PHYSICS

BOOKS - CHHAYA PHYSICS (BENGALI ENGLISH)

ONE - DIMENSIONAL MOTION

Numerical Examples

1. A particle moves along a circular path of radius 7 cm. Estimate the distance covered and

displacement when the particle (i) covers half circular path and (ii) completes the total circular path once.

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2. A particle move $10\sqrt{3}$ m towards east and then 10 m towards north. Find the magnitude and direction of its displacement .

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3. A particle moves in a circular path of radius 7 cm. It covers (i) half of the circle in 4s and (ii) one complete round in 10 s. In each case find the average speed and average velocity.

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4. An aeroplane travels 2000 km to the west. It then turns north and moves 2000 km more. Finally it follows the shortest path to return to its starting point. If the speed of the plane is

200 km.h^{-1}, find its average velocity for the total journey .

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5. Find the speed of the tip of a 3 cm long second's hand in a clock.

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6. A train travels from station A to station B at a constant speed of 40 km. h^{-1} and returns

from B to A at 60 km . h^{-1} . Find the average speed and average velocity of the train.

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7. The motion of a particle, along x-axis, follows the relation x = 8t-$3t^2$. Here x and t are expressed in metre and second respectively . Find (i) the average velocity of the particle in time interval 0 to 1 s and (ii) its instantaneous velocity at t = 1 s.

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8. A person travels half of a distance at an average velocity of 24 km.h^{-1}. At what average velocity should he move to cover the second half of the path so that his average velocity for the total path becomes 32 km . h^{-1}?

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9. A velocity of 60 km.h^{-1} of a train is reduced by the application of brakes. A retardation of 40 cm .s^{-1} is produced . After how much time

will the train stop? What will be the velocity of the train after 20 s?

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10. A body covers 200 cm in the first 2s of motion and 220 cm in the next 4s. Calculate the velocity 7s after the start.

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11. A man is 9 m behind a train at rest. The train starts with an acceleration of 2 $\mathrm{m.s}^{-2}$ and simultaneously the man starts running. He is able to board the train somehow after 3 s. Find the acceleration of the man.

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12. A particle moves with a uniform acceleration along a straight line. It covers 41 cm and 49 cm in the 6th and the 10th seconds

respectively. What will be the distance covered by the particle in 15 s?

13. A train begins its journey from station A and stops at station B after 45 min. C is a certain point between A and B where the train attains its maximum velocity of 50 $km.h^{-1}$. If the train travels from A to C with a uniform acceleration and from C to B with a uniform

retardation, calculate the distance between A and B.

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14. A train moving with a constant acceleration crosses an observer standing on the platform. The first and the second compartments, each 15 m long cross the observer in 2s and 2.5 s, respectively. Find the velocity of the train when its first compartment just crosses the observer and also find its acceleration.

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15. A bullet with an initial velocity u penetrates a target. After penetrating a distance x, its velocity decreases by $\frac{u}{n}$. How much farther will the bullet move through the before if comes to rest?

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16. Starting from rest, a train travels a certain distance with a uniform acceleration α. Then it

travels with a uniform retardation β and finally comes to rest again. If the total time of motion is t,find (i) the maximum velocity attained and (ii) the total distance travelled by the train.

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17. A partical travelling with uniform acceleration along a straight line has average velocities v_1, v_2 and v_3 in successive time intervals t_1, t_2 and t_3 respectively . Prove that,

$$\frac{v_2 - v_1}{v_3 - v_2} = \frac{t_1 + t_2}{t_2 + t_3}$$

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18. A bullet, moving with a velocity of 200 $\mathrm{m.s}^{-1}$ can just go through a 4 cm thick plank. What should be the velocity of a bullet for just going through a 10 cm thick identical plank?

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19. The speed of a train drops 48 $\mathrm{km.h}^{-1}$ to 24 $\mathrm{km.h}^{-1}$ after moving through a distance of 108 m with uniform retardation. How much

farther would it move with the same retardation before coming to rest?

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20. A particle starts with a velocity u with a uniform acceleration f. In the p-th, q-th and r-th seconds, it moves through distances a,b and c respectively. Prove that

$$a(q-r)+b(r-p)+c(p-q)=0$$

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21. From two stations A and B, two trains started simultaneously towards each other with velocities $v_1 \text{and} v_2$ respectively. After they crossed each other the first train reached B in time t_1 and the second train reached A in time t_2. Show that $v_1 : v_2 =$ sqrt(t_(2)):sqrt(t_(1))`

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22. A train attains a velocity v after starting from rest with a uniform acceleration α. Then the train travels for sometime withuniform

velocity, and at last comes to rest with a uniform retardation β. If the overall displacement is s in time t , show that $t = \frac{s}{v} + \frac{v}{2}\left(\frac{1}{\alpha} + \frac{1}{\beta}\right)$

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23. s-t graph for a partical, moving with a constant acceleration, subtends 45° angle with the time axis at time t. That angle becomes 60° 1s later. Find the acceleration of the partical.

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24. Displacement x and time t, in a rectilinear motion of a partical are related as $t = \sqrt{x} + 3$. Here x is measured in metre and t in second. Find the displacement of the partical when its velocity is zero.

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25. A body starts from rest and moves with an acceleration proportional to time. (i) Find its

velocity n s after starting. (ii) What distance will it travel in n s?

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26. Velocity of a moving partical v decreases with its displacement. Given, $v = v_0 - \alpha x$ where v_0= initial velocity ,x = displacement and alpha is a constant. How long will the partical take to reach a point B on the x- axis at a distance $x_m$from the origin?

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27. The relation between the time taken and the displacement of a moving body is s = $2t - 3t^2 + 4t^3$, where the unit of s is in metre and that of t is in second. Find out the displacement, velocity and acceleration of the body 2s after initiation of the journey.

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28. For a particle travelling along a straight line the equation of motion is s = 16 t+5t^2. Show

that it will always travel with uniform acceleration.

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29. If a,b and c are constant of motion and $s = at^2 + bt + c$, then prove that 4a(s-c) = $v^2 - b^2$.

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30. The retardation α of a particle in rectilinear motion is proportional to the square root of its velocity v. Assume that the constant A of proportionality is positive. The initial velocity of the particle is v_0 . How far would the particle move before coming to rest? What would be the time required to travel that distance?

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31. The acceleration-time graph of a particle starting from rest is given in. Draw the

corresponding velocity-time graph and hence find out the displacement in 6s.

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32. A stone is dropped from a height of 19.6m. What is the time taken by the stone to travel the last metre of the path?

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33. An object is thrown vertically upwards with an initial velocity of 40 $\mathrm{m.s^{-1}}$. (i) How long will the object move upwards? (ii) What will be the maximum height attained? (iii) How much time will it taken to reach the ground ? (iv) When will the object be at a height of 25 m from the ground ? (v) What will be its velocity after 2 s? [$g = 9.8\mathrm{m.s^{-2}}$].

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34. A ball falls freely on a perfectly elastic plate from a height of 3m . At the instant t = 0 , the velocity of the ball is zero. Draw velocity -time graph for the motion of the ball. [g = 9.8 $\mathrm{m.s}^{-2}$]

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35. A body is thrown vertically upwards. After attaining half of its maximum height its velocity becomes 14 $\mathrm{m.s}^{-2}$. (i) How high will the body rise? (ii)What will be the velocity of

the body 1 s and 3 s after its projection?

(iii)What is the average velocity of the body in the first half second?

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36. A piece of stone was dropped from a stationary baloon. The stone covered 13.9 m during the last $\frac{1}{7}$s of its descent. Find the height of the balloon and the velocity of the stone whe it strikes the ground. [g = 9.8 $\mathrm{m.s}^{-2}$]

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37. A stone is dropped from the top of a tower 400 m high. At the same time another stone is thrown upwards from the ground with a velocity of 100 $\mathrm{m.s}^{-2}$. When and where will they meet each other? [g = 9.8 $\mathrm{m.s}^{-2}$]

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38. A stone is dropped from the top of a vertical pillar. When the stone has fallen through a height x, another stone is dropped

from height y below the top of the pillar. Both the stones touch the ground at the same time . Prove that the height of the pillar should $\frac{(x+y)^2}{4x}$.

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39. A,B,C and D are four points on a vertical line such that AB = BC CD. A body is allowed to fall freely from A. Prove that the respective times required by the body to cross the distances AB,

BC, CD should be in the ratio $1:(\sqrt{2}-1):(\sqrt{3}-\sqrt{2})$.

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40. A rubber ball is thrown vertically downwards from the top of a tower with an initial velocity of $14\mathrm{m.s}^{-1}$. A second ball is dropped 1 s later from the same place. In 2 s the first ball reaches the ground and rebounds upwards with the same velocity. When will they collide with each other?

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41. An object moving with a speed of 6.25 m/s, is deaccelerated at a rate given by $a = -2.5\sqrt{v}$, where v is the instantaneous speed. What is the time taken by the object to come to rest?

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42. Two bodies released from different heights fall freely and reach the ground at the same

time. The first body takes a time,$t_1 = 2$s and second body takes a time, $t_2 = 1$s. What was the height of the first body at the time of release of the second body?

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43. A balloon moves vertically upwards with a uniform velocity v_0. A weight is tied to balloon with a rope. When the balloon attains a height h_0, the rope snaps. How much time will the weight take to reach the ground?

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44. According to , three cars P, Q and R are at three points along the x-axis at a given moment. Now the car p starts its motion towards P_1 parallel to the y-axis with a uniform velocity v. Again, R is in motion parallel to the y-axis along RR_1 with uniform acceleration a. If the car Q too moves parallel to the y-axis then under what condition will all of them remain collinear? Given PQ = QR.

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Section Related Questions

1. Define rest and motion.

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2. What do you mean by (i) absolute rest and (ii) absolute motion ?

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3. Rest and motion are relative. Explain.

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4. What is complex motion? Given examples .

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5. Define speed of a moving body. Write its unit and dimension.

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6. Differentiate between average speed and instantaneous speed.

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7. Define velocity of a moving body. Write its units and dimension.

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8. Differentiate between speed and velocity.

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9. Can a body moving with uniform speed have nonuniform velocity?

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10. Can a body moving with uniform velocity have non-uniform speed?

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11. Define acceleration. What are its units and dimension?

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12. What is understood by the term instantaneous speed?

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13. Define deceleration or retardation. What are its units and dimension?

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14. Draw and explain the velocity -time graph for the motion of a body starting from rest with a constant acceleration.

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15. Discuss how displacement is represented on a velocity - time graph.

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16. Deduce the equation s = $ut + \frac{1}{2}at^2$, where symbols have their usual meanings.

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17. Establish the formula v = u +at, where symbols have their usual meanings.

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Higher Order Thinking Skill Hots Questions

1. Can a partical, moving with a uniform speed have a non-uniform velocity?

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2. Can a particle, moving with a uniform velocity have a non-uniform speed?

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3. Even if the average velocity of a body is zero, its average speed may be non-zero-is it possible?

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4. State whether a particle having constant acceleration may have a velocity of constant magnitude.

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5. Velocity is zero but acceleration is non-zero. Is it possible?

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6. Can the directions of velocity and acceleration be different?

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7. Can there be any change in direction of the velocity of a body moving under a constant

acceleration?

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8. What kind of motion is described by the equation $s = s_0 + ut + \frac{1}{2}at^2$?

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9. For a body moving with a uniform acceleration, prove that its average velocity is

the arithmetic mean of its initial and final velocities.

10. Starting from rest, a body moves in a straight line with a constant acceleration. Describe the nature of the graph relating the displacement with time.

11. State the nature of the graphs representing motions of a body with uniform velocity, with uniform acceleration and with uniform retardation respectively in a dispalcement - time graph.

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12. How can you represent (i) motion with uniform velocity, (ii) motion with uniform acceleration and (iii) motion with uniform retardation in a velocity time graph?

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13. Draw the velocity -time graph of a body moving (i) with uniform acceleration , (ii) with increasing acceleration and (iii) with decreasing acceleration.

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14. In a velocity - time graph how (i) uniform retardation , (ii) gradually increasing

retardation and (iii) gradually decreasing retardation can be represented ?

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15. A body with an initial velocity u and a uniform acceleration, covers a distance s in time t and acquires a velocity v. Compare the velocity of the body at half at half of the distance covered with the velocity at half of the total time of travel.

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16. State whether any body with a two-dimensional motion may have an acceleration in one dimension only.

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17. This displacement of a particle during its motion is equal to half of the product of its instantaneous velocity and time. Show that the particle moves with a constant acceleration.

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18. When the speed of car is doubled, the distance required to stop it becomes 4 times. Why?

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19. Does the magnitude of a physical quantity depend on the chosen frame of reference?

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20. A particle in motion covers half of a circular path of radius r in time t . Find the average speed and average velocity of the body.

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21. From the top of a tower, one ball is thrown vertically upwards and another ball vertically downwards with the same speed. Which of the balls will touch the ground with higher velocity ?

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22. A ball is projected upwards from the ground with a velocity v_1. After some time the ball comes back to the ground and rebounds with a velocity $v_2 (< v_1)$. Neglecting air resistance draw the velocity - time graph for the motion of the ball.

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23. State whether the displacement can be more than the total distance covered by a

particle.

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24. Two objects are thrown vertically upwards with the same velocity v from the same point. If the second object is thrown a time T later than the first object, when will the two objects collide with each other?

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25. Sketch the nature of the position - time graph for the unidirectional motion of a particle, having a variable velocity.

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26. Can you explain the translation of a car by the translation of a single particle? Justify your answer.

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27. A particle travels for a time $2t_0$ with velocity $v = c|t - t_0|$, where c is a constant. What is the distance travelled?

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28. The velocity-displacement (v-x) graph of a moving particle is given in Fig. Draw the corresponding acceleration - displacement (a-x) graph.

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29. An object is thrown vertically upwards. What will be the nature of its displacement - time graph?

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30. The equation x= A sin ω t gives the relation between the time t and the corresponding displacement x of a moving particle where A and ω are constant. Prove that the acceleration

of the particle is proportional to its displacement and is directed opposite to it.

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31. The velocity-time graph for a given particle is shown in Fig. 1.49. Draw the acceleration-time displacement -time and distance -time graphs for the particle.

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32. The figure below represents the acceleration-time graph of a particle at a given time. Assuming that the particle starts from rest, draw the velocity-time and displacement-time graphs for the particle.

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33. Identify the types of motion: whether it is one dimensional two dimensional or three dimensional.

(i) Kicking a football

(ii) Motion of clock needle

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34. Which of the following graphs represents one dimensional motion of a particle? Given reasons for your answer.

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35. Considering that a particle starts its motion from rest draw the displacement- velocity graph from the given acceleration-time graph.

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Exercise Multiple Choice Questions

1. A vehicle is moving with a uniform speed of 18 $\mathrm{km.h^{-1}}$. The distance covered by it in 1 s is

A. 18 m

B. 5 m

C. 10 m

D. 1 m

Answer: B

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2. Distance travelled by a particle in motion is directly proportional to the square of the time

of travel. In this stage acceleration of the particle is

A. increasing

B. decreasing

C. zero

D. constant

Answer: D

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3. A person covers half of his path at a speed of 30 $\mathrm{km.h^{-1}}$ and the remaining half at 40 $\mathrm{km.h^{-1}}$. His average speed is

A. 35 $\mathrm{km.h^{-1}}$

B. 60 $\mathrm{km.h^{-1}}$

C. 34.3 $\mathrm{km.h^{-1}}$

D. 50 $\mathrm{km.h^{-1}}$

Answer: C

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4. Starting from rest a car moves for sometime with a constant acceleration x and then with a constant retardation y and finally it comes to rest. If the car is in motion for a total time t, the maximum velocity of the car is

A. $\frac{xy}{x+y}.t$

B. $\frac{xy}{x-y}.t$

C. $\frac{x^2y^2}{x^2+y^2}.t$

D. $\frac{x^2y^2}{x^2-y^2}.t$

Answer: A

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5. Displacement (x) and time (t) of a particle in motion are related as x = at $+bt^2 - ct^3$ where a,b, and c, are constants. Velocity of the particle when its acceleration becomes zero is

A. $a + \frac{b^2}{c}$

B. $a + \frac{b^2}{2c}$

C. $a + \frac{b^2}{3c}$

D. $a + \frac{b^2}{4c}$

Answer: C

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6. The motion of a particle is described by the equation v = at. The distance travelled by the particle in the first 4s

A. 4a

B. 8a

C. 12a

D. 6a

Answer: B

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7. A particle starting from rest with constant acceleration travels a distance x in first 2s and a distance y in next 2s then

A. $y = 3x$

B. $y = 2x$

C. $y = x$

D. $y = 4x$

Answer: A

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8. The displacement of a particle is given by y = $a + bt + ct^2 + dt^4$. The initial velocity and acceleration are respectively

A. b,-4d

B. b, 2c

C. $-b, \ -2c$

D. 2c , -4d

Answer: B

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9. The displacement of a particle starting from rest (at t = 0) is given by s = $6t^2 - t^3$. The time in second at which the particle obtain zero velocity again is

A. 2

B. 4

C. 6

D. 8

Answer: B

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10. A car starts from rest and travels a distance s with a uniform acceleration f, then it travels with uniform velocity for a time t, and at last comes to rest with a uniform retardation $\frac{f}{2}$. If the total distance travelled is 5s. Then

A. s = ft

B. $s = \frac{1}{2} ft^2$

C. $s = \frac{1}{4} ft^2$

D. $s = \frac{1}{6} ft^2$

Answer: B

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11. Two stations A and B are 2km apart. A train moves at first with a uniform acceleration a_1 and then with a uniform retardation a_2 to travel the distance AB in 4 min.Then

A. $a_1 + a_2 = 2a_1a_2$

B. $\frac{1}{a_1} + \frac{1}{a_2} = \frac{1}{2}$

C. $a_1 + a_2 = 4a_1a_2$

D. $a_1 + a_2 = 2\sqrt{a_1a_2}$

Answer: C

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12. A car moves with a uniform velocity of 36 $km.\, h^{-1}$ on a straight road Then it attains a uniform acceleration and doubles its velocity in

10s. The radius of a wheel of the car it 25 cm. The number of complete rotations of the wheel in those 10s would be about

A. 84

B. 95

C. 126

D. 135

Answer: B

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13. Two scooters start at an interval of 1 min between them, each moving with a uniform acceleration of 0.4 m/s^2. How much later the distance between them would be 4.2 km?

A. 195s

B. 205s

C. 175s

D. 250s

Answer: B

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14. A passenger in a train with speed 72 km/h observed another train coming from the opposite direction with speed 32.4 km/ h . What is the length of the second train if it crosses the passenger in 10s ?

A. 300 m

B. 110 m

C. 2.9 m

D. 290 m

Answer: D

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15. A runner wins a race in front of another runner. The uniform accelerations of them were a_1 and a_2 respectively . The time taken by the first runner is less by t, and the velocity at the finishing point is higher by v, relative to the second runner. Then

A. $t = v\sqrt{a_1 a_2}$

B. $v = t\sqrt{a_1 a_2}$

C. $a_1 = a_2\sqrt{vt}$

D. $\frac{1}{v} = t\sqrt{a_1 a_2}$

Answer: B

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16. A body is thrown vertically upwards at 40 $\mathrm{m.s}^{-1}$. After sometime the body returns to the initial point at the same speed. Average velocity of the body for the motion is

A. $45\ \mathrm{m.s}^{-1}$

B. $40\ \mathrm{m.s}^{-1}$

C. $48\ \mathrm{m.s}^{-1}$

D. zero

Answer: D

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17. A body freely falling from rest has a velocity v after it falls through a height of h. The

distance it has to fall down for its velocity to become 2 v is

A. 4 h

B. 6 h

C. 8 h

D. 10 h

Answer: A

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18. A ball is thrown vertically upward with a speed v from a height h above the ground . The time taken for the ball to hit the ground is

A. $\frac{v}{g}\sqrt{1-\frac{2hg}{v^2}}$

B. $\sqrt{1+\frac{2hg}{v^2}}$

C. $\frac{v}{g}\left[1+\sqrt{1+\frac{2hg}{v^2}}\right]$

D. $\frac{v}{g}\sqrt{1+\frac{2hg}{v^2}}$

Answer: C

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19. A body A is thrown up vertically from the ground with a velocity v_0 and another body B is simultaneously dropped from from a height H. They meet at a height $\frac{H}{2}$, if v_0 is equal to

A. $\sqrt{2gH}$

B. $\sqrt{gH}$

C. $\frac{1}{2}\sqrt{gH}$

D. $\sqrt{\frac{2g}{H}}$

Answer: B

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20. A stone is dropped from a height h. Another stone is thrown simultaneously in the vertical direction so as to rise to a height 4h. How much later would the two stones cross each other?

A. $\sqrt{\frac{h}{8g}}$

B. $\sqrt{8gh}$

C. $\sqrt{2gh}$

D. $\sqrt{\frac{h}{2h}}$

Answer: A

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21. A stone is falling freely. The distance travelled in the last second is equal to that travelled in the first three seconds. The time spent by the stone in air is

A. 6s

B. 5 s

C. 7 s

D. 4 s

Answer: B

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22. A stone is thrown vertically upwards from some high point P. The velocity of the stone at a height h above P is half that at a depth h below P. The maximum height attained by the stone is

A. $\frac{7}{3}h$

B. $\frac{5}{3}$h

C. $\frac{7}{5}$h

D. $\frac{9}{7}$h

Answer: B

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23. A hail drop is falling freely due to gravity. It travels distance h_1, h_2 and h_3 respectively in the first second and third seconds of motion. The relation among h_1, h_2 and h_3 is

A. $h_1 = \frac{h_2}{3} = \frac{h_3}{5}$

B. $h_2 = 3h_1$ and $h_3 = h_2$

C. $h_1 = h_2 = h_3$

D. $h_1 = 2h_2 = 3h_3$

Answer: A

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24. A parachute is dropped from an aeroplane. The parachute opens after 10 s and then comes down with a uniform retardation of 2.5 $\mathrm{m.s}^{-2}$.

If the aeroplane was at a height of 2.495 km and g = 10 $\mathrm{m.s}^{-2}$, then the velocity at which the parachute touches the ground is

A. 2.5 $\mathrm{m.s}^{-1}$

B. 7.5 $\mathrm{m.s}^{-1}$

C. 5 $\mathrm{m.s}^{-1}$

D. 10 $\mathrm{m.s}^{-1}$

Answer: C

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25. A body falls freely from a certain height. It takes times t_1 and t_2 to travel the first and the first and the last half -distances, respectively. Then

A. $(\sqrt{2}+1)t_1 = t_2$

B. $(\sqrt{2}+1)t_2 = t_1$

C. $(\sqrt{2}-1)t_1 = t_2$

D. $(\sqrt{2}-1)t_2 = t_1$

Answer: C

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26. A small cube falls from rest along a frictionless inclined plane. If this distance travelled between times t = n -1 and t = n be s_n then the value of $\frac{s_n}{s_n + 1}$ is

A. $\frac{2n - 1}{2n}$

B. $\frac{2n + 1}{2n - 1}$

C. $\frac{2n - 1}{2n + 1}$

D. $\frac{2n}{2n + 1}$

Answer: C

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27. The area under velocity-time graph for a particle in a given interval to time represents -

(A) Velocity.

(B) Acceleration.

(C) Work done.

(D) Displacement.

A. velocity

B. acceleration

C. work done

D. displacement

Answer: D

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28. Which one of the following displacement-time graphs represents one dimensional motion of a particle?

A. 

B. 

C. 

D. 

Answer: D

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29. Position-time graph for motion with zero acceleration is

A. 

B. 

C. 

D. 

Answer: C

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30. On an acceleration- time graph, the area under the graph represents

A. distance travelled

B. active force

C. change of acceleration

D. change of velocity

Answer: D

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31. A ball is dropped on a fixed horizontal plane from a certain height. After recoil from the plane, it rises to a lower height. The correct nature of the height-time graph is

A. 

B. 

C. 

D. 

Answer: C

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Exercise Graphical Analysis

1. For a freely falling body the acceleration graph is -

(A) Straight line parallel to the acceleration axis.

(B) Straight line parallel ot the time axis.

(C) Straight line passing through the origin.

(D) Parabola passing through the origin.

A. straight line parallel to the acceleration axis

B. straight line parallel ot the time axis

C. straight line passing through the origin

D. parabola passing through the origin

Answer: B

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Exercise Miscellaneous

1. Equation of motion of a particle is $x = \left(2t^2 - t^3\right)m$. Calculate the acceleration in t=2 s.

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2. In a three dimensional space of zero gravity, the equation of motion of a partical is

A. one-dimensional

B. two-dimensional

C. three-dimensional

D. four-dimensional

Answer: A

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3. Which of the following is a one-dimensional motion?

(A) Landing of an aircraft.

(B) Earth revolving around the sun.

(C) Motion of wheels of a moving train.

(D) Train running on a straight track.

A. Landing of an aircraft

B. Earth revolving around the sun

C. Motion of wheels of a moving train

D. Train running on a straight track

Answer: D

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Very Short Answer Type Questions

1. A particle is in uniform motion with respect to a reference frame. Is it possible for the particle to be at rest with respect to another frame?

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2. Retardation is essentially a _____ acceleration.

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3. For a particle displacement (x) and time (t) are related by the following equation : x = $\left(3t^2 + 2t + 5\right)$m. If time is expressed in second, find the initial velocity of the particle.

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4. Displacement of a moving particle is directly proportional to the square of the time duration. State whether the particle is moving at a constant velocity or at a constant acceleration.

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5. When is the average velocity of a particle equal to its instantaneous velocity?

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6. Does a particle with a uniform speed in a curved path posses any acceleration?

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7. How many dimensions are there in the motion of a ship in a turbulent sea?

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8. If position of a particle at instant t is given by x = t^4 find acceleration of the particle.

Watch Video Solution

9. For a moving body displacement y (in meter) and time t (in second) are related as $y = \frac{2}{3}t^2 - 16t + 2$. When will the body stop?

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10. Displacement equation for a particle moving in a straight line is x = $at^3 + \beta t^2 + \gamma t + \delta$. The ratio of the initial acceleration to the initial velocity depends only on _____ .[Fill in the blank]

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11. Motion of an artificial satellite around the earth is a _____ dimensional motion. [Fill in the blank]

Watch Video Solution

Watch Video Solution

12. An athlete runs with a velocity of 18 $\mathrm{km.h^{-1}}$. How much distance will he cover in 10 min?

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Very Short Answer Type Questions Graphical Analysis

1. What is the nature of the time-displacement graph for a particle moving with a constant

velocity?

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2. What does the slope of a position-time graph represent ?

Watch Video Solution

3. Area under v-t graph = ?

Watch Video Solution

4. In the same displacement -time graph , two motions are represented by two straight lines having slopes 45° and 60° respectively. Which line represents a higher velocity and what is the ratio between the first and the second velocities?

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5. Velocity (in $\mathrm{m.s}^{-1}$ unit)-time (in s unit) graph of a particle moving in a straight line is a straight line and it is inclined at an angle 45°

with the time axis. What is the acceleration of the particle ?

Watch Video Solution

Short Answer Type Questions I

1. Can the directions of velocity and acceleration be opposite to each other? Explain with examples.

Or,Can the velocity of a particle be towards east but its acceleration towards west?

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2. Explain with an example how a moving body can have a uniform acceleration even if its velocity is zero?

Or, Is it possible for a moving particle to have a non zero acceleration but zero velocity?

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3. What is meant by a frame of reference ? Does the magnitude of a physical quantity

depend on the choice of frame of reference ?

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4. The distance travelled by a body is directly proportional to the square of time. What type of motion this body has?

Watch Video Solution

5. What is the difference between distance travelled and displacement? What are the

characteristics of displacement?

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Short Answer Type Questions Ii

1. Drivers are trained that if the velocity of a car is doubled then the distance required to bring the car to a halt should be four times. Explain.

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2. State in each case if the motion is one two or three dimensional.

A paper flying on a wind day

Watch Video Solution

3. State in each case if the motion is one two or three dimensional.

A train accelerating on a long straight track

Watch Video Solution

4. State in each case if the motion is one two or three dimensional.

An ant moving on a globe

Watch Video Solution

5. State in each case if the motion is one two or three dimensional.

The earth revolving around the sun

Watch Video Solution

6. Acceleration is defined as the rate of change of velocity Suppose we call the rate of change of acceleration SLAP.

(i) What is the unit of SLAP?

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7. Acceleration is defined as the rate of change of velocity Suppose we call the rate of change of acceleration SLAP.

How can you calculate instantaneous SLAP?

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Watch Video Solution

8. Draw the displacement -time graphs for a particle moving with (i) uniform , (ii) non-uniform velocity.

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Problem Set I Based On Speed Velocity And Acceleration

1. A car moves with a speed of 30 $\mathrm{km.h^{-1}}$ in half of the total time taken and with 40 $\mathrm{km.h^{-1}}$ rest of the time, What is the average speed of the body?

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2. An object after travelling at a uniform velocity of $4\mathrm{m.s^{-1}}$ for 5 s travels with a constant acceleration of 0.5 $\mathrm{m.s^{-2}}$ in the same direction for another 5s. Find the average velocity throughout the journey.

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3. Distance covered by a particle moving in a straight line from origin in time t is given by x = t-$6t^2 + t^3$. For what value of t, will the particle's acceleration be zero?

Watch Video Solution

4. Relation between distance covered s and time t of a moving particles is ,

$s = 2t^3 - 4t^2 + 3t$, What will be the velocity and acceleration after 3 s?

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5. A motor car covers $\frac{1}{3}$ part of total distance with velocity $v_1 = 10\text{km.h}^{-1}$, the second $\frac{1}{3}$ part with velocity $v_2 = 20\text{km.h}^{-1}$ and the rest with velocity $v_3 = 60\text{km.h}^{-1}$. What is the average speed of the car?

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6. A train 500 m long crosses a bridge of 1000 m in 10 s. Find the average speed of the train.

Watch Video Solution

7. The displacement -time graphs of two bodies P and Q are straight lines making angles 30° and 60° respectively with the time axis. Calculate the ratio of the velocities of P and Q.

Watch Video Solution

8. The velocity v of a particle is related to time t as $v = 4 + 2(c_1 + c_2 t)$, where c_1 and c_2 are constants . Find out the initial velocity and acceleration.

Watch Video Solution

9. The coordinates of a body at time t are x = 7t+$4t^2$ and y = 5t, where x and y are in metres and t in seconds . What its acceleration at t = 5s?

Watch Video Solution

Watch Video Solution

10. A ball moving at 30 m/s towards south is hit by a cricketer by his bat. As a result, the ball moves towards north at 20 m/s. What is the change in velocity ? If the collision lasts for 0.02s , what is the acceleration?

Watch Video Solution

Problem Set I Based On Rectilinear Motion

1. A train moving at $54 km.\ h^{-1}$ is brought to rest in 1 min on application of brakes. What is the retardation of the train? Also find the distance travelled by the train after application of the brakes.

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2. Velocity of a particle changes from 10 $\mathrm{cm.s}^{-1}$ to 20 $\mathrm{cm.s}^{-1}$ as it covers a path of 50 cm with a uniform acceleration. Find the acceleration.

Watch Video Solution

3. Starting from rest and under constant acceleration an object covers 400 m.

(i) How far does the object move in half the time ?

Watch Video Solution

4. Starting from rest and under constant acceleration an object covers 400 m.

What percentage of the total time will be required by the object to cover half of its path?

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5. On penetrating 1 cm of a wooden block a bullet loses half of its velocity. How far would it penetrate before it comes to rest ?

Watch Video Solution

6. A bullet, on penetrating two successive wooden planks of unequal thickness loses its velocity by 200 $\mathrm{m.s}^{-1}$ in each case. If the initial velocity of the bullet is 1000 $\mathrm{m.s}^{-1}$ calculate the acceleration after 2 seconds.

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7. The position x of a particle varies with t as x = $at^2 - bt^3$. Calculate the acceleration after 2 seconds.

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8. A particle is in motion along a straight track. As it crosses a fixed point a stop- watch is started. The particle travels a distance 180 cm in the first 3 s and 220 cm in the next 5 s. What will be its velocity at the end of ninth second ?

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9. During the n th second of its motion a body covers a distance s_n with uniform acceleration

a and initial velocity u. Show that a = $\frac{2s_n - 2u}{2n - 1}$

.

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10. A particle starts from rest with a uniform acceleration and travels 57 cm in the 10th second. Find out this distance travelled in 12 s and the velocity at that instant.

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11. A particle moves along a straight line with uniform acceleration. If it travels through distances a and b, respectively in the l- th and m-th seconds then prove that the distance travelled in the n-th second is $s_n = \frac{a(n-m)+b(l-n)}{l-m}$

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12. A particle covers 25 cm and 33 cm in the 5 th and 7 th seconds respectively. What is the

velocity of the particle 9 seconds after the initiation of the journey?

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13. If a particle starting from rest travels a distance x in first 2s and a further distance y in the next 3 s, then find the relation between x and y.

Watch Video Solution

Problem Set I Based On Vertical Motion

1. A piece of stone is dropped from a height of 19.6 m. What will be the time required for the stone to cover the last metre of its path? [g = 9.8 $\mathrm{m.s^{-1}}$]

Watch Video Solution

2. Prove that the path covered by a body projected vertically upwards during the last second of its upward motion is equal to the

path covered by a freely falling body during the first second of its downward motion.

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3. A rocket is fired vertically upwards with an acceleration. $10\mathrm{m.s}^{-2}$. To what maximum height would the rocket rise if its fuel gets exhausted in 1 min?

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4. A balloon is rising upwards with an acceleration. A stone is dropped frome the balloon, is at a height of 50.4 m. The stone reaches the ground after 6s. What was the velocity of the balloon when the stone was dropped?

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5. A food packet is released from a helicopter which is rising steadily at 2 $\mathrm{m.s}^{-1}$. After 2 s what is the velocity of the packet?

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6. A food packet is released from a helicopter which is rising steadily at 2 $\mathrm{m.s}^{-1}$. After 2 s how far is it below the helicopter? G = 9.8 $\mathrm{m.s}^{-2}$

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7. A stone is dropped from the top of a tower 50 m high. Simultaneously another stone is

thrown upwards from the ground with a speed of 20 $\mathrm{m.s}^{-1}$. Calculate the time at which both the stone cross each other.

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8. A ball A is dropped from a certain height h. Another ball B is thrown simultaneously from the ground vertically upwards with a velocity $\sqrt{gh}$. When and where would the two balls cross each other?

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9. A ball dropped from a height of 10 m rebounds from the floor and rises to a height of 2.5 m. If the ball spends 0.01 s in contact with the floor then find out the average acceleration during that contact.

Watch Video Solution

10. A body falling freely from a certain height travels half of that height in the last second of

its motion. Find the height from which it stated to fall.

Watch Video Solution

11. The s-t graph of a particle moving with constant acceleration at time t, makes an angle 45° with the time axis. After 1 second the angle changes to 60°. Find the acceleration of the particle.

Watch Video Solution

Problem Set Ii Based On Speed Velocity And Acceleration

1. An athlete covers a circular path of radius 70 m in 55 s and returns to the starting point. Find the magnitude of his aevrage speed and averge velocity. If he completes the last 40 m of the path at the same rate in 4 s, find the value of instantaneous speed and velocity in that interval of time.

View Text Solution

2. A partical is moving along the x-axis. The position of the partical at any instant is given by x = a+bt^2 where, a = 6 m and b = 3.5 $\mathrm{m.s}^{-2}$,t is measured in second. Find

the velocity of the partical at t = 3s .

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3. A partical is moving along the x-axis. The position of the partical at any instant is given by x = a+bt^2 where, a = 6 m and b = 3.5 $\mathrm{m.s}^{-2}$,t

is measured in second. Find

the average velocity between t = 3s and t = 6 s.

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4. Two towns A and B are connected by a regular bus service with a bus leaving in either direction every T minutes. A man cycling with a speed of 20 $\mathrm{km.h^{-1}}$ in the direction A to B notices that bus goes past him every 18 min in the direction of his motion, and every 6 min in the opposite direction. What is the period T of

the bus service and with what speed (assumed constant) do the buses ply on the road?

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Problem Set Ii Based On Rectilinear Motion

1. An object, starting with an initial speed and moving at constant acceleration travels 150 m in 5 s. The acceleration stops after this and in the next 5 s the object travels 200 m farther.

Find the initial velocity and acceleration of the object.

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2. A train begins its journey from a station with a uniform acceleration of 0.2 $\mathrm{m.s}^{-2}$ and moves for 1 min. Next, it moves for a further 5 min at uniform velocity. It then applies brakes producing a retardation of 0.3 $\mathrm{m.s}^{-2}$ and stops at the next station. What is the distance between the two station?

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3. An object moving with a constant acceleration covers 145 cm and 185cm, during its 6th and 10th second of motion respectively. What distance would it cover in the 16th second?

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4. A policeman starts chasing a thief with a uniform velocity V along a straight path in a

jeep. When the jeep is at a distance d from the thief rides on a motorcycle and moves with a constant acceleration a starting from rest. Show that the policeman can catch the thief if $V > \sqrt{2ad}$.

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5. When a train start from rest with a uniform acceleration of 2 $\mathrm{m.s}^{-2}$, a man was exactly 9 m behind the door of the train. The man

moving with a constant speed could just board the train. What was the speed of the man?

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6. Two particles start moving from point A along a straight line AB at the same time in the same direction. One particle moves with a uniform velocity of 12 $\mathrm{m.s}^{-1}$ and the other with an acceleration of 2 $\mathrm{m.s}^{-2}$ and an initial velocity of 5 $\mathrm{m.s}^{-1}$. After how much time will the two particles meet ?

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7. Car A moving along a straight horizontal road with a velocity 60 $\mathrm{km.h^{-1}}$ is followed by car B moving with a velocity 70 $\mathrm{km.h^{-1}}$. When car B is at a distance 2.5 km from car A car B applies a retardation of 20 $\mathrm{km.h^{-2}}$. Where and when will the two cars meet?

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8. A partical covers 35 cm, 50 cm, 89 cm distances during the third, seventh and twelfth seconds respectively of ite motion. Show that the partical is moving with a constant acceleration. Find (i) initial velocity and (ii) distance covered in 8 s by the partical.

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9. A jet plane starts from rest with an acceleration of 3 $\mathrm{m.s}^{-2}$, and makes a run for 35 s before taking off. What is the minimum

length of the runway and what is the velocity of the jet at take off?

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10. A partical is subjected to an acceleration $a = \alpha t^1 + \beta t^2$, where α and β are constants. The velocity of the partical at t = 0 is $v0$. What is the expressions for velocity v of the particle at time t?

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11. A body travels 400 cm in the 3rd second and 1200 cm in the 5th second. If the motion is uniformly accelerated, how far willl it travel in next 3 seconds?

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12. The displacement x of a particle in rectilinear motion at time t is represented as $x^2 = at^2 + 2bt + c$, where a ,b, and c are constants. Show that the acceleration of this particle varies $\frac{1}{x^3}$.

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13. A particle moves along a straight line retardation a = $k\sqrt{v}$ [k is a positive constant]. The velocity of the particle at time t = 0 is u. How far would the particle move before coming to rest ?

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14. A particle is moving along a straight line OX. The displacement (x) from the point o and the time (t) taken are related as x = 40 +12t- t^3, where x is in metre and t in second. How far would the particle move before coming to rest ?

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15. A train of length 200 m is moving with uniform acceleration. It front and rear crosses a post beside the railtrack with velocities u and

v respectively. Show that the mid-point of the train crosses the post with a velocity $\sqrt{\frac{u^2+v^2}{2}}$.

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16. A car starts from rest and travels with uniform acceleration α for some time and then with uniform retardation β and comes to rest. If the total time of travel of the car is t, then what is the maximum velocity attained by the car ?

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17. On a two-lane car A is travelling with a speed of 36 $\mathrm{km.h}^{-1}$. Two cars B and C approach car A in opposite directions with a speed of 54 $\mathrm{km.h}^{-1}$ each. At a certain instant when the distance AB is equal to AC both being 1 km, B decides to overtake A before C does. What minimum acceleration of car B is required to avoid an accident?

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Problem Set Ii Based On Vertical Motion

1. A piece of stone is dropped from the top of a tower 90 m tall and at the same time another piece of stone is thrown upwards with a velocity of 30 $\mathrm{m.s}^{-1}$ from the base of the tower. When and where will the stone pieces meet?

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2. A man bailed out of a balloon. After some time the parachute opened up and he could land on the earth's surface with a retardation of $2.4 \mathrm{m.s}^{-2}$ and took 4 times that elapsed before the parachute opened. If the balloon was at a height of 398.4 m, how long was he airborne ?

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3. A lift of height 3.375 m is moving up with an acceleration of 2.2 $\mathrm{m.s}^{-2}$. What is the time

required by any object to fall from the roof of the lift to its floor?

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4. When a piece of stone is dropped in a deep well the sound of splash is heard 7.7 s after it is dropped. If speed of sound is 343 $\mathrm{m.s}^{-1}$ find the depth of the well.

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5. Two pieces of stone are thrown vertically upwards at the same time. One reaches a height 35 m more than the other and touches the ground 2s later. What are the initial velocities of the stones ? [g =10 $\mathrm{m.s^{-2}}$]

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6. A balloon rising vertically up with uniform velocity 15 $\mathrm{m.s^{-1}}$ releases a ball at a height of 100 m. Calculate the time taken by the ball to hit the ground. Take g = $10\mathrm{m.s^{-2}}$.

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7. Drops of water from the roof of a house are falling at a regular interval of one second. Find the position of 3rd, 4th and 5th drops when the 6th drop just falls from the roof.

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8. A juggler is showing a trick with n balls. When one of the balls is in his hand all of the

rest are in flight. If each ball rises to a height of h, then how long does the juggler hold a ball before throwing it up?

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9. Water drops are falling at regular intervals from the defective roof of a room of height 6 m. When the first drop touches this floor the third drop is about to fall from the roof. What would be the height above the floor of the second drop at that instant ?

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Problem Set Ii Miscellaneous

1. A man walks on a straight road from his home to a market 2.5 km away with a speed of 5 km.h^{-1} . Finding the market closed he instantly turns and walks back home with a speed of 7.5 km.h^{-1} . What is the

(a) magnitude of average velocity and

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2. A man walks on a straight road from his home to a market 2.5 km away with a speed of 5 km.h^{-1} . Finding the market closed he instantly turns and walks back home with a speed of 7.5 km.h^{-1} . What is the

average speed of the man over the interval of time (i) 0 to 30 min (ii) 0 to 50 min (iii) 0 to 40 min?

[Note: you will appreciate speed as total path length divided by time and not as magnitude of average velocity. You would not like to tell

the tired man on his return home that his average speed was zero!]

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3. An object moving with a speed of 6.25 $\mathrm{m.s}^{-1}$ is decelerated at a rate given by:

$$\frac{dv}{dt} = -2.5\sqrt{v}$$

where v is the instantaneous speed. What would be the time taken by the object to come to rest?

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4. Suggest a suitable physical situation for each of the following graphs :

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5. Two boys are standing at the two end-points A and B of a field where AB = a. The boy at B now starts running at a uniform speed v_1 in a direction perpendicular to AB. Simultaneously, the boy at A also starts at a uniform speed v

along a straight line and meets B after a time t.

Find t.

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6. Along a vertical oily part a monkey rises for the first 3 s and then slips down for the next 3 s. The velocity of the monkey is given as

v(t) = 2t(3-t), when $0 < t < 3$ and v (t) = -(t-3) (6-t), when $3 < t < 6$

Find (i) the average speed of the monkey (ii) time at which its speed is maximum.

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Hots Numerical Problems Based On Rectilinear Motion

1. A car starting with velocity 10 $\mathrm{m.s}^{-1}$ attains an acceleration 1 $\mathrm{m.s}^{-2}$.

After what time interval will its velocity be 20 $\mathrm{m.s}^{-1}$?

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2. A car starting with velocity 10 $\mathrm{m.s}^{-1}$ attains an acceleration 1 $\mathrm{m.s}^{-2}$.

What would be the distance traveled in time interval 10 sec?

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3. A car starting with velocity 10 $\mathrm{m.s}^{-1}$ attains an acceleration 1 $\mathrm{m.s}^{-2}$.

What would be the velocity after traveling the first 100 m of the path?

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4. The acceleration of an obeject starting from rest is related to time as a = Kt+c. What will be its velocity after time t ?

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5. A particle starts moving from rest with uniform acceleration. It travels a distance x in first 2 seconds and distance y in the next 2 seconds. Then:

A. $y=3x$

B. $y=4x$

C. $y=x$

D. $y=2x$

Answer:

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6. A body with a uniform acceleration travels $\frac{9}{25}$ part of its total path during the last second of its motion. If the body, starting from

rest travel 6 cm in the first second

how long does the body remain in motion?

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7. A body with a uniform acceleration travels $\frac{9}{25}$ part of its total path during the last second of its motion. If the body, starting from rest travel 6 cm in the first second

What is the length of the total path traveled ?

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8. A particle was at x =0 at t = 0 . It moves with velocity v along the positive x -axis . If v changes with respect to x following the rule v = k $\sqrt{x}$, how do its velocity and acceleration change with time?

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9. Two trains, moving at velocities u_1 and u_2 travel along the same line towards each other. Drivers of both the trains when the trains are at a distance x apart simultaneously apply

brakes producing retardations a_1 and a_2 , respectively. Prove that a collision can be avoided only if $u_1^2 a_2 + u_2^2 a_1 = 2a_1 a_2 x$.

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10. Acceleration of a body is given by a = $2\sqrt{t}$, where t is the time. If the body starts from rest what will be its velocity and acceleration 4 s later ? [SI units are to be used]

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11. A particle moves in a straight line with constant acceleration, starting from a point on the line. It moves through distances a ,b,c and d, in 0. n, 2n and 3n s respectively. Show that, (i) d-a = 3(c-b) (ii) initial velocity = $\frac{4b-3a-c}{2n}$ and (iii) acceleration = $\frac{c+a-2b}{n^2}$.

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12. A particle with constant acceleration travels x m in t th second and y m in (t+n)th second. Show that the acceleration is $\frac{y-x}{n}\mathrm{m.s}^{-2}$.

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13. A train starts from a station and stops at another station. First the velocity of the train increases at a uniform rate, reaches a maximum velocity v and then starts decreasing at a constant rate. If the time spent for the entire journey is t, prove that the distance between the two stations is $\frac{1}{2}$vt.

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14. Starting from rest a body moves at first with constant acceleration a. Then it moves with a uniform velocity and finally comes to rest with a constant retardation a. If the displacement is s and time taken is t, prove that the body was in motion with uniform velocity for a time interval of $\sqrt{t^2 - 4s/a}$.

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15. A particle crosses points A, B, C in a straight line at a constant acceleration. The particle

travels from A to B in time t_1 and B to C in time t_2 . If AB = a , BC = b then prove that the acceleration of the particle is $2(bt_1 - at_2)/t_1t_2(t_1 + t_2)$.

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16. A particle moves along a straight line with a retardations of av^{n+1} , where v is the velocity at time t and a is a positive constant. If at t = 0 the velocity of the particle is u, show that at = $\frac{1}{n}\left(\frac{1}{v^n} - \frac{1}{u^n}\right)$.

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17. If the time taken by a particle moving at constant acceleration to travel equal distances along a straight line are t_1, t_2, t_3 respectively prove that $\frac{1}{t_1} - \frac{1}{t_2} + \frac{1}{t_3} = \frac{3}{t_1 + t_2 + t_3}$.

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18. An object moving with a constant acceleration in a straight line travels from A to B. At half -time , the position of the object is P .

Prove that $\frac{AP}{BP} = \frac{3u+v}{3v+u}$, where u and v are the velocities at A and B respectively.

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19. A particle travels half of the distance between A and B with a velocity v_0. During half of the time required to travel the remaining distance the particle moves with a velocity v_1 and the rest with a velocity v_2. Find the average velocity of the particle.

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20. A train, initially at station A , starts its journey and eventually stops at station B after travelling a distance s . The first part of its journey is under uniform acceleration u and the later part under uniform retardation v . Show that the time taken for the journey is $\sqrt{2s\left(\frac{1}{u}+\frac{1}{v}\right)}$.

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21. Two cyclists are in motion towards each other along a slightly inclined hill road. The first cyclist starts with a velocity of 5.4 kg /h and attains a downhill acceleration $0.2m/s^2$. The second cyclist is under an uphill retardation of 0.2 m/s^2 after starting with a velocity of 18 km/h . If the initial distance between them is 130 m , then when would they meet? What would be their velocities at that instant?

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22. The velocity of a particle moving along the positive direction of x-axis is v=$A\sqrt{x}$, where A is a positive constant. At time t = 0 , the displacement of the particle is taken as x = 0 . (i) Express velocity and acceleration as functions of time , and (ii) find out the average velocity of the particle in the period when it travels through a distance s ?

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23. A particle, starting from rest, is in uniform acceleration. Its displacement in (P- 1) seconds and P seconds are $s_1$and s_2 respectively . Then what would be its displacement in the $\left(P^2 - P + 1\right)$ -th second?

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24. From what height should a stone be dropped so that the ratio of the distances traveled during the first and the last second of

the fall is 1:9 ? Find the total time of its fall. [$g = 9.8\mathrm{m.s}^{-2}$].

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25. Points P, Q and R are in a vertical line such that PQ = QR. A ball at P is allowed to fall freely. The ratio of times of descent through PQ and QR is

A. 1:1

B. $1:\sqrt{2}$

C. $1:\left(\sqrt{2}-1\right)$

D. $1:\left(\sqrt{2}+1\right)$

Answer: 80 m, 4 s

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26. An object is thrown vertically upward with a speed of 30 $m.s^{-1}$.The velocity of the object half a second before it reaches the maximum height is

A. $4.9m.s^{-1}$

B. $9.8 m.s^{-1}$

C. $19.6 m.s^{-1}$

D. $25 m.s^{-1}$

Answer:

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27. A lift starts moving upwards from ground with a constant acceleration a $cm.s^{-2}$. After t s a piece of stone is dropped from it. Show that

the stone touches the ground after $\frac{t\sqrt{a}}{g}\left(\sqrt{a}+\sqrt{a+g}\right)s.$

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28. A piece of stone is dropped from the top of a pillar. It travels the last h ft of the height in t s. Prove that the time of fall for the stone is $\left(\frac{t}{2}+\frac{h}{\mathrm{gt}}\right)$s.

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29. Figure 1.68 gives the speed -time graph of a particle in motion along a constant direction. Three equal intervals of time are shown. In which interval is the average acceleration greatest in magnitude ? In which interval is the average speed greatest? Choosing the positive direction as the constant direction of motion give the signs of v and a in the three intervals. What are the acceleration at the points A,B,C and D?

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30. Two stones are thrown up simultaneously from the edge of a cliff 200 m high with initial speeds of 15 $\mathrm{m.s^{-1}}$ and 30 $\mathrm{m.s^{-1}}$. Verify that the graph shown in correctly represents the time variation of the relative position of the second stone with respect to the first. Neglect air resistance and assume that the stones do not rebound after hitting the ground. Take g = 10 m.s^{-2}. Give the equations for the linear and curved parts of the plot.

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Entrance Corner Assertion Reason Type

1. These questions have statement I and statement II. Of the four choices given below, choose the one that best describes the two statements.

Statement I : The average velocity of a particle may be equal to its instantaneous velocity.

Statement II: For a given time interval of a

given motion average velocity is single valued while average speed can have many values.

A. Statement I is true, statement II is true , statement II is a correct explanation for statement I.

B. Statement I is true statement II is true , statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: C

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2. Statement I : A scooter moves towards north and then moves towards south with the same speed. There will be no change in the velocity of scooter.

Statement II : Velocity is a vector quantity.

A. Statement I is true, statement II is true , statement II is a correct explanation for

statement I.

B. Statement I is true statement II is true , statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: D

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3. Statement I : An object can possess acceleration even when it has a uniform speed.

Statement II : When the direction of motion of an object keeps changing, its velocity also changes with time.

A. Statement I is true, statement II is true , statement II is a correct explanation for statement I.

B. Statement I is true statement II is true , statement II is not a correct explanation

for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: A

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4. Statement I : Acceleration of a moving particle can change its direction without any change in the direction of velocity.

Statement II : If the direction two particles

moving with constant velocities always remains vector also changes.

A. Statement I is true, statement II is true , statement II is a correct explanation for statement I.

B. Statement I is true statement II is true , statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: B

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5. Statement I : Distance between two particles moving with constant velocities always remains constant.

Statement II : The relative motion between two particles moving with constant velocities always remains constant.

A. Statement I is true, statement II is true , statement II is a correct explanation for statement I.

B. Statement I is true statement II is true , statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: D

6. Statement I : A particle with zero velocity may have a non - zero acceleration.

Statement II : A particle comes to rest at the instant of reversing its direction of motion.

A. Statement I is true, statement II is true , statement II is a correct explanation for statement I.

B. Statement I is true statement II is true , statement II is not a correct explanation

for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: A

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7. Statement I : A particle moving with uniform acceleration has its displacement proportional to the square of time.

Statement II : If the motion of a particle is

represented by a straight line on the velocity - time graph its acceleration is uniform.

A. Statement I is true, statement II is true , statement II is a correct explanation for statement I.

B. Statement I is true statement II is true , statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: B

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8. Statement I : A freely falling body travels through distances in this ratio $1:3:5:7:\cdots$ in successive equal intervals of time (Galileo's law of odd integers).

Statement II : In one -dimensional motion, a particle with zero speed may have a non-zero velocity.

A. Statement I is true, statement II is true , statement II is a correct explanation for statement I.

B. Statement I is true statement II is true , statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: C

9. Statement I : If the average velocity of a body is equal in two successive time intervals, its velocity is a constant.

Statement II : When a body travels with constant velocity its displacement is proportional to time.

A. Statement I is true, statement II is true , statement II is a correct explanation for statement I.

B. Statement I is true statement II is true , statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: D

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10. Statement I : If two bodies of different masses one dropped simultaneously from the same height then they touch the ground simultaneously.

Statement II : The time of flight of a freely falling body is independent of its mass.

A. Statement I is true, statement II is true , statement II is a correct explanation for statement I.

B. Statement I is true statement II is true , statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: A

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11. Statement I : The distance between two bodies does not change if they move in the same direction with the same constant acceleration.

Statement II : Two bodies moving with the same velocity are at rest relative to each other.

A. Statement I is true, statement II is true , statement II is a correct explanation for statement I.

B. Statement I is true statement II is true , statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: D

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12. Statement I : A body is dropped from a height h and another body is thrown simultaneously from the ground with a velocity u in the vertically upward direction. The meet after a time of $\frac{h}{u}$.

Statement II : For a body projected in the vertically upward direction the ascent in the last second is always 4.9 m, whatever be the velocity of projection.

A. Statement I is true, statement II is true , statement II is a correct explanation for

statement I.

B. Statement I is true statement II is true , statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: B

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Entrance Corner Multiple Correct Answers Type

1. A body will speed up if

A. velocity and acceleration are in the same direction.

B. velocity and acceleration are in perpendicular directions .

C. velocity and acceleration are in perpendicular directions.

D. velocity and acceleration are acting at an acute angle with respect to each other.

Answer: A::D

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2. Two bodies having masses m_1 and m_2 are dropped from heights h_1 and h_2 respectively. They reach the ground after times t_1 and t_2 and strike the ground with velocities v_1 and v_2 respectively. Choose the correct relations from the following:

A. $\frac{t_1}{t_2} = \sqrt{\frac{h_1}{h_2}}$

B. $\frac{t_1}{t_2} = \sqrt{\frac{h_2}{h_1}}$

C. $\frac{v_1}{v_2} = \sqrt{\frac{h_1}{h_2}}$

D. $\frac{v_1}{v_2} = \frac{h_2}{h_1}$

Answer: A::C

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3. Mark the correct statements.

A. instantaneous velocity is always in the direction of motion

B. instantaneous acceleration is always in the direction of motion

C. instantaneous acceleration is always in the direction of instantaneous velocity

D. instantaneous velocity and instantaneous acceleration may be in opposity directions

Answer: A::D

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4. Of the following situations which are possible in practice

A. zero velocity and non-zero acceleration

B. constant velocity and variable acceleration

C. variable velocity and constant acceleration

D. non-zero velocity and zero acceleration

Answer: A::C::D

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5. In the motion of the tip of the second -hand of a clock which of the following quantities are zero after an interval of 1 min?

A. displacement

B. distance travelled

C. average speed

D. average velocity

Answer: A::D

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6. A particle is moving with a uniform acceleration along a straight line AB. Its velocity at A and B are 2 m/s and 14 m/s respectively. Then

A. the velocity is 10 m/s at the midpoint C of AB

B. the velocity is 6 m/s at an intermediate point P, for which AP : PB = 1:5

C. the time taken to travel the distance AC (C is the midpoint of AB) is twice that for the distance CB

D. at half-time the particle travels one fourth of the total distance

Answer: A::B::C

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7. The displacement (s) of a particle depends on time (t) as s = $2at^2 - bt^3$. Then

A. the particle will come to rest after a time $\frac{4a}{3b}$

B. the particle comes back to the starting point after a time $\frac{2a}{b}$

C. the acceleration is zero at a time $\frac{2a}{3b}$

D. the initial velocity is zero but the initial acceleration is not

Answer: A::B::C::D

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8. A object falls from rest through a resistive medium. The equation of its motion is $\frac{dv}{dt} = \alpha - \beta v$. Then

A. the initial acceleration = α

B. at time t , the velocity = $\frac{\alpha}{\beta}\left(1 - e^{-\beta t}\right)$

C. when the acceleration is zero the velocity

$= \frac{\alpha}{\beta}$

D. the constant β has the dimension of time

Answer: A::B::C

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9. The acceleration (a) and the velocity of a particle in rectilinear motion are related as a = $-\sqrt{v}$. Then

A. if the particle comes to rest after 1 s its initial velocity = 0.25 m/s

B. if the initial velocityis v_0 then after a time t velocity = $v_0 - \sqrt{v_0}t + \frac{t^2}{4}$

C. if the initial velocity is v_0 then after a fine t, velocity = v_0-at

D. if the initial velocity is 1 m/s the particle comes to rest after 2 s

Answer: A::B::D

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10. A body thrown vertically upwards from a point with a velocity v_0 rises to a maximum height and then comes back to the point. Then

A. the average velocity of downward motion is $\frac{v_0}{2}$

B. the average speed in the flight is zero

C. the time of flight is $\frac{2v_0}{g}$

D. the acceleration in the whole flight is not uniform

Answer: A::C

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Entrance Corner Comprehension Type

1. Vertical rise or fall of a particle under gravity is governed by the equations : (i) v =u +gt, (ii) h = ut + $\frac{1}{2}gt^2$, and (iii) $v^2 = u^2 + 2gh$ the symbols having their usual meanings. Then for a particle dropped from the top of a tower and falling freely. choose the correct options:

(i) The distance covered by it after n seconds is directly proportional to

A. n^2

B. n

C. 2n-1

D. $2n^2 - 1$

Answer: A

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2. Vertical rise or fall of a particle under gravity is governed by the equations : (i) v =u +gt, (ii) h = ut + $\frac{1}{2}gt^2$, and (iii) $v^2 = u^2 + 2gh$ the symbols having their usual meanings. Then for a particle dropped from the top of a tower and falling freely. choose the correct options:

The distance covered in the nth second is proportional to

A. n^2

B. n

C. 2n-1

D. $2n^2 - 1$

Answer: C

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3. Vertical rise or fall of a particle under gravity is governed by the equations : (i) v =u +gt, (ii) h = ut + $\frac{1}{2}gt^2$, and (iii) $v^2 = u^2 + 2gh$ the symbols having their usual meanings. Then for a particle dropped from the top of a tower and falling freely. choose the correct options:

The velocity of the body after n second is proportional to

A. n^2

B. n

C. $2n - 1$

D. $2n^2 - 1$

Answer: B

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Entrance Corner Integer Answer Type

1. The displacement x of a particle moving in one dimension under the action of a constant force is related to time t by the equation t = $\sqrt{x+3}$ where x is in meters and t is in seconds. Finds the displacement (in metres) of the particle when its velocity is zero.

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2. The motion of a body is defined by $\frac{dv(t)}{dt}$ = 6-3 v(t) where v (t) is the velocity (in m/s) of

the body at time t (in seconds). If the body was at rest at t= 0 , find its velocity (in m/s) when the acceleration is half the initial value.

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3. A balloon is at a height of $40m$ and is ascending with a velocity of $10\mathrm{m.s}^{-1}$. A bag of $5kg$ weight is dropped from it. When will the bag reach the surface of the earth? Given $g = 10\mathrm{m.s}^{-2}$.

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4. A bike initially at rest travels the first $20m$ in $4s$ along a straight line with constant acceleration. Determine the acceleration of the bike in $\mathrm{m.s}^{-2}$.

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5. Starting from rest a particle moving along a straight line attains a speed of $2\ \mathrm{m.s}^{-1}$ in $1.5s$. What is the particle's speed after an

additional $3s$ has elapsed assuming that the particle is moving with constant acceleration?

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Examination Archive With Solutions Wbchse

1. A particle starts from rest with constant acceleration. It travels a distance x in the first $10s$ and a distance y in the next $20s$. The relation between x and y is-

(A) $y = x$

(B) $y = 2x$

(C) $y = 8x$

(D) $y = 4x$

A. y =x

B. y = 2x

C. y = 8x

D. y = 4x

Answer: C

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2. Show that the instantaneous speed of a particle is equal to the slope of the distance-time graph.

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3. The position-time relation of a moving particle is $x = 2t - 3t^2$. What is the maximum positive velocity of the particle?

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4. The position-time relation of a moving particle is x = $2t - 3t^2$. When does the velocity of the particle become zero? (x is in metre and t is in second)

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5. What information do we get from the slope of the velocity-time graph?

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6. A ball is thrown vertically upward. For the motion of the ball till it returns to ground, draw the

(i)height vs time graph

(ii) velocity vs time graph

(iii) acceleration vs time graph

(iv) velocity vs height graph

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7. A particle moves in the $x - y$ plane with constant acceleration of $4\mathrm{m.s}^{-2}$ in the

direction making an angle of 60° with the x-axis. Initially, the particle is at the origin and its velocity is $5\mathrm{m.s}^{-1}$ along the x-axis. Find the velocity and the position of the particle at $t = 5s$.

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8. What will be the nature of velocity-time curve for a uniform motion?

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9. A balloon is rising upwards from rest with acceleration $\frac{g}{8}$. A stone is dropped from the balloon when it is at height H. Show that the time by which the stone will touch the ground is $2\sqrt{\frac{H}{g}}$.

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10. A car at rest accelerates at a constant rate α for sometime after which it decelerates at a constant rate β to come ot rest . If the total

time elapsed is t second find the maximum velocity attained.

11. The initial velocity is u and acceleration (f) is uniform. Final velocity and distance covered in the interval t are v and s respectively. Show that the velocity of the particle at half-distance is more than the velocity for half -time.

12. The equation of displacement of a particle along the X-axis is $x = 40 + 12t - t^3$. How much distance does it travel before stop?

A. 16 m

B. 40 m

C. 56 m

D. 36 m

Answer: C

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13. In the s-t graph of a particle with uniform acceleration at time t makes an angle 45° with the time axis. After one second it makes angle of 60°. What is the acceleration of the particle?

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14. Which of the following figures cannot be speed-time graph ?

A. 

B. 

C. 

D. 

Answer: D

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15. A ball is dropped from a height of a building while another is thrown horizontally at the same instant. Do they touch ground simultaneously?

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16. A body is moving from rest with an acceleration $a\ m.s^{-2}$ which is related to time t s by $a = (3t + 4)$. What will be its velocity in time 2 s?

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17. A body is moving with uniform acceleration. Draw its (a) velocity -time and (b) distance

travelled -time curve.

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18. A car travelling on a straight road moves with a uniform velocity v_1 for some time and with uniform velocity v_2 for the next equal time. The average velocity of the car is

A. $\sqrt{v_1 v_2}$

B. $\frac{1}{v_1} + \frac{1}{v_2}$

C. $\frac{1}{2}\left(\frac{1}{v_1} + \frac{1}{v_2}\right)$

D. $\frac{(v_1 + v_2)}{2}$

Answer: D

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19. Establish the equation $v^2 = u^2 + 2fs$ by using graph where symbols used carry the usual meaning. (Graph sheet is not required .)

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20. The displacement of a particle is directly proportional to the third power of time. What will be the nature of acceleration of the particle?

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21. A bullet enters a block of wood with a velocity u. Its velocity decreases to v after going through a distance x inside. After

covering a further distance y inside the bullet stops. Prove that $\frac{u}{v} = \sqrt{\frac{y+x}{y}}$.

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22. Under what condition is the average velocity of a moving particle equal to its instantaneous velocity?

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23. The velocity $(m.\ s^{-1})$-time (s) graph of a body is a straight line inclined at an angle of 45° with the time axis. The acceleration (in $\mathrm{m.s}^{-2}$unit) of the body is

A. 1

B. $\frac{1}{\sqrt{2}}$

C. $\sqrt{2}$

D. $\frac{1}{\sqrt{3}}$

Answer: A

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24. At any instant the speeds of two identical cars with the same retardation are u and 4u, starting from that instant the respective distances the cars travel before stopping are in the ratio

A. $1:1$

B. $1:4$

C. $1:8$

D. $1:16$

Answer: D

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25. The distance-time graph of a moving particle is given by $x = 4t - 6t^2$. What is the positive maximum speed?

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26. The distance-time graph of a moving particle is given by $x = 4t - 6t^2$. At what time

would the speed of the particle be zero ? (x is in metre and t is in second).

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27. A balloon at rest on the ground is rising upward with acceleration $\frac{g}{8}$. A stone is dropped from the balloon when it is at height H. Show that the time taken by the stone to touch the ground is $\frac{1}{2}\sqrt{\frac{H}{g}}$.

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Examination Archive With Solutions Wbjee

1. A particle moves with constant acceleration along a straight line starting from rest. The percentage increase in its displacement during the 4th second compared to that in the 3rd second is

A. $33\ \%$

B. $40\ \%$

C. $66\ \%$

D. $77\ \%$

Answer: B

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2. Two particles A and B having different masses are projected from a tower with same speed. A is projected vertically upward and B vertically downward. On reaching the ground

A. velocity of A is greater than that of B

B. velocity of B is greater than that of A

C. both A and B attain the same velocity

D. the particle with the larger mass attains higher velocity

Answer: C

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3. At a particular height, the velocity of an ascending body is $\overrightarrow{u}$. The velocity at the same height while the body falls freely is -

(A) $2\overrightarrow{u}$

(B) $-\overrightarrow{u}$

(C) $\overrightarrow{u}$

(D) $-2\overrightarrow{u}$

A. $2\overrightarrow{u}$

B. $-\overrightarrow{u}$

C. $\overrightarrow{u}$

D. $-2\overrightarrow{u}$

Answer: B

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4. A train moves from rest with acceleration α and in time t_1 covers a distance x. It then decelerates to rest at a constant retardation β for distance y in time t_2. Then -

(A) $\frac{x}{y} = \frac{\beta}{\alpha}$

(B) $\frac{\beta}{\alpha} = \frac{t_1}{t_2}$

(C) $x = y$

(D) $\frac{x}{y} = \frac{\beta t_1}{\alpha t_2}$

A. $\frac{x}{y} = \frac{\beta}{\alpha}$

B. $\frac{\beta}{\alpha} = \frac{t_1}{t_2}$

C. x =y

D. $\frac{x}{y} = \frac{\beta t_1}{\alpha t_2}$

Answer: A::B

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Examination Archive With Solutions Jee Main

1. From a tower of height H, a particle is thrown verticially upward with a speed u. The time taken by the particle to hit the ground is n

times that taken by it to reach the highest point of its path. The relation between H, u and n is

A. $2gH=n^2u^2$

B. $2gH = (n-2)^2u^2$

C. $2gH=nu^2(n-2)$

D. $gH = (n-2)^2u^2$

Answer: C

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2. Two stones are thrown up simultaneously from the edge of a cliff 240 m high with initial speeds of 10 m/s and 40 m/s respectively. Which of the following graphs best represents the time variation of relative position of the second stone with respect to the first?

(Assume stones do not rebound after hitting the ground and neglect air resistance take g = 10 m/s^2) The figures are schematic and not drawn to scale)

A. 

B. 

C. 

D. 

Answer: C

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3. A body is thrown vertically upwards. Which one of the following graphs correctly represent the velocity vs time?

A. 

B. 

C. 

D. 

Answer: C

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4. All the graphs below are intended to represent the same motion. One of them does it incorrectly. Pick it up.

A. 

B. 

C. 

D. 

Answer: D

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Examination Archive With Solutions Aipmt

1. A particle of unit mass undergoes one-dimensional motion such that its velocity varies according to v (x) = βx^{-2n} , where β and n are constants and x is the position of the particle. The acceleration of the particle as a function of x is given by

A. $-2n\beta^2 x^{-2n-1}$

B. $-2n\beta^2 x^{-4n-1}$

C. $-2n\beta^2 x^{-2n+1}$

D. $-2n\beta^2 e^{-4n+1}$

Answer: B

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Examination Archive With Solutions Neet

1. If the velocity of a particle is v = $At + Bt^2$, where A and B are constant then the distance travelled by it between 1 s and 2 s is -

(A) $(3A + 7B)$

(B) $\frac{3}{2}A + \frac{7}{3}B$

(C) $\frac{A}{2} + \frac{B}{3}$

(D) $\frac{3}{2}A + 4B$

A. 3 A +7B

B. $\frac{3}{2}A + \frac{7}{3}B$

C. $\frac{A}{2} + \frac{B}{3}$

D. $\frac{3}{2}A + 4B$

Answer: B

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1. A car moving with a speed of $50\mathrm{km.h}^{-1}$ can be stopped by brakes after at least 6 m. What will be the minimum stopping distance, if the same car is moving at a speed of $100\mathrm{km.h}^{-1}$?

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2. The displacement-time graphs of two bodies P and Q are represented by OA and BC respectively. What is the ratio of the velocity of

P and Q ? $\angle OBC = 60^\circ$ and $\angle AOC = 30^\circ$

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3. What does the slope of a velocity-time graph represent?

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4. Draw velocity-time graph for an object starting from rest. Acceleration is constant and

remains positive.

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5. An object moving on a straight line covers first half of the distance at speed v and second half at speed 2v. Find -

(i) Average speed

(ii) Mean speed

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6. A ball is thrown vertically upward. Draw its (i) velocity -time graph (ii) acceleration -time graph.

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7. A car is moving along a straight line in the given figure 1.83. It moves from O to P in 18 seconds and returns from P to Q in 6 seconds . What are the average velocity and average speed of the car in going (a) from Q to P ? And

(b) from O to P and back to Q ?

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8. Draw (i) position-time (ii) velocity-time and (iii) acceleration-time graph for the motion of an object under free fall.

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9. The x-t graph of an object in straight line motion is shown in the fig . Predict the type of motion it undergoes.

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10. Having seen a big stone falling from the top of a tower Rabi pulled his friend Kiran away. The stone hits Kiran slightly and he got a little

hurt . But he was saved from a major accident. What made Rabi act in such a way?

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11. From the top of a tower 100 m in height, a ball is dropped and at the same time another ball is projected vertically upwards from the ground with a velocity of 25 $\mathrm{m.s}^{-1}$. Find when and where the two balls meet. Take g = 9.8 $\mathrm{m.s}^{-2}$.

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12. The displacement of a particle along x-axis is given by x = 3 $+8t - 2t^2$. What is its acceleration? At what time it will come into rest ? All are in SI units.

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13. The acceleration-time graph for a body is shown in fig. Plot the corresponding velocity-time graph and draw the inference. The body

starts with non-zero positive velocity.

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14. Describe the second equation of motion using graphical method.

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15. The position coordinate of a moving particle is given by x = 6+18t +9t^2 (where x is in

metre, t in seconds. What is its velocity and acceleration at t = 2 s.

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16. Is it possible to have constant speed when velocity changes?

Watch Video Solution

17. The velocity of a moving particle is given by v = 6 +18t + $9t^2$ (x in metre t in second) what is

its acceleration at t = 2 s?

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18. Plot the position-time graph for an object (i) moving with positive velocity (ii) moving with negative velocity and (iii) at rest.

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19. The position of an object moving along x - axis is given by x = a $+bt^2$ where a = 8.5 m , b=

2.5 m/s^2 and t is measured in seconds. What is its velocity at t=0 and t = 2.0 s? What is the average velocity between t = 2.0 s and t = 4.0 s?

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