NEET Ultimate Crash Course

Question Bank   Chapter – Motion in plane, Motion in stright line (Physics)

1. A car accelerates from rest at a constant rate a for some time, after which it decelerates at a constant rate β and comes to rest. If the total time elapsed is t, then the maximum velocity acquired by the car is

(A) $\left(\frac{\alpha t+\beta^2}{\alpha\beta}\right)t$ (B) $\left(\frac{\alpha^2-\beta^2}{\alpha\beta}\right)t$

(C) $\frac{(\alpha+\beta)t}{\alpha\beta}$ (D) $\frac{\alpha\beta t}{\alpha+\beta}$

2. A body of mass 10 kg is moving with a constant velocity of 10 m/s. When a constant force acts for 4 seconds on it, it moves with a velocity 2 m/sec in the opposite direction. The acceleration produced in it is

(A) 3 m/sec^2 (B) –3 m/sec^2

(C) 0.3 m/sec^2 (D) –0.3 m/sec^2

3. A body starts from rest, with uniform acceleration. If its velocity after n seconds is v, then its displacement in the last two seconds is

(A) $\frac{2v(n+1)}{n}$ (B) $\frac{v(n+1)}{n}$

(C) $\frac{v(n-1)}{n}$ (D) $\frac{2v(n-1)}{n}$

4. A particle moves along a semicircle of radius 10m in 5 seconds. The average velocity of the particle is

(A) 2π ms^{-1} (B) 4π ms^{-1}

(C) 2 ms^{-1} (D) 4 ms^{-1}

5. Two balls are dropped from height h and 2 h respectively from the earth surface. The ratio of time of these balls to reach the earth is

(A) $1:\sqrt{2}$ (B) $\sqrt{2}:1$

(C) 1 : 2   (D) 1 : 4

6. A point initially at rest moves along x-axis. Its acceleration varies with time as a = (6t + 5) ms^{-2}. If it starts from origin, the distance covered in 2 s is

(A) 20 m   (B) 18 m

(C) 16 m   (D) 25 m

7. A body released from a great height falls freely towards the earth. Another body is released from the same height exactly one second later. The separation between the two bodies two second after the release of the second body is

(A) 9.8 m   (B) 4.9 m

(C) 24.5 m   (D) 19.6 m

8. A body of mass 3 kg falls from the multi-storeyed building 100m high and buries itself 2m deep in the sand. The time of penetration will be is

(A) 0.09 s   (B) 0.9 s

(C) 9 s   (D) 10 s

9. At t = 0, a stone of mass 10 gm. is thrown straight up from the ground level with a speed 10 m/s. After 1 s, a second stone of the same mass is thrown from the same position with a speed 20 m/s. What is the position of the first stone from the ground level at that moment? (Take g=10 m/s^2)

(A) 10 m   (B) 1 m

(C) 2 m   (D) 5 m

10. A particle is constrained to move on a straight line path. It returns to the starting point after 10 sec. The total distance covered by the particle during this time is 30 m. Which of the following statement about the motion of the particle is false

(A) Displacement of the particle is zero

(B) Average speed of the particle is 3 m/s

(C) Displacement of the particle is 30 m

(D) Both (a) and (b)

11. A boy standing at the top of a tower of 20 m height drops a stone. Assuming g=10 ms^{-2}, the velocity with which it hits the ground is

(A) 5.0 m/s (B) 10.0 m/s
(C) 20.0 m/s (D) 40.0 m/s

12. Speed of two identical cars u and 4 *u* at a specific instant. The ratio of the respective distances in which the two cars are stopped from that instant is

(A) 1 : 1 (B) 1 : 4
(C) 1 : 8 (D) 1 : 16

13. A boy walks to his school at a distance of 6km with constant speed of 2.5 km/hour and walks back with a constant speed of 4 km/hr. His average speed for round trip expressed in km/hour, is

(A) 24/13 (B) 40/13
(C) 3 (D) 1/2

14. A car moves from X to Y with a uniform speed v_u and returns to Y with a uniform speed v_d. The average speed for this round trip is

(A) $\frac{2v_d v_u}{v_d + v_u}$ (B) $\sqrt{v_u v_d}$

(C) $\frac{v_d v_u}{v_d + v_u}$ (D) $\frac{vu + v_d}{2}$

15. A car moves a distance of 200 m. it covers first half of the distance at speed 60 kmh^{-1} and the second half at speed v. If the average speed is 40 kmh^{-1}, the value of v is

(A) 30 kmh^{-1} (B) 13 kmh^{-1}
(C) 60 kmh^{-1} (D) 40 kmh^{-1}

16. A car moving with speed of 40 km/h can be stopped by applying brakes after atleast 2 m. If the same car is moving with a speed of 80 km/h, what is the minimum stopping distance

(A) 8 m (B) 2 m
(C) 4 m (D) 6 m

17. A body is projected vertically upwards. The times corresponding to height h while ascending and while descending are t_1 and t_2 respectively. Then the velocity of projection is (g is acceleration due to gravity)

(A) $g\sqrt{t_1 t_2}$ (B) $\frac{g t_1 t_2}{t_1 + t_2}$

(C) $\frac{g\sqrt{t_1 t_2}}{2}$ (D) $\frac{g(t_1 + t_2)}{2}$

18. A body is moving with uniform acceleration covers 200 m in the first 2 s and 220 m in the next 4 s. find the velocity in ms^{-1} after 7 s.

(A) 10 (B) 15
(C) 20 (D) 30

19. A stone thrown vertically upward files past a window one second after it was thrown upward and after three second on its way downward. The height of the window above the ground is (Take g = 10ms^{-2})

(A) 20 m (B) 15 m
(C) 10 m (D) 5 m

20. A particle is projected with velocity v_0 along x-axis. The deceleration on the particle is proportional to the square of the distance from the origin i.e., a = $-ax^2$. The distance at which the particle stops is

(A) $\sqrt{\frac{3v_0}{2\alpha}}$ (B) $\left(\frac{3v_0}{2\alpha}\right)^{\frac{1}{3}}$

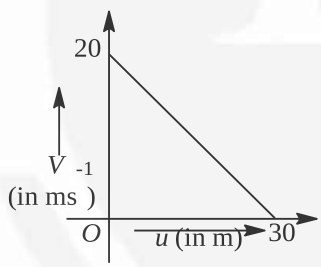
(C) $\sqrt{\frac{3v_0^2}{2\alpha}}$ (D) $\left(\frac{3v_0^2}{2\alpha}\right)^{\frac{1}{3}}$

21. A boat crosses a river from port *A* to port *B*, which are just on the opposite side. The speed of the water is V_W and that of boat is V_B relative to still water. Assume $V_B = 2V_W$. What is the time taken by the boat, if It has to cross the river directly on the *AB* line

(A) $\frac{2D}{V_B\sqrt{3}}$ (B) $\frac{\sqrt{3}D}{2V_B}$

(C) $\frac{D}{V_B\sqrt{2}}$ (D) $\frac{D\sqrt{2}}{V_B}$

22. If the velocity v of a particle moving along a straight line decreases linearly with its displacement *s* from $20 ms^{-1}$ to a value approaching zero s = 30 m, then acceleration of the particle at s = 15m is



(A) $\frac{2}{3} ms^{-2}$ (B) $-\frac{2}{3} ms^{-2}$

(C) $\frac{20}{3} ms^{-2}$ (D) $-\frac{20}{3} ms^{-2}$

23. A ball is released from the top of a tower of height *h* metre. It takes *T* sec to reach the ground. What is the position of the ball in *T*/3 s?

(A) h/9 m from the ground

(B) 7h/9 m from the ground

(C) 8h/9 m from the ground

(D) 17h/18 m from the ground

24. A particle has initial velocity $(2\hat{i} + 3\hat{j})$ and acceleration $(0.3\hat{i} + 0.2\hat{j})$. The magnitude of velocity after 10 seconds will be

(A) $9\sqrt{2}$ unit (B) $5\sqrt{2}$ unit

(C) 5 unit (D) 9 unit

25. A ball thrown upward from the top of a tower with speed v reaches the ground in t_1 second. If this ball is thrown downward from the top of he same tower with speed *v* it reaches the ground in t_2 second. In what time the ball shall reach the ground if it is allowed to falls freely under gravity from the top of the tower?

(A) $\frac{t_1 + t_2}{2}$ (B) $\frac{t_1 - t_2}{2}$

(C) $\sqrt{t_1 - t_2}$ (D) $t_1 + t_2$

26. A body freely falling from the rest has a velocity '*v*' after it falls through a height '*h*'. The distance it has to fall down for its velocity to become double, is

(A) 2*h* (B) 4*h*

(C) 6*h* (D) 8*h*

27. Two forces, each of magnitude *F*, have a resultant of the same magnitude *F*. The angle between the two forces is

(A) 45°

(B) 120º

(C) 150º

(D) 180º

28. A ball is projected with kinetic energy *E* at an angle of 45° to the horizontal. At the highest point during its flight, its kinetic energy will be

(A) Zero (B) *E*/2

(C) $E/\sqrt{2}$ (D) *E*

29. A body is acted upon by a constant force directed towards a fixed point. The magnitude of the force varies inversely as the square of the distance from the fixed point. What is the nature of the path?

(A) Straight line (B) Parabola

(C) Circle (D) Hyperbola

30. A ball of mass 0.25 kg attached to the end of a string of length 1.96 m is moving in a horizontal circle. The string will break if the tension is more than 25N. What is the maximum speed with which the ball can be moved?

(A) $14 ms^{-1}$

(B) $3 ms^{-1}$

(C) $3.92 ms^{-1}$

(D) $5 ms^{-1}$

31. In a projectile motion, velocity at maximum height is

(A) $\frac{u\cos\theta}{2}$

(B) $u\cos\theta$

(C) $\frac{u\sin\theta}{2}$

(D) None of these

32. A particle of mass m is projected with a velocity v making an angle of 45° with the horizontal. The magnitude of angular momentum of projectile about the point of projection when the particle is at its maximum height h is

(A) Zero (B) $\frac{mvh}{\sqrt{2}}$

(C) $\frac{mvh^2}{\sqrt{2}}$ (D) None of these

33. Two projectiles thrown from the same point at angles 60° and 30° with the horizontal attain the same height. The ratio of their initial velocities is

(A) 1 (B) 2

(C) $\sqrt{3}$ (D) $\frac{1}{\sqrt{3}}$

34. If KE of the particle of mass m performing UCM in a circle of radius *r* is *E*. Find the acceleration of the particale

(A) $\frac{2E}{mr}$ (B) $\left(\frac{2E}{mr}\right)^2$

(C) $2\,Emr$ (D) $\frac{4E}{mr}$

35. An object of mass 5 kg is whirled round in a vertical circle of radius 2 m with a constant speed of 6 ms^{-1}. The maximum tension in the string is

(A) 152 N (B) 139 N

(C) 121 N (D) 103 N

36. For a projectile the ratio of maximum height reached to the square of time of flight is (g = 10 ms^{-1})

(A) 5 : 1 (B) 5 : 2

(C) 5 : 4 (D) 1 : 1

37. A car rounds an unbanked curve of radius 92 m without skidding at a speed of 26 ms^{-1}. The smallest possible coefficient of static friction between the tyres and the road is

(A) 0.75 (B) 0.60

(C) 0.45 (D) 0.30

38. A body of mass 5 kg is whirled in a vertical circle by a string 1 m long. Calculate velocity at the top of the circle for just looping the vertical loop

(A) 3.1 ms^{-1} (B) 7 ms^{-1}

(C) 9 ms^{-1} (D) 7.3 ms^{-1}

39. Two projectile are thrown with the same initial velocity at angles α and (90°– α) with the horizontal. The maximum heights attained by them are h_1 and h_2 respectively. Then h_1/h_2 is equal to

(A) $\sin^2\alpha$ (B) $\cos^2\alpha$

(C) $\tan^2\alpha$ (D) 1

40. A simple pendulum oscillates in a vertical plane. When it passes through the mean position, the tension in the string is 3 times the weight of the pendulum bob. What is the maximum displacement of the pendulum with respect to the vertical

(A) 30° (B) 45°

(C) 60° (D) 90°

41. The string of pendulum of length ℓ is displaced through 90° from the vertical and released. Then the minimum strength of the string in order to withstand the tension, as the pendulum passes through the mean position is

(A) *mg* (B) 3 *mg*

(C) 5 *mg* (D) 6 *mg*

42. A car is moving on a circular road of diameter 50 *m* with a speed of 5 ms^{-1}. It is suddenly accelerated at rate 1 ms^{-2}. If the mass is 500 kg, find the net force acting on the car

(A) 5 *N* (B) 1000 *N*

(C) $500\sqrt{2}N$ (D) $500/\sqrt{2}N$

43. An unbanked curve has a radius of 60 m. The maximum speed at which the car make a turn is (Take $\mu = 0.75$)

(A) 7 ms^{-1} (B) 14 ms^{-1}

(C) 21 ms^{-1} (D) 2.1 ms^{-1}

44. A particle moves with constant angular velocity in circular path of certain radius and is acted upon by a certain centripetal force *F*. If the angular velocity is doubled keeping radius the same, the new force will be

(A) 2*F* (B) F^2

(C) 4*F* (D) *F*/2

45. A projectile is fired at an angle of 30° to the horizontal such that the vertical component of its initial velocity is 80 ms^{-1}. Its time of flight is T. Its velocity at t = T/4 has a magnitude of nearly

(A) 200 ms^{-1} (B) 300 ms^{-1}

(C) 140 ms^{-1} (D) 100 ms^{-1}

46. Two particles *A* and *B* are projected with same speed so that the ratio of their maximum heights reached is 3 : 1. If the speed of *A* is doubled without altering other parameters, the ratio of the horizontal ranges attained by *A* and *B* is

(A) 1 : 1 (B) 2 : 1

(C) 4 : 1 (D) 3 : 2

47. A projectile is given an initial velocity of $\hat{i} + 2\hat{j}$. The cartesian equation of its path is (g = 10 ms^{-2})

(A) $y = x - 5x^2$

(B) $y = 2x - 5x^2$

(C) $y = 2x - 15x^2$

(D) $y = 2x - 25x^2$

48. The coordinates of a moving particle at any time '*t*' are given by $x = \alpha t^3$ and $y = \beta t^3$. The speed of the particle at time '*t*' is given by

(A) $\sqrt{\alpha^2 + \beta^2}$ (B) $3t\sqrt{\alpha^2 + \beta^2}$

(C) $3t^2\sqrt{\alpha^2 + \beta^2}$ (D) $t^2\sqrt{\alpha^2 + \beta^2}$

49. A body of mass 1 kg is moving in a vertical circular path of radius 1 m. The difference between the kinetic energies at its highest and lowest point is

(A) 20 *J* (B) 10 *J*

(C) $4\sqrt{5}J$ (D) $10\sqrt{5}J$

50. The angle of projection of a projectile for which the horizontal range and maximum height are equal is

(A) $\tan^{-1}(2)$ (B) $\tan^{-1}(4)$

(C) $\cot^{-1}(2)$ (D) 60°

51. A body is thrown horizontally from the top of a tower of height 5 m. It touches the ground at a distance of 10 m from the foot of the tower. The initial velocity of the body is (g = 10 ms^{-2})

(A) 2.5 ms^{-1} (B) 5 ms^{-1}

(C) 10 ms^{-1} (D) 20 ms^{-1}

ANSWERS

1.	(D)	27.	(B)
2.	(B)	28.	(B)
3.	(D)	29.	(C)
4.	(D)	30.	(A)
5.	(A)	31.	(B)
6.	(B)	32.	(B)
7.	(C)	33.	(D)
8.	(A)	34.	(A)
9.	(D)	35.	(B)
10.	(C)	36.	(C)
11.	(C)	37.	(A)
12.	(D)	38.	(A)
13.	(B)	39.	(C)
14.	(A)	40.	(D)
15.	(A)	41.	(B)
16.	(A)	42.	(C)
17.	(D)	43.	(C)
18.	(A)	44.	(C)
19.	(B)	45.	(C)
20.	(D)	46.	(C)
21.	(A)	47.	(B)
22.	(D)	48.	(C)
23.	(C)	49.	(A)
24.	(B)	50.	(B)
25.	(C)	51.	(C)
26.	(B)		

HINTS & SOLUTIONS

1. (D)

Let the car accelerate at rate α for time t_1 then maximum velocity attained,

$v = 0 + at_1 = at_1$

Now, the car decelerates at a rate β for time $(t - t_1)$ and finally comes to rest. Then,

$0 = v - \beta(t - t_1) \Rightarrow 0 = \alpha t_1 - \beta t + \beta t_1$

$\Rightarrow t_1 = \dfrac{\beta}{\alpha + \beta} t$

$\therefore v = \dfrac{\alpha\beta}{\alpha+\beta} t$

2. (B)

$v = u + at \Rightarrow -2 = 10 + a \times 4 \Rightarrow a = -3 m/sec^2$

3. (D)

$\because v = 0 + na \Rightarrow a = v/n$

Now, distance travelled in n sec.

$\Rightarrow S_n = \frac{1}{2}an^2$ and

distance travelled in $(n-2) sec \Rightarrow S_{n-2}$

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

$\therefore$ Distance travelled in last 2 seconds,

$= S_n - S_{n-2} = \frac{1}{2}an^2 - \frac{1}{2}a(n-2)^2$

$\dfrac{a}{2}[n^2 - (n-2)^2]$

$= \dfrac{a}{2}[n + (n-2)][n - (n-2)]$

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

4. (D)

Velocity of particle $= \dfrac{\text{Total displacement}}{\text{Total time}}$

$= \dfrac{\text{Diameter of circle}}{5} = \dfrac{2 \times 10}{5} = 4 m/s$

5. (A)

$t = \sqrt{\dfrac{2h}{g}} \Rightarrow \dfrac{t_1}{t_2} = \sqrt{\dfrac{h_1}{h_2}} = \sqrt{\dfrac{1}{2}} = \dfrac{1}{\sqrt{2}}$

6. (B)

Given, $a = \dfrac{dv}{dt} = 6t + 5$

Or $dv = (6t + 5)\, dt$

Integrating, we get

$\int_0^v dv = \int_0^t (6t + 5)\, dt$

Or $v = \left(\dfrac{6t^2}{2} + 5t\right)$

Again $v = \dfrac{ds}{dt}$

$\therefore ds = \left(\dfrac{6t^2}{2} + 5t\right) dt$

Integrating again, we get

$\int_0^s ds = \int_0^t \left(\dfrac{6t^2}{2} + 5t\right) dt$

$\therefore s = \dfrac{3t^3}{3} + \dfrac{5t^2}{2}$

When, $t = 2$ s, $s = 3 \times \dfrac{2^3}{3} + \dfrac{5 \times 2^2}{2}$

$= 3 \times \dfrac{8}{3} + \dfrac{5 \times 4}{2}$

$= 8 + 10 = 18$ m

7. (C)

$\Delta x = \dfrac{1}{2}gt^2 - \dfrac{1}{2}g(t-1)^2$

$= \dfrac{1}{2}g[t^2 - (t-1)^2] = \dfrac{1}{2}g(2t - 1)$

$= \dfrac{1}{2} \times 9.8 \times 5\text{m} = 24.5\text{m}$

8. (A)

$v = \sqrt{2 \times 9.8 \times 100} = \sqrt{1960} \text{ms}^{-1}$

$\dfrac{\sqrt{1960}+0}{2} = \dfrac{2}{t}$ or $t = \dfrac{4}{\sqrt{1960}}$ s $= \dfrac{4}{44.27}$ s $= 0.09$s

9. (D)

$h = ut - \dfrac{1}{2}gt^2$

$= 10 \times 1 - \dfrac{1}{2} \times 10 \times 1$

$= 10 - 5 = 5m$

10. (C)

Displacement of the particle will be zero because it comes back to its starting point

Average speed $= \frac{\text{Total distance}}{\text{Total time}} = \frac{30m}{10sec}$

$= 3$ m/s

11. (C)

$v = \sqrt{2gh} = \sqrt{2 \times 10 \times 20} = 20m/s$

12. (D)

$S \propto u^2 \Rightarrow \frac{S_1}{S_2} = \left(\frac{1}{4}\right)^2 = \frac{1}{16}$

13. (B)

Distance average speed $= \frac{2v_1v_2}{v_1+v_2} = \frac{2\times2.5\times4}{2.5+4}$

$= \frac{200}{65} = \frac{40}{13} km/hr$

14. (A)

Let t_1 and t_2 be times taken by the car to go from X to Y and then from Y to X respectively.

Then, $t_1 + t_2 = \frac{XY}{v_{u}} + \frac{XY}{v_d} = XY\left(\frac{v_u+v_d}{v_uv_d}\right)$

Total distance travelled

$= XY + XY = 2\,XY$

Therefore, average speed of the car for this round trip is

Average speed $= \frac{\text{distance travelled}}{\text{time taken}}$

$v_{av} = \frac{2\,XY}{XY\left(\frac{v_u+v_d}{v_uv_d}\right)}$ or $v_{av} = \frac{2v_uv_d}{v_u+v_d}$

15. (A)

Average velocity $= \frac{2v_1v_2}{v_1+v_2}$

Given, $v_{av} = 40\frac{\text{km}}{\text{h}}, v_1 = 60\frac{\text{km}}{\text{h}}$ and v_2 = ?

$\therefore \quad 40 = \frac{2 \times 60 \times v_2}{60 + v_2}$

$80v_2 = 2400$

$v_2 = 30$ km/h

16. (A)

$S \propto u^2 \therefore \frac{S_1}{S_2} = \left(\frac{u_1}{u_2}\right)^2 \Rightarrow \frac{2}{S_2} = \frac{1}{4} \Rightarrow S_2 = 8\,m$

17. (D)

In case of motion under gravity, time taken to go up is equal to the time taken to fall down through the same distance.

Time of desent(t_2) = time of ascent$(t_1) = \frac{u}{g}$

$\therefore$ Total time of flight $T = t_1 + t_2 = \frac{2u}{g}$

Or $u = \frac{g(t_1+t_2)}{2}$

18. (A)

Le the initial velocity $= u$

And acceleration $= a$

In Ist case $\quad s_1 = ut_1 + \frac{1}{2}at_1^2$

$200 = 2u + 2a \qquad (\because t_1 = 2\text{ s})$

Or $\quad u + a = 100 \qquad$ ... (i)

In IInd case

$s_2 = ut_2 + \frac{1}{2}at_2^2$

$420 = 6u + 18a \qquad (\because t_2 = 2 + 4 = 6\text{ s})$

Or $\quad 3a + u = 70 \qquad$ ... (ii)

Solving Eqs. (i) and (ii), we get

$a = -15\text{ ms}^{-2}$

And $u = 115\text{ ms}^{-1}$ $v = u + at$

$= 115 - 15 \times 7 = 10\text{ ms}^{-1}$

19. (B)

$h = vt - \frac{1}{2}gt^2$ or $\frac{1}{2}gt^2 - vt + h = 0$

or $gt^2 - 2vt + 2h = 0 \Rightarrow t_1t_2 = \frac{2h}{g}$

$1 \times 3 = \frac{2h}{10}$ or $2h$ =30m or $h = 15$m

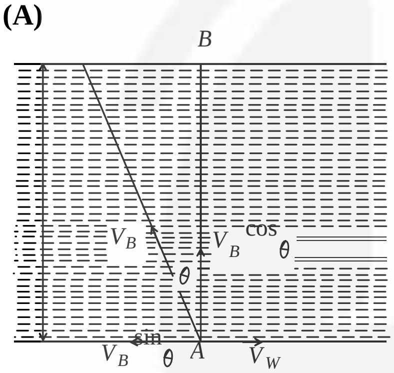
20. (D)

$a = \frac{dv}{dt} = \frac{dv}{dx}\frac{dx}{dt} = v\frac{dv}{dx} = -\alpha x^2$ [Given]

$\Rightarrow \int_{v_0}^{0} v\,dv = \alpha\int_{0}^{S} x^2\,dx \Rightarrow \left[\frac{v^2}{2}\right]_{v_0}^{0} = -\alpha\left[\frac{x^3}{3}\right]_0^S$

$\Rightarrow \frac{v_0^2}{2} = \frac{\alpha S^3}{3} \Rightarrow S = \left(\frac{3v_0^2}{2\alpha}\right)^{\frac{1}{3}}$

21. (A)



From figure, $V_B \sin\theta = V_W$

$\sin\theta = \frac{V_W}{V_B} = \frac{1}{2} \Rightarrow \theta = 30°$ [$\because V_B = 2V_W$]

Time taken to cross the river,

$t = \frac{D}{V_B\cos\theta} = \frac{D}{V_B\cos 30°} = \frac{2D}{V_B\sqrt{3}}$

22. (D)

Slope of line $= -\frac{2}{3}$

Equation of line is $(v-20) = -\frac{2}{3}(s-0)$

$\Rightarrow v = 20 - \frac{2}{3}s$ ...(i)

Velocity at $s = 15m$ i.e.,

$v = \frac{ds}{dt}\Big|_{s=15m} = 20 - \frac{2}{3}(15) = 10\,ms^{-1}$

Differentiate Eq.(i) with respect to time,

acceleration $= \frac{dv}{dt} = -\frac{2}{3}\frac{ds}{dt}$

$\therefore \frac{dv}{dt}\Big|_{s=15m} = -\frac{2}{3}\frac{ds}{dt}\Big|_{s=15m} = -\frac{20}{3}\,ms^{-2}$

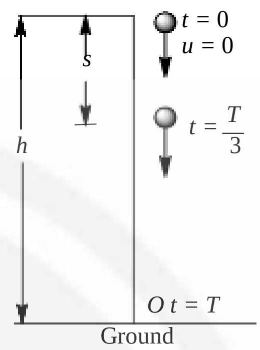
23. (C)

Second law of motion gives

$h = ut + \frac{1}{2}gT^2$

or $h = 0 + \frac{1}{2}gT^2$ ($\because u = 0$)

$\therefore T = \sqrt{\frac{2h}{g}}$



At $t = \frac{T}{3}$ s,

$s = 0 + \frac{1}{2}g\left(\frac{T}{3}\right)^2$

Or $s = \frac{1}{2}g \cdot \frac{T^2}{9}$

Or $s = \frac{g}{18} \times \frac{2h}{g}$ $\left(\because T = \sqrt{\frac{2h}{g}}\right)$

$\therefore s = \frac{h}{9}$ m

Hence, the position of ball from the ground $= h - \frac{h}{9} = \frac{8h}{9}$ m.

24. (B)

$\vec{v} = \vec{u} + \vec{a}t$

$v = (2\hat{i} + 3\hat{j}) + (0.3\hat{i} + 0.2\hat{j}) \times 10$

$= 5\hat{i} + 5\hat{j}$

$|\vec{v}| = 5\sqrt{2}$

25. (C)

$h = -vt_1 + \frac{1}{2}gt_1^2$ or $\frac{h}{t_1} = -v + \frac{1}{2}gt_1$ ...(i)

$h = vt_2 + \frac{1}{2}gt_1^2$ or $-\frac{h}{t_2} = -v + \frac{1}{2}gt_2$ ...(ii)

$\therefore \frac{h}{t_1} + \frac{h}{t_2} = \frac{1}{2}g(t_1 + t_2)$

or $h = \frac{1}{2}gt_1t_2$

For falls under gravity from the top of the tower

$h = \frac{1}{2}gt^2$

$\therefore \frac{1}{2}gt_1t_2 = \frac{1}{2}gt^2 \Rightarrow t = \sqrt{t_1t_2}$

26. (B)

$h = -vt_1 + \frac{1}{2}gt_1^2$ or $\frac{h}{t_1} = -v + \frac{1}{2}gt_1$ ...(i)

$h = vt_2 + \frac{1}{2}gt_1^2$ or $-\frac{h}{t_2} = -v + \frac{1}{2}gt_2$ ...(ii)

$\therefore \frac{h}{t_1} + \frac{h}{t_2} = \frac{1}{2}g(t_1 + t_2)$

or $h = \frac{1}{2}gt_1t_2$

For falls under gravity from the top of the tower

$h = \frac{1}{2}gt^2$

$\therefore \frac{1}{2}gt_1t_2 = \frac{1}{2}gt^2 \Rightarrow t = \sqrt{t_1t_2}$

27. (B)

$F^2 = F^2 + F^2 + 2F^2\cos\theta$

or $F^2 = 2F^2(1 + \cos\theta)$

or $1 + \cos\theta = \frac{1}{2}$

or $\cos\theta = -\frac{1}{2}$ or $\theta = 120°$

$\therefore \cos 120° = -\frac{1}{2}$

28. (B)

New kinetic energy $E' = E = \cos^2\theta$

$= E\cos^2(45°)$

$\frac{E}{2}$

29. (C)

When the force acting on a body is directed towards a fixed point, then it changes only the direction of motion of the body without changing its speed. So, the particle will describe a circular motion

30. (A)

$25 = 0.25 \times v^2/1.96$

or $v = \left(25 \times \frac{1.96}{0.25}\right)^{\frac{1}{2}} = 5 \times \frac{14}{5} = 14\,\text{ms}^{-1}$

31. (B)

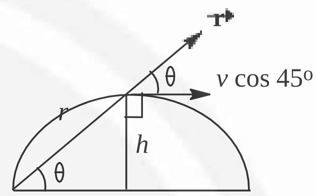
Only horizontal component of velocity $(u\cos\theta\theta)$

32. (B)

The angular momentum of a particle is given by

$\vec{L} = \vec{r} \times m\vec{v}$

$L = mvr\sin\theta$



From figure,

$L = rm(v\cos 45°)\sin\theta$

$= \frac{mv}{\sqrt{2}}(r\sin\theta) = \frac{mvh}{\sqrt{2}}$ $\because \sin\theta = \frac{h}{r}$

33. (D)

$h_{\text{max.}} = \frac{v^2\sin^2\theta}{2g}$

In the given problem, $h_{\text{max.}}$ is same in both the cases

$\therefore v_1^2\sin^2 60° = v_2^2\sin^2 30°$

or $\frac{v_1}{v_2} = \frac{\sin 30°}{\sin 60°} = \frac{1}{2} \times \frac{2}{\sqrt{3}} = \frac{1}{\sqrt{3}}$

34. (A)

Kinetic energy

$E = \frac{1}{2}mv^2$

or $\frac{1}{2}mr\frac{v^2}{r} = E$

or $\frac{1}{2}mra = E$

or $a = \frac{2E}{mr}$

35. (B)

Here, $m = 5$ kg, $r = 2$m, $v = 6\,\text{ms}^{-1}$

The tension is maximum at the lowest point

$T_{\max} = mg + \frac{mv^2}{r}$

$= 5 \times 9.8 + \frac{5 \times 6 \times 6}{2}$

$= 139\text{N}$

36. (C)

Maximum height, $H = \frac{u^2 \sin^2 \theta}{2g}$

Time of flight, $T = \frac{2u \sin \theta}{g}$

$\therefore \frac{H}{T^2} = \frac{u^2 \sin^2 \theta/2g}{4u^2 \sin^2 \theta/g^2} = \frac{g}{8} = \frac{10}{8} = \frac{5}{4}$

37. (A)

Here, $r = 92$ m, $v = 26$ ms^{-1}, $\mu = ?$

As $\frac{mv^2}{r} = F = \mu R = \mu mg$

$\mu = \frac{v^2}{rg} = \frac{26 \times 26}{92 \times 9.8} = 0.75$

38. (A)

$v_H = \sqrt{rg} = \sqrt{1 \times 9.8} = 3.1$ ms^{-1}

39. (C)

$h_1 = \frac{v^2 \sin^2 \alpha}{2g}, h_2 = \frac{v^2 \cos^2 \alpha}{2g}, \frac{h_1}{h_2} = \tan^2 \alpha$

40. (D)

Tension at mean position, $mg + \frac{mv^2}{l} = 3mg$

$v = \sqrt{2gl}$

And if the body displaces by angle θ with the vertical

Then $v = \sqrt{2gl(1 - \cos\theta)}$

Comparing (i) and (ii), $\cos\theta = 0 \Rightarrow \theta = 90°$

41. (B)

$T = mg + \frac{mv^2}{l} = mg + 2mg = 3mg$

Where $v = \sqrt{2gl}$ from $\frac{1}{2}mv^2 = mgl$

42. (C)

Here, $r = 25$m, $v = 5$ ms^{-1}, m $= 500$ kg

$a_t = 1$ ms^{-2},

$a_r = \frac{v^2}{r} = \frac{5 \times 5}{25} = 1$ ms^{-2}

$a_{net} = \sqrt{a_r^2 + a_t^2} = \sqrt{1^2 + 1^2} = \sqrt{2}$ ms^{-2}

$F = ma_{net} = 500\sqrt{2}$ N

43. (C)

From $\frac{mv^2}{r} = F = \mu mg$

$\therefore v = \sqrt{\mu rg} = \sqrt{0.75 \times 60 \times 10} = \sqrt{450}$

$= 21$ms^{-1}

44. (C)

$F = m\omega^2 R \therefore F \propto \omega^2$ (m and R are constant)

If angular velocity is doubled force will becomes four times.

45. (C)

$\frac{u_x}{u_y} = \cot 30° = \sqrt{3} \therefore u_x = 80\sqrt{3}$ ms^{-1}

$T = \frac{2u_y}{g} = \frac{2 \times 80}{10} = 16$ s

At $t = \frac{T}{4} = 4$ s, $v_x = 80\sqrt{3}$ ms^{-1}

$v_y = 80 - 10 \times 4 = 40$ ms^{-1}

$\therefore v = \sqrt{(80\sqrt{3})^2 + (40)^2} = 140$ ms^{-1}

46. (C)

$H = \frac{u^2 \sin^2 \theta}{2g} \Rightarrow \frac{H_1}{H_2} = \frac{\sin^2 \theta_1}{\sin^2 \theta_2}$

$\frac{\sqrt{3}}{1} = \frac{\sin \theta_1}{\sin \theta_2}$ So, $\frac{\cos \theta_1}{\cos \theta_2} = \frac{1}{\sqrt{3}}$

$\frac{R_1}{R_2} = \frac{(2u)^2 \sin 2\theta_1}{u^2 \sin 2\theta_2} = \frac{4 . \sin \theta_1 \cos \theta_1}{\sin \theta_2 \cos \theta_2} = \frac{4}{1}$

47. (B)

Given, $\vec{u} = \hat{i} + 2\hat{j} = u_x\hat{i} + u_y\hat{j}$

Then $u_x = u \cos\theta$

and $u_y = 2 = u \cos\theta$

$\therefore \tan\theta = \frac{u \sin\theta}{u \cos\theta} = \frac{2}{1} = 2$

The equation of trajectory of a projectile motion is

$y = x \tan\theta - \frac{gx^2}{2u^2 \cos^2 \theta}$

$= x \tan\theta - \frac{gx^2}{2(u \cos\theta)^2}$

$= x \times 2 - \frac{10 \times x^2}{2(1)^2} = 2x - 5x^2$

48. (C)

$x = \alpha t^3$ and $y = \beta t^3$ [Given]

$v_x = \frac{dx}{dt} = 3\alpha t^2$ and $v_y = \frac{dy}{dt} = 3\beta t^2$

Resultant velocity $= v = \sqrt{v_x^2 + v_y^2}$

$= 3t^2\sqrt{\alpha^2 + \beta^2}$

49. (A)

$(\mathrm{KE})_L - (\mathrm{KE})_H = \frac{1}{2}m(v_L^2 - v_H^2)$

$= \frac{1}{2}m(5\,gr - gr) = 2mgr$

$= 2 \times 1 \times 10 \times 1 = 20$ J

50. (B)

Given, $R = H$

$\frac{u^2 \sin 2\alpha}{g} = \frac{u^2 \sin^2 \alpha}{2g}$

or $2 \sin\alpha \cos\alpha = \frac{\sin^2\alpha}{2}$

or $\frac{\sin\alpha}{\cos\alpha} = 4$ or $\tan\alpha = 4$

$\therefore\ \alpha = \tan^{-1}(4)$

51. (C)

$S = u \times \sqrt{\frac{2h}{g}} \Rightarrow 10 = u\sqrt{2 \times \frac{5}{10}} \Rightarrow u = 10\ m/s$