4}{3\pi}$

(d) $\frac{2\sqrt{2}}{3\pi}$

4. An object is moving along a straight line with uniform acceleration of 6 m/s^2. It starts from rest at x = 0. The average velocity of the object during the period it travels from 3 m to 12 m is

(a) 6 m/s

(b) 9 m/s

(c) 12 m/s

(d) 18 m/s

5. A car travels a distance of 2 km along a straight line. It covers a distance of 0.5 km at a uniform speed of 10m/s. With what uniform speed it should travel the remaining distance so that the average speed for the entire journey is 15 m/s?

(a) 18 m/s

(b) 20 m/s

(c) 24 m/s

(d) 30 m/s

Answers:

1. (b)

Options:

(a) By definition, displacement is difference in final position and initial position. The displacement is same for both balls. Hence this option is wrong.

(b) For both the balls, final and initial positions are the same. Thus displacements (difference in final and initial positions) for both balls are the same. Hence this option is correct.

(c) Ball A moves up till its speed is zero. Then it falls to ground. Hence distance travelled by A is more than distance travelled by B. Time taken by ball A is also more than time taken by ball B. Thus average speed of A is not equal to average speed of B. Hence this option is wrong.

(d) Displacement of ball A is equal to that of ball B as the final and initial positions are the same for both balls. But time taken to

reach the ground by balls A and B are different. Thus average velocity of ball A is not equal to the average velocity of ball B. Hence this option is wrong.

Note for teachers:

(i) This question is based on four concepts – distance, displacement, average speed and average velocity.

(ii) One can design less difficult question by taking only 2 or 3 concepts.

(iii) This question is based on upward and downward motion. One can generate similar questions for motion (with a turn-around) along x-axis.

(iv) A graph-based question can also be generated.

2. (c)

Options:

(a) As the ball is going in positive y-direction, its velocity is upward and is decreasing. So acceleration cannot be positive. For acceleration, note that the force acting on the ball is the force of attraction due to the earth. This force is downward and thus acceleration is also downward. Whenever a body moves vertically upwards or downwards, its acceleration (g) is always downwards. Hence this option is wrong.

(b) The ball is going in positive y-direction. So velocity is upward, while its acceleration is downward. Hence this option is wrong.

(c) Upward is taken as positive. As the ball goes up, displacement is positive and increasing. Hence velocity is upward. For acceleration, note that the force acting on the ball is the force of attraction due to earth. The force is downward and thus acceleration is also downward. Hence this option is correct.

(d) The ball is going in positive y-direction. Thus velocity is upward and is decreasing. The acceleration is downward as the force acting on the ball is the force of attraction due to earth which is downward. Hence this option is wrong.

Note for teachers:

(i) Similar questions can be designed for downward motion.

(ii) One can also design similar questions for motion along x-axis.

(iii) Graph-based questions can also be designed.

3. (d)

Options:

(a) The distance travelled is along arc PRSQ, while displacement is the line joining initial position P to final position Q. They are not equal. Hence this option is wrong.

(b) Distance along arc PRSQ is (3/4)th of the circumference of the circle. Therefore it is $\frac{3}{4} \times 2\pi r = \frac{3}{2}\pi r$. If you take the displacement as distance along arc PQ (which is wrong), you will get the answer as $\pi r/4$. The ratio of displacement to distance that you would get would be 1/3. Hence this option is wrong.

(c) Distance along arc PRSQ is (3/4)th of the circumference of the circle. Therefore it is $\frac{3\pi r}{2}$. If you take displacement by moving along path PCQ (which is wrong) then displacement is r + r = 2r. Thus ratio of displacement to distance is $\frac{2r}{\frac{3\pi r}{2}} = \frac{4}{3\pi}$. Hence this option is wrong.

(d) Distance along arc PRSQ is (3/4)th of circumference of circle. Therefore it is $\frac{3\pi r}{2}$. Magnitude of Displacement = PQ = $\sqrt{PC^2 + CQ^2}$ = $\sqrt{r^2 + r^2}$ = $r\sqrt{2}$. Thus ratio is $= r\sqrt{2}/(3\pi r/2) = 2\sqrt{2}/3\pi$. Hence this option is correct.

Note for teachers:

(i) Similar question can be designed for anticlockwise motion.

(ii) One can also design questions by taking starting point at any suitable point on the circumference.

4. (b)

Options:

(a) Object is at x = 0 at t = 0. Applying $s = ut + \frac{1}{2}at^2$, object will reach 3 m at t = 1s. It will be at 12 m at t = 2s. At t = 1s, $v = 0 + 6t = 6\,m/s$. This is not the velocity for the rest of the motion, as the object is being accelerated. Note that, in an accelerated motion, the average velocity cannot be equal to the initial velocity. Hence the average velocity cannot be 6m/s. Therefore this option is wrong.

(b) Object is at x = 0 at t = 0. Applying $s = ut + \frac{1}{2}at^2$, object will reach 3 m at t = 1s. It will be at 12 m at t = 2s. Velocity at t = 1s is v_1=6 m/s (v=u + at) and at t = 2s, velocity v_2 = 0 + 6 × 2 = 12 m/s. Hence average velocity $= \frac{v_1 + v_2}{2}$ = (6 +12)/2 = 9 m/s. Therefore this option is correct.

(c) Object is initially at x = 0 at t = 0. Applying $s = ut + (1/2)\,at^2$, object will be at 12 m at t = 2 s. Again using $v=u+at$, thus velocity at position x = 12 m is 12 m/s. Note that, in an accelerated motion, the average velocity cannot be equal to the final velocity which is not the average velocity. Hence this option is wrong.

(d) Object is at x = 0 at t = 0. Applying $s = ut + \frac{1}{2}at^2$, object will reach 3 m at t = 1s. It will be at 12 m at t = 2s. Velocity at t = 1s is v_1=6 m/s ($v=u + at$) and at t = 2s, velocity v_2= 0 + 6 × 2 = 12 m/s. Thus velocity at position 3 m and 12 m are 6 m/s and 9 m/s respectively. The average of 6 m/s and 12 m/s cannot be 18 m/s. Hence this option is wrong.

Note for teachers:

(i) Similar question can be designed by taking different values of acceleration and initial position at t=0 s.

(ii) Graph-based question can also be designed by providing a suitable displacement-time graph.

5. (a)

Options:

(a) Average speed is given by total distance covered divided by the total time taken. Let u be the required speed. Then time for travelling 500 m is $\frac{500m}{10\,m/s} = 50s$ and time taken for the rest of the journey is $\frac{1500m}{u}$. Therefore total time for the journey $= \left(50\,s + \frac{1500}{u}s\right)$. Thus the average speed for the entire journey is $\frac{2000}{50 + \frac{1500}{u}} = 15$ m/s. Solving we get, u = 18 m/s. Hence this option is correct.

(b) Average speed is given by total distance covered divided by total time taken. Let u be the required speed. If you take the average of u and 10m/s as 15 i.e. $\frac{10+u}{2} = 15$, then you get this value for u i.e. 20 m/s which is wrong. This method is not correct for this case because distances travelled in the two parts of the journey are not equal. Hence this option is wrong.

(c) Average speed is given by total distance covered divided by total time taken. Let u be the required speed. Then time for travelling 500 m is $\frac{500m}{10\,m/s} = 50s$ and time taken for the rest of the journey is $\frac{1500m}{u}$ s. Therefore total time for the journey $= \left(50 + \frac{1500}{u}\right)s$ Thus the

average speed for the entire journey is $\frac{2000}{50 + \frac{1500}{u}} = 15$. Solving we get, u = 18 m/s. Hence this option is wrong.

(d) Average speed is given by total distance covered divided by total time taken. Let u be the required speed. Then time for travelling 500 m is $\frac{500m}{10\ m/s} = 50s$ and time taken for the rest of the journey is $\frac{1500m}{u}$ s. Therefore total time for the journey = $\left(50 + \frac{1500}{u}\right) s$ Thus the average speed for the entire journey is $\frac{2000}{50 + \frac{1500}{u}} = 15$. Solving we get, u = 18 m/s. Hence this option is wrong.

Note for teachers:

(i) Similar question can be designed by taking different values of distances and velocity values.

(ii) Similar questions in which time is the same, but the distances covered are not equal, can be designed.

(iii) Similar questions can be designed for motion under gravity.

(iv) Graph-based question can also be designed by providing a suitable displacement-time graph.