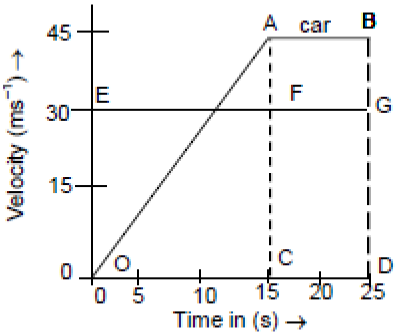
KINEMATICS

1. An automobile travelling with a speed of 60 kmh^{-1} can brake to stop with a distance of 20 m. If the car is going twice as fast i.e., 120 kms^{-1}, the stopping distance will be (2004)

(a) 20 m
(b) 40 m
(c) 60 m
(d) 80 m

2. The velocity-time graphs of a car and a scooter are shown in the figure. (i) The difference between the distance travelled by the car and the scooter in 15 s and (ii) the time at which the car will catch up with the scooter are, respectively. (2018)



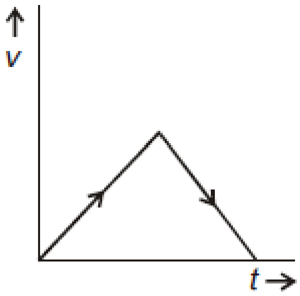
(a) 112.5 m and 22.5 s
(b) 337.5 m and 25 s
(c) 225.5 m and 10 s
(d) 112.5 m and 15 s

3. An automobile, travelling at 40 km/h, can be stopped at a distance of 40 m by applying brakes. If the same automobile is travelling at 80 km/h, the minimum stopping distance, in metres, is (assume no skidding): (2018)

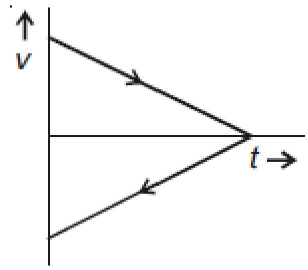
(a) 150m
(b) 100m
(c) 75m
(d) 160m

4. A body is thrown vertically upwards. Which one of the following graphs correctly represent the velocity vs time? (2017)

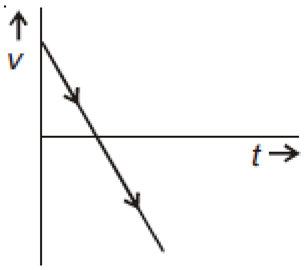
(a)



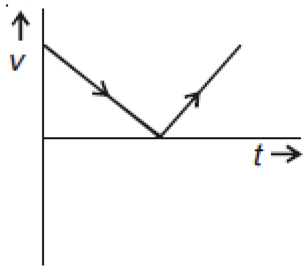
(b)



(c)



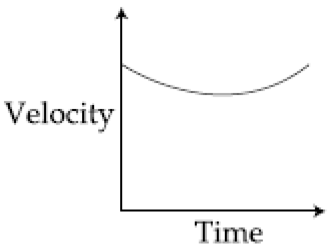
(d)



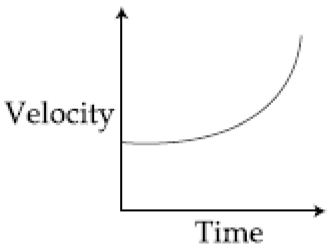
5. Which graph corresponds to an object moving with a constant negative acceleration and a positive velocity ?

(2017)

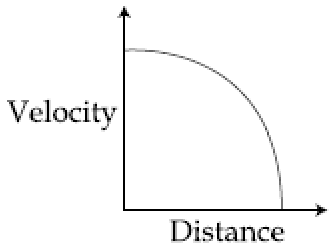
(a)



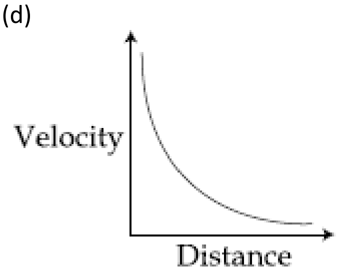
(b)



(c)

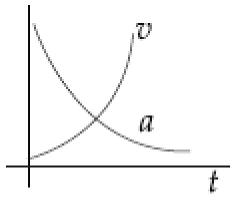


(d)

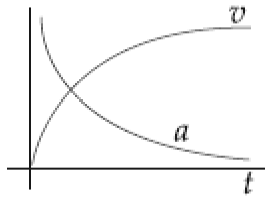


6. A wheel of radius 1 m rolls forward half a revolution on a horizontal ground. The magnitude of the displacement of the point of the wheel initially in contact with the ground is
(a) 2π
(b) $\sqrt{2}\pi$
(c) $\sqrt{\pi^2+4}$
(d) π

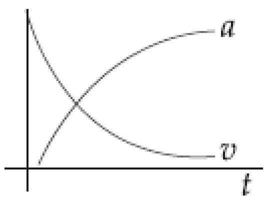
7. Which of the following option correctly describes the variation of the speed v and acceleration 'a' of a point mass falling vertically in a viscous medium that applies a force F =-kv, where 'k' is a constant, on the body ? (Graphs are schematic and not drawn to scale) (2016)
(a)



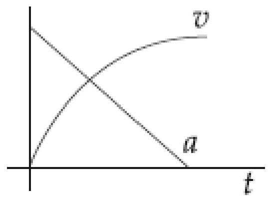
(b)



(c)

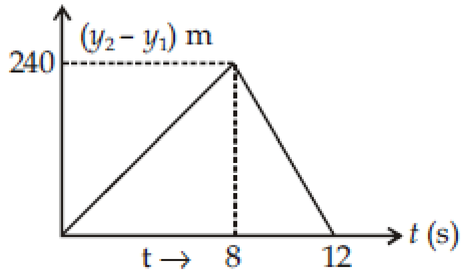


(d)

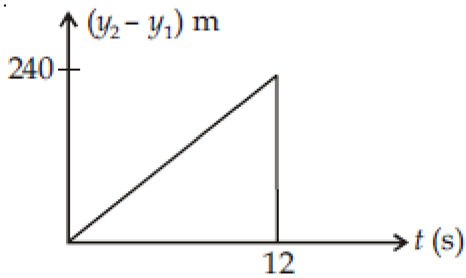


8. Two stones are thrown up simultaneously from the edge of a cliff 240 m high with initial speed of 10 m/s and 40 m/s respectively. Which of the following graph best represents the time variation of relative position of the second stone with respect to the first? (Assume stones do not rebound after hitting the ground and neglect air resistance, take g = 10 m/s^2) (The figures are schematic and not drawn to scale) (2015)

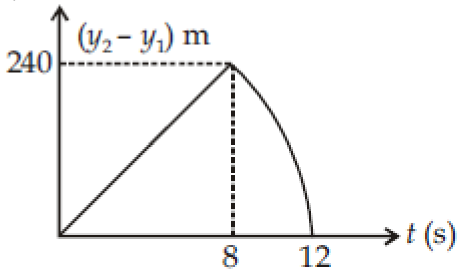
(a)



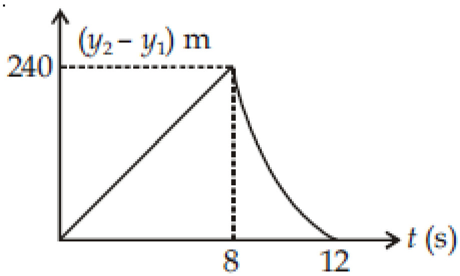
(b)



(c)



(d)



9. From a tower of height H, a particle is thrown vertically upwards 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: (2014)

(a) $2gH = n^2u^2$

(b) $gH = (n-2)^2 u^2$

(c) $2gH = nu^2 (n-2)$
(d) $gH = (n-2)u^2$

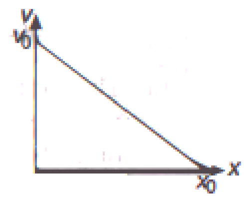
10. A person climbs up a stalled escalator in 60 s. If standing on the same but escalator running with constant velocity he takes 40 s. How much time is taken by the person to walk up the moving escalator ? (2014)
(a) 27 s
(b) 45 s
(c) 37 s
(d) 24 s

11. A small block slides without friction down an inclined plant starting from rest. Let s_n be the distance travelled from t = n - 1 to t = n. Then, $\frac{s_n}{s_{n+1}}$ is (2004)
(a) $\frac{2n-1}{2n}$
(b) $\frac{2n+1}{2n-1}$
(c) $\frac{2n-1}{2n+1}$
(d) $\frac{2n}{2n+1}$

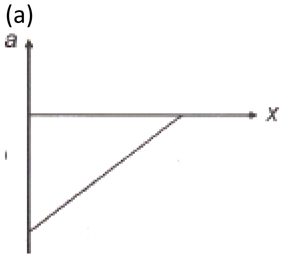
12. A point particle starting from rest has a velocity that increases linearly with time such that v = pt, where p = 4 ms^{-2}. The distance covered in the first 2 s will be
(a) 6 m
(b) 4 m
(c) 8 m
(d) 10 m

13. The displacement of a body along x-axis depends on time as $\sqrt{x} = t + 1$. Then, the velocity of body
(a) increase with time
(b) decrease with time
(c) independent of time
(d) None of these

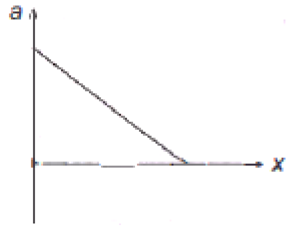
14. The given graph shows the variation of velocity with displacement. Which one of the graph given below correctly represents the variation of acceleration with displacement? (2005)



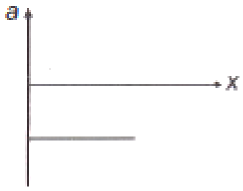
(a)



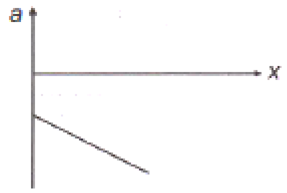
(b)



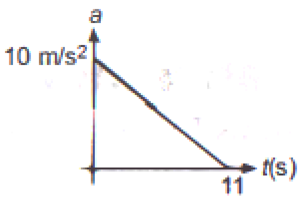
(c)



(d)



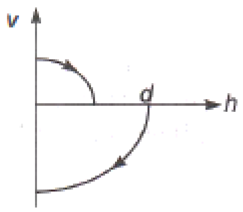
15. A particle starts from rest. Its acceleration (a) versus time (t) is as shown in the figure. The maximum speed of the particle will be (2004)



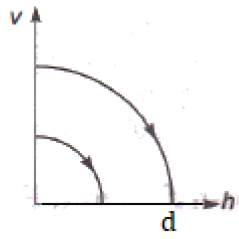
(a) 110 m/s
(b) 55 m/s
(c) 550 m/s
(d) 660 m/s

16. A ball is dropped vertically from a height d above the ground. It hits the ground and bounces up vertically to a height d/2. Neglecting subsequent motion and air resistance, its velocity v varies with height h above the ground as (2000)

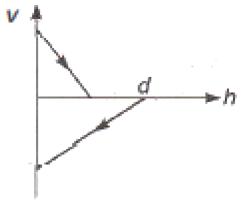
(a)



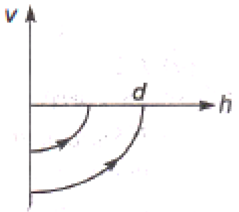
(b)



(c)

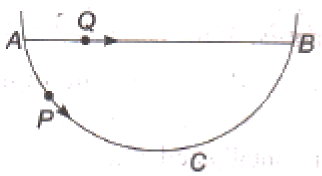


(d)



17. A panicle P is sliding down a frictionless hemispherical bowl. It passes the point A at r = 4 At this instant of time, the horizontal component of its velocity is v. A bead Q of the same mass as P is ejected from A at: = 0 along the horizontal string AB. with the speed v. Friction between the bead and the string may be neglected. Let t_P and t_Q, be the respective times taken by P and Q to reach the point B. Then

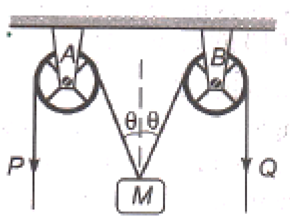
(1993)



(a) $t_P < t_Q$
(b) $t_P = t_Q$
(c) $t_P > t_Q$
(d) $\dfrac{t_P}{t_Q} = \dfrac{\text{length of arc ACB}}{\text{length of chord AB}}$

18. In the arrangement shown in the figure, the ends P and Q of an unstretchable string move downwards with uniform speed U. Pulleys A and B are fixed. Mass M moves upwards with a speed

(1982)

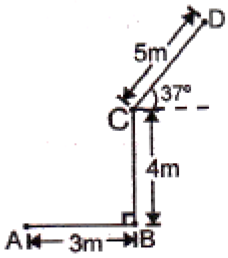


(a) $2U\cos\theta$
(b) $\dfrac{U}{\cos\theta}$

(c) $\dfrac{2U}{\cos\theta}$

(d) $U\cos\theta$

19. A particle moves along a path ABCD as shown in the figure. Then the magnitude of net displacement of the particle from position A to D is:



(a) 10 m

(b) $5\sqrt{2}\text{m}$

(c) 9 m

(d) $7\sqrt{2}\text{m}$

20. A particle starts from rest with uniform acceleration a. Its velocity after 'n' second is 'v'. The displacement of the body in the last two second is

(a) $\dfrac{2v(n-1)}{n}$

(b) $\dfrac{v(n-1)}{n}$

(c) $\dfrac{v(n+1)}{n}$

(d) $\dfrac{2v(2n+1)}{n}$

21. A particle whose speed is 50 m/s moves along the line from A(2,1) to B(9,25). Find its velocity vector in the form of $a\hat{i}+b\hat{j}$

(a) $7\hat{i}+24\hat{j}$

(b) $8\hat{i}+24\hat{j}$

(c) $14\hat{i}+48\hat{j}$

(d) None of these

22. A clock has a minute-hand 10 cm long. Find the average velocity between 6.00 AM to 6.30 AM for the tip of minute-hand.

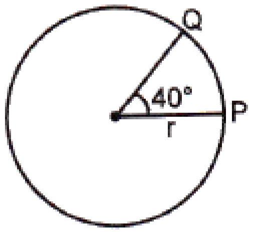
(a) $\dfrac{22}{21}\text{cm min}^{-1}$

(b) $\dfrac{2}{21}\text{cm min}^{-1}$

(c) $\dfrac{12}{21}\text{cm min}^{-1}$

(d) $\dfrac{2}{3}\text{cm min}^{-1}$

23. A particle is moving in a circle of radius r with speed v as shown in the figure. The magnitude of change in velocity in moving from P to Q is:



(a) 2 v cos 40^0
(b) 2 v sin 20^0
(c) 2 v cos 20^0
(d) none of these

24. A car starts from rest and moves with constant acceleration. The ratio of the distance covered in the nth second to that covered in n seconds is:

(a) $\frac{2}{n^2}-\frac{1}{n}$
(b) $\frac{2}{n^2}+\frac{1}{n}$
(c) $\frac{2}{n}-\frac{1}{n^2}$
(d) $\frac{2}{n}+\frac{1}{n^2}$

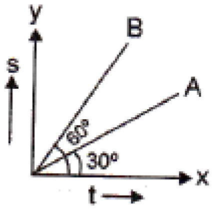
25. A body starts from rest and moves with a constant acceleration. The ratio of distance covered in the nth second to the distance covered in n second is

(a) $\frac{2}{n}-\frac{1}{n^2}$
(b) $\frac{1}{n^2}-\frac{1}{n}$
(c) $\frac{2}{n^2}-\frac{1}{n}$
(d) $\frac{2}{n}+\frac{1}{n^2}$

26. A stone is dropped from the top of a tower. When it has fallen by 5m from the top, another stone is dropped from a point 25m below the top. If both stones reach the ground at the same moment, then height of the tower from ground is: (take g = 10m/s^2)
(a) 45 m
(b) 50 m
(c) 60 m
(d) 65 m

27. For a particle moving in a straight line, the displacement of the particle at time t is given by
$S = t^3 - 6t^2 + 3t + 7$. What is the velocity of the particle when its acceleration is zero?
(a) - 9 m s^{-1}
(b) - 12 m s^{-1}
(c) 3 m s^{-1}
(d) 42 m s^{-1}

28. The displacement time graphs of two bodies Aand B are shown in figure. The ratio of velocity of A to of B, V_A / V_B is:



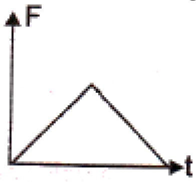
(a) $\frac{1}{\sqrt{3}}$

(b) $\sqrt{3}$

(c) $\frac{1}{3}$

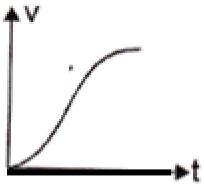
(d) 3

29. The force acting on a particle moving along a straight line varies with time as shown in the diagram.

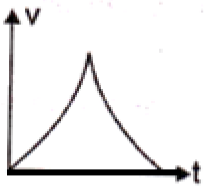


Which of the following graphs is best representative of its speed and time graphs. Initial velocity of the particle is zero.

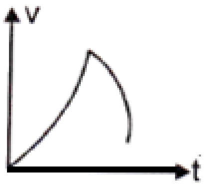
(a)



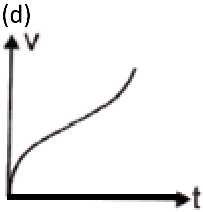
(b)



(c)

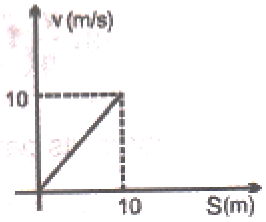


(d)

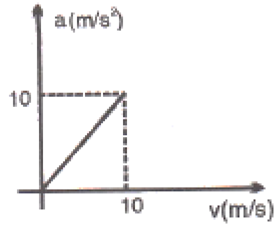


30. A particle initially at rest is subjected to two forces ; one is constant, the other is a retarding force proportional to the particle velocity. In the subsequent motion of the particle, the acceleration:
(a) will increase then decrease
(b) will decrease than increase
(c) will decrease to zero
(d) will decrease and become constant at some non zero value.

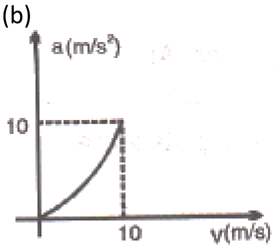
31. Velocity (v) versus displacement (S) graph of a particle moving in a straight line is shown in figure. Corresponding acceleration (a) versus velocity (v) graph will be



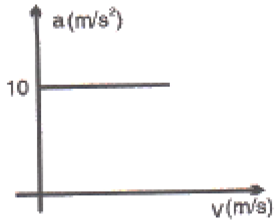
(a)



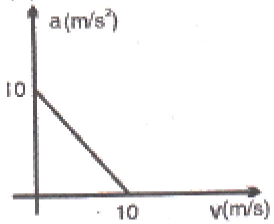
(b)



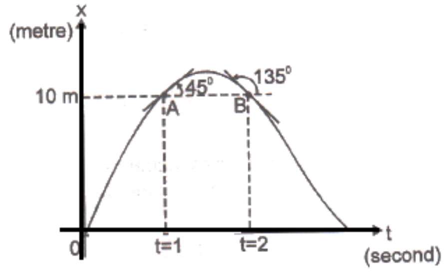
(c)



(d)



32. Displacement-time curve of a particle moving along a straight line is shown. Tangents at A and B make angles 45^0 and 135^0 with positive x-axis respectively. The average acceleration of the particle during t = 1, t = 2 second is :



(a) -2 m/s^2
(b) 1 m/s^2
(c) -1 m/s^2
(d) zero

33. Two balls of equal masses are thrown upwards, along the same Vertical direction at an interval 01 2 seconds, with the same initial velocity of 40 m/s. Then these collide at a height of (Take g = 10 m/s^2)
(a) 120 m
(b) 75 m
(c) 200 m
(d) 45 m

34. A stone is thrown vertically upward with an initial speed u from the top of a tower, reaches the ground with a speed 3u. The height of the tower is :
(a) $\frac{3u^2}{g}$
(b) $\frac{4u^2}{g}$
(c) $\frac{6u^2}{g}$
(d) $\frac{9u^2}{g}$

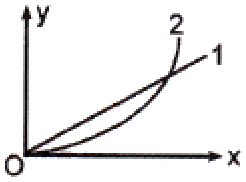
35. Three particles are projected upward with initial speeds 10m/s, 20m/s and 30m/s. The displacements covered by them in their last second of motion are x_1 ,x_2, and x_3 then :
(a) $x_1 : x_2 : x_3 = 1 : 2 : 3$
(b) $x_1 : x_2 : x_3 = 1 : 4 : 9$
(c) $x_1 : x_2 : x_3 = 1 : 5 : 7$
(d) None of these

36. A ball is thrown vertically upwards from the top of a tower of height h with velocity v. The ball strikes ground after time.
(a) $\frac{v}{g}\left[1+\sqrt{1+\frac{2gh}{v^2}}\right]$
(b) $\frac{v}{g}\left[1-\sqrt{1+\frac{2gh}{v^2}}\right]$
(c) $\frac{v}{g}\left[1+\frac{2gh}{v^2}\right]^{1/2}$

(d) $\frac{v}{g}\left[1-\frac{2gh}{v^2}\right]^{1/2}$

37. Particle is projected along a rough horizontal table, its path must be :(assuming only gravity and aril force due to the table acting).
(a) straight line
(b) circular
(c) parabolic
(d) elliptical

38. A particle is resting over a smooth horizontal floor. At t = 0, a horizontal force starts acting on it. Magnitude of the force increases with time according to law F = αt, where α is a positive constant and t is time. For the figure shown which of the following statements is/are incorrect ?



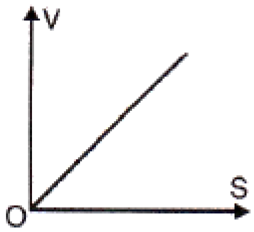
(a) Curve 1 shows acceleration against time
(b) Curve 2 shows velocity against time
(c) Curve 2 shows velocity against acceleration
(d) none of these

39. A particle is moving with initial velocity $\vec{u}=\hat{i}-\hat{j}+\hat{k}$. What should be its acceleration so that it can remain moving in the same straight line?
(a) $\vec{a}=2\hat{i}-2\hat{j}+2\hat{k}$
(b) $\vec{a}=-2\hat{i}+2\hat{j}+2\hat{k}$
(c) $\vec{a}=3\hat{i}+3\hat{j}+3\hat{k}$
(d) $\vec{a}=1\hat{i}-1\hat{j}$

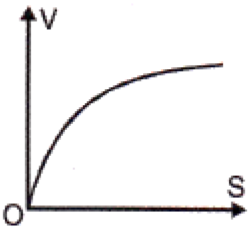
40. A particle moving along a straight line with a constant acceleration of - 4 m/s^2 passes through a point A on the line with a velocity of + 8 m/s at some moment. Find the distance travelled by the particle in 5 after that moment.
(a) 10
(b) 26
(c) 13
(d) 20

41. A moving train is stopped by applying brakes. It stops after travelling 80 m. If the speed of the train doubled and retardation remain the same. it will cover a distance-
(a) Same as earlier
(b) Double the distance covered earlier
(c) Four times the distance covered earlier
(d) Half the distance covered earlier

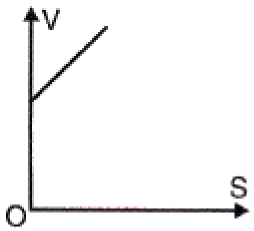
42. A particle starting from rest moves along a straight line with constant acceleration for this velocity displacement graph will have the form-
(a)



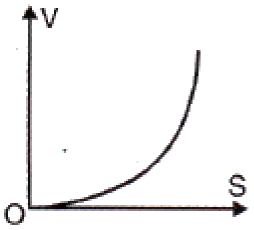
(b)



(c)



(d)



43. A body starts from rest. What is the ratio of the distance travelled by the body during the 4th and 3rd second-

(a) $\frac{7}{5}$

(b) $\frac{5}{7}$

(c) $\frac{7}{3}$

(d) $\frac{3}{7}$

44. The initial velocity of a body moving along a straight line is 7m/s. It has a uniform acceleration of 4 m/s^2 the distance covered by the body in the 5th second of its motion is-

(a) 25 m

(b) 35 m

(c) 50m

(d) 85 m

45. A bee files a line from a point A to another point B in 4 s with a velocity of $|t - 2|$ ms^{-1}. The distance between A and B in metre is

(a) 2
(b) 4
(c) 6
(d) 8

ANSWER KEY

1. (d) 2. (a) 3. (d) 4. (c) 5. (c) 6. (c) 7. (b) 8. (c) 9. (c) 10. (d) 11. (c) 12. (c) 13. (a) 14. (c) 15. (b) 16. (a) 17. (a) 18. (b) 19. (d) 20. (a) 21. (c) 22. (d) 23. (b) 24. (c) 25. (a) 26. (a) 27. (a) 28. (c) 29. (a) 30. (c) 31. (a) 32. (a) 33. (b) 34. (b) 35. (d) 36. (a) 37. (a) 38. (d) 39. (a) 40. (b) 41. (c) 42. (b) 43. (a) 44. (a) 45. (b)

SOLUTIONS

1. (d)

$$x'n^2x = \left(\frac{12}{60}\right)^2 \times 20 = 80 \text{ m}$$

Let a be the retardation in both the cases. Using the relation, $v^2 = u^2 + 2\,as$, when automobile is stopped, $v = 0$.

So, $\quad 0 = u^2 + 2\,as$

or $\quad s \propto u^2$

$\therefore \quad s_2 = 4\,s_1 = 4 \times 20 = 80 \text{ m}$

2. (a)

Distance travelled by car in 15 sec = $\frac{1}{2}(45)\ (15) = \frac{675}{2}$m, Distance traveled by scooter in 15 seconds = 30 × 15 = 450

Let car catches scooter in time t;

$$\frac{675}{2} + 45(t - 15) = 30t$$

$337.5 + 45t - 675 = 30t \quad \Rightarrow \quad 15t = 337.5 \quad \Rightarrow \quad t = 22.5 \text{ sec}$

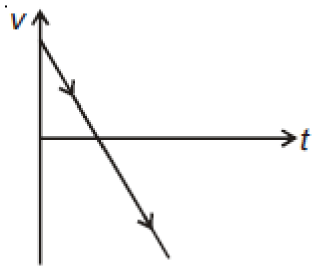
3. (d)

$$S = \frac{u^2}{2a}$$

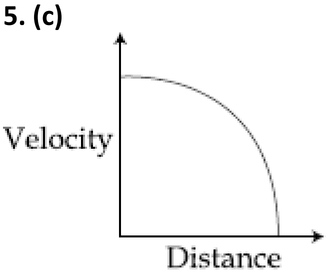
$$\frac{S_1}{S_2} = \frac{u_1^2}{u_2^2} \Rightarrow S_2 = \left(\frac{u_2}{u_1}\right)^2 S_1 = (2)^2\,(40) = 160 \text{ m}$$

4. (c)

Acceleration is constant and negative

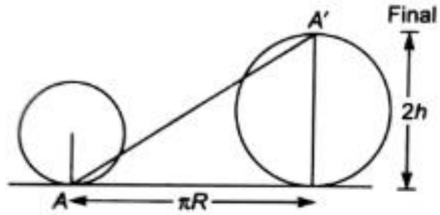


5. (c)



6. (c)

Horizontal distance covered by the wheel in half revolution πR.

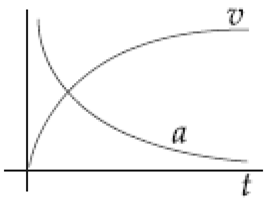


So, the displacement of the point which was initially in contact with ground

$$= AA' = \sqrt{(\pi R)^2 + (2R)^2}$$

$$= R\sqrt{n^2 + 4} = \sqrt{\pi^2 + 4} \qquad [\because R = 1\,\text{m}]$$

7. (b)



8. (c)

Till both are in air (From $t = 0$ to $t = 8$ sec)

$$\Delta x = x_2 - x_1 = 30t$$

$$\Rightarrow \quad \Delta x \propto t$$

When second stone hits ground and first stone is in air Δx decreases.

9. (c)

Time taken to reach highest point is $t_1 = \dfrac{u}{g}$

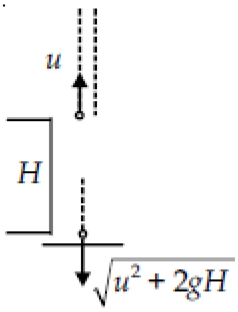
Speed on reaching ground $= \sqrt{u^2 + 2gh}$

Now, $v = u + at$

$$\Rightarrow \quad \sqrt{u^2 + 2gh} = -u + gt$$

$$\Rightarrow \quad t = \frac{u + \sqrt{u^2 + 2gH}}{g} = \frac{nu}{g}$$

$$\Rightarrow \quad 2gH = n(n-2)u^2$$



10. (d)

$$60 = \frac{d}{v_{man}}$$

$$40 = \frac{d}{v_{es}}$$

$$t = \frac{d}{v_{man} + v_{es}}$$

$$\frac{1}{t} = \frac{v_{man}}{d} + \frac{v_{es}}{d} = \frac{1}{60} + \frac{1}{40}$$

$$t = 24 \text{ sec}$$

11. (c)

Distance travelled in tth second is, $s_t = u + at - \frac{1}{2}a$

Given, $u = 0$

$$\therefore \qquad \frac{s_n}{s_{n+1}} = \frac{an - \frac{1}{2}a}{a(n+1) - \frac{1}{2}a} = \frac{2n-1}{2n+1}$$

$\therefore$ Correct option is (c).

12. (c)

Given, $\quad v = pt$

$$\Rightarrow \qquad \int_0^x dx = p\int_0^2 t\,dt = \frac{pt^2}{2} = \frac{4 \times 4}{2} = 8\text{ m}$$

13. (a)

$\sqrt{x} = t + 1$

Squaring both sides, we get

$$x = (t+1)^2 = t^2 + 1 + 2t$$

Differentiating it w.r.t. t, we get

$$\frac{dx}{dt} = 2t + 2$$

$$\text{Velocity} = v = \frac{dx}{dt} = 2t + 2$$

so increase with time.

14. (c)

(a) The v-x equation from the given graph can be written as

$$v = \left(-\frac{v_0}{x_0}\right)x + v_0 \quad \ldots(i)$$

$$a = \frac{dv}{dt} = \left(-\frac{v_0}{x_0}\right)\frac{dx}{dt} = \left(-\frac{v_0}{x_0}\right)v$$

Substituting v from Eq. (i) we get,

$$a = \left(-\frac{v_0}{x_0}\right)\left[\left(-\frac{v_0}{x_0}\right)x + v_0\right]$$

$$\Rightarrow a = \left(\frac{v_0}{x_0}\right)^2 x - \frac{v_0^2}{x_0}$$

Thus, a-x graph is a straight line with positive slope and negative intercept.

15. (b)

Area under acceleration-time graph gives the change in velocity.

Hence, $v_{max} = 1/2 \times 10 \times 11 = 55\text{ m/s}$

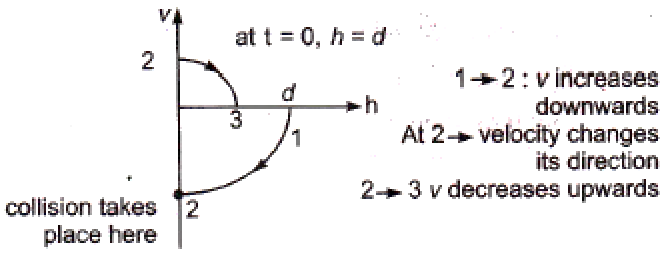
16. (a)

(a) For uniformly accelerated/decelerated motion

$$v^2 = u^2 \pm 2gh$$

i.e. v-h graph will be a parabola (because equation is quadratic).

(b) Initially velocity is downwards (−ve) and then after collision, it reverses its direction with lesser magnitude, i.e. velocity is upwards (+ve). Graph (a) satisfies both these conditions.



NOTE At time $t = 0$ corresponds to the point on the graph where $h = d$

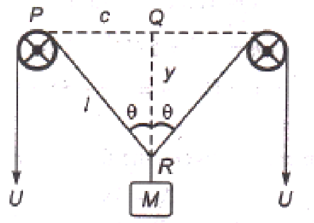
17. (a)

For particle P, motion between AC will be an accelerated one while between CB a retarded one. But in any case horizontal component of its velocity will be greater than or equal to v. On the other hand, in case of particle Q, it is always equal to v. Horizontal displacement for both the particles are equal. Therefore, $t_P < t_Q$.

18. (b)

In the right angle ΔPQR

$$l^2 = c^2 + y^2$$



c = constant, l and y are variable

Differentiating this equation with respect to time, we get

$$2l\frac{dl}{dt} = 0 + 2y\frac{dy}{dt}$$

or $$\left(-\frac{dy}{dt}\right) = \frac{l}{y}\left(-\frac{dl}{dt}\right)$$

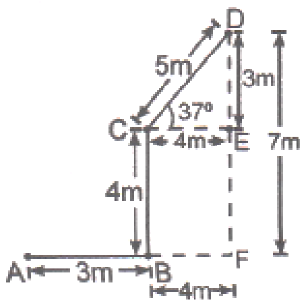
Here, $$-\frac{dy}{dt} = v_M \quad \Rightarrow \quad \frac{l}{y} = \frac{1}{\cos\theta}$$

and $-dl/dt = U$

Hence, $$v_M = \frac{U}{\cos\theta}$$

19. (d)

As seen from the figure



the displacement is $\sqrt{(AF)^2 + (FD)^2} = 7\sqrt{2}$ m

20. (a)

distance travelled in last 2 seconds.

$$S_2 = ut + \frac{1}{2}at^2$$

$= 2a(n-2) + 2a$

$= 2a(n-1)$

also $\frac{v}{n} = a$

$$\Rightarrow \qquad s = 2 \times \frac{v}{n}(n-1)$$

21. (c)

Position vector of point A = $2\hat{i} + \hat{j}$

Position vector of point B = $9\hat{i} + 25\hat{j}$

$\therefore \quad \overrightarrow{AB} = (9\hat{i} + 25\hat{j}) - (2\hat{i} + \hat{j}) = 7\hat{i} + 24\hat{j}$

Unit vector in the direction of $\overrightarrow{AB}$

$$\hat{AB} = \frac{\overrightarrow{AB}}{|\overrightarrow{AB}|} = \frac{7\hat{i} + 24\hat{j}}{25}$$

$\therefore \quad \vec{v} = 50\,\hat{AB} = 14\hat{i} + 48\hat{j}.$

22. (d)

$$\text{average velocity} = \frac{\text{displacement}}{\text{time}}$$

$$= \frac{20\text{cm}}{30}$$

$$= \frac{2}{3}\ \text{cm min}^{-1}$$

23. (b)

velocity at p = $v\hat{j}$

velocity at Q = $-v \sin 40^\circ\ \hat{i} + v \cos 40^\circ\ \hat{j}$

magnitude of change in velocity = $2 v \sin 20^\circ$

24. (c)

distance covered n^{th} second is $\frac{a}{2}(2n-1)$

distance covered in n seconds = $\frac{1}{2} a n^2$

this implies ratio = $\frac{2}{n} - \frac{1}{n^2}$

25. (a)

Here, $S_n = \frac{1}{n} an^2$

S_{nth} = distance travelled in n second

– distance travelled in $(n-1)$ second

$= \left(\frac{2n-1}{2}\right) a$

$\therefore \quad \frac{S_{nth}}{S_n} = \frac{2n-1}{n^2} = \frac{2}{n} - \frac{1}{n^2}$

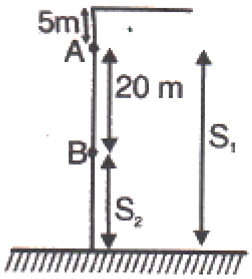
26. (a)

Vel. of Ist stone when passing at A $\rightarrow$

$V^2 = 0 + 2.10.5$

$V = 10$ m/s

$S_1 - S_2 = 20$ m.



$\Rightarrow \left(10.t + \frac{1}{2}10.t^2\right) - \left(\frac{1}{2}.10.t^2\right) = 20$

t = 2s

$S_2 = \frac{1}{2} . 10 . 4 = 20$ m

Ht = 25 + 20 = 45 m.

27. (a)

$V = \frac{ds}{dt} = 3t^2 - 12t + 3$

$a = \frac{dv}{dt} = 6t - 12 = 0$

t = 2s

At. t = 2s,

$V = 3 \times 2^2 - 12 \times 2 + 3 = 12 - 24 + 3 = -9$ m/s.

28. (c)

For A, $\frac{ds}{dt} = V_A = \frac{1}{\sqrt{3}}$

For B, $\frac{ds}{dt} = V_B = \sqrt{3}$

$\frac{V_A}{V_B} = \frac{1}{3}$.

29. (a)

from the given graph of F versus t it is clear that finally acceleration is zero.

so $\frac{dv}{dt} = 0$ $\Rightarrow$ Option (1)

30. (c)

31. (a)

From the given graph relation between velocity (V) and displacement (S) is given by

$$v = S$$

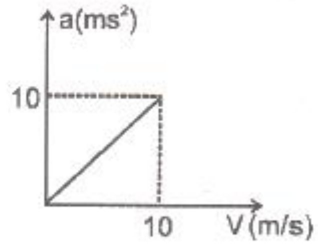
$$\frac{dv}{dS} = 1$$

Hence, acceleration $a = v\frac{dv}{dS}$

$$a = v \times 1$$

$$a = v$$

Therefore, graph between acceleration and velocity will be as shown.

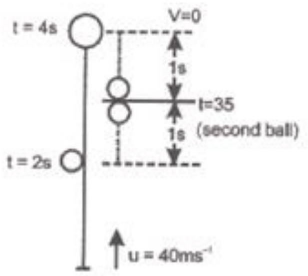


32. (a)

$$a_{av} = \frac{V_f - V_i}{\Delta t} = \frac{(\text{Slope at B}) - (\text{Slope at A})}{1s}$$

$$= \frac{-1-1}{1} = -2\ m/s^2$$

33. (b)



$u = 40$ m/s , $g = 10$ m/s^2

Let t be time taken by the first ball to reach the highest point.

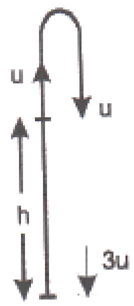
$V = u - gt$ $\qquad$ $O = 40 - 10\,t$ $\qquad$ $t = 4$ s

After reaching the first ball at the highest point now both the balls will collide after 1 sec as both the balls cover equal distances in opposite directions during 1 sec.

there fore, the height of collision point

= height gained by the second ball in 3 sec

34. (b)



I method – Let downward direction is taken as +ve, initial vel is -ve = - u (say)

∴ From the equation; $v^2 - u^2$ = as we get $(3u)^2 - (-u)^2 = 20hg$

$\Rightarrow h = \frac{u^2}{g}$ "B"Ans.

The stone is thrown vertically upward with an initial velocity u from the top of a tower it reaches the highest point and returns back and reaches the top of tower with the same velocity u vertically downward. Now, from the equation, $V^2 = u^2 + 2gh$

$\Rightarrow (3u)^2 = u^2 + 2gh \Rightarrow 2gh = 9u^2 - u^2 \Rightarrow h = \frac{8u^2}{2g} \Rightarrow h = \frac{4u^2}{g}$ "B"Ans.

35. (d)

Distance travelled by each particle in last second of motion i.e., downwards is equal to the distance travelled by it in first second of its motion i.e. upwards.

So,

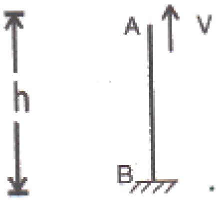
$x_1 = 10 - \frac{1}{2} \times 10 \times 1^2 = 5m$

$x_2 = 20 - \frac{1}{2} \times 10 \times 1^2 = 15m$

$x_3 = 30 - \frac{1}{2} \times 10 \times 1^2 = 25m$

so, $x_1 : x_2 : x_3 = 1:3:5$

36. (a)



For AB AB

$s = ut + \frac{1}{2}at^2.$

$-h = vt - \frac{g}{2}t^2$

$\frac{g}{2}t^2 - vt - h = o$

$$t = \frac{v \pm \sqrt{v^2 + 4 \times \frac{g}{2} \times h}}{2 \times \frac{g}{2}}$$

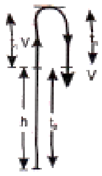
$$t = \frac{v \pm \sqrt{v^2 + 2gh}}{g}$$

$$t = \frac{v}{g}\left[1 + \sqrt{1 + \frac{2gh}{v^2}}\right], \quad t = \frac{v}{g}\left[1 - \sqrt{1 + \frac{2gh}{v^2}}\right]$$

$\therefore$ we neglect]

$$\therefore \qquad t = \frac{v}{g}\left[1 + \sqrt{1 + \frac{2gh}{v^2}}\right]$$

Aliter



Let t_1 be the time taken by ball from top of tower to the highest point then it will taken again t_1 time back to the top of tower Let t_2 be the time taken be ball from top of tower to the ground.

For t_1 : From equation

$V = u - gt$ i.e., $0 = V - gt_1$ or, $t_1 = V/g$

For t_2 : From equation

$h = ut + \frac{1}{2} gt^2$ $h = Vt^2 + \frac{1}{2} gt_2^2$; or, $gt_2^2 + 2Vt_2 - 2h = 0$, or, $t_2 = \frac{-2V \pm \sqrt{4V^2 + 8gh}}{2g}$

Taking (+) sign only (as we are interested in time projection i.e., t = 0) $t_2 = \frac{-V + \sqrt{V^2 + 2gh}}{g}$

Note that, –ve time indicate time before the projection.

Hence, the time after which the ball strikes ground $T = 2t_1 + t_2$ $\Rightarrow T = \frac{2V}{g} + \frac{-V + \sqrt{V^2 + 2gh}}{g}$

$T = \frac{V + \sqrt{V^2 + 2gh}}{g}$ $\Rightarrow$ $T = \frac{V}{g}\left[1 + \sqrt{1 + \frac{2gh}{V^2}}\right]$

37. (a)

38. (d)

$F = \alpha t$

$ma = \alpha t$ $\Rightarrow$ $a \propto t$

curve 1 is a against time $\frac{mdv}{dt} = \alpha t$.

Integrating this we get $v \propto t^2$ this implies parabola.

also $v \propto a^2$ $\Rightarrow$ curve 3 shows velocity against accelaration.

39. (a)

To move in a straight line

$\vec{a} \parallel \vec{u}$

40. (b)

$u = +8$ m/s
$a = -4$ m/s^2
$v = 0$

$\Rightarrow \quad 0 = 8 - 4t \qquad$ or $\quad t = 2$ sec.

displacement in first 2 sec.

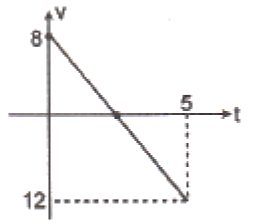
$$S_1 = 8 \times 2 + \frac{1}{2}.(-4).\,2^2 = 8 \text{ m}$$

displacement in next 3 sec.

$$S_2 = 0 \times 3 + \frac{1}{2}(-4)3^2 = -18 \text{ m.}$$

distance travelled $= |S_1| + |S_2| = 26$ m.

Alter:



$$\text{total distance} = \frac{1}{2} \times 2 \times 8 + \frac{1}{2} \times 3 \times 12 = 8 + 18 = 26 \text{ m}$$

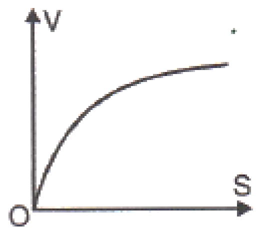
41. (c)

$$0^2 = u^2 - 2ax$$

$$\left(\frac{u_1}{u_2}\right)^2 = \frac{x_1}{x_2}$$

$$x_2 = 4 \times x_1$$

42. (b)



43. (a)

$$\frac{S_1}{S_2} = \frac{2n_1 - 1}{2n_2 - 1} = \frac{2 \times 4 - 1}{2 \times 3 - 1} = \frac{7}{5}$$

44. (a)

$$S = 7 + \frac{4}{2}(2 \times 5 - 1) = 25 \text{ m}$$

45. (b)

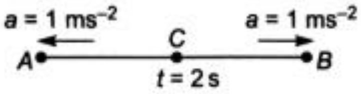
Here, $v = |t-2|\ \text{ms}^{-1}$

$v = t-2$, when $t > 2$ s

$v = 2-t$, when $t < 2$ s

$\therefore \quad a = \frac{dv}{dt} = 1\text{ms}^{-2}$ when $t > 2$ s

$a = -1\text{ms}^{-2}$ when $t < 2$ s



In the direction of motion from A to C, bee decelerates but for C to B, bee accelerates.

Let $\quad AC = s_1, BC = s_2$

$u_A = 2\text{ ms}^{-1}, t = 0$

$u_C = 0$ at $t = 4$ s

$\therefore \quad s_1 = \left(\frac{u_A + u_C}{2}\right)t_1$

$s_2 = \left(\frac{u_C + u_B}{2}\right)t_2$

$\therefore \quad s = s_1 + s_2 = \left(\frac{2+0}{2}\right)2 + \left(\frac{0+2}{2}\right)2 = 4\text{ m}$