JEE MAIN ANSWER KEY & SOLUTIONS

SUBJECT :- PHYSICS
CLASS :- 11th
CHAPTER :- KINEMATICS
PAPER CODE :- CWT-3

ANSWER KEY

1.	(C)	**2.**	(B)	**3.**	(C)	**4.**	(C)	**5.**	(D)	**6.**	(A)	**7.**	(D)
8.	(D)	**9.**	(C)	**10.**	(A)	**11.**	(A)	**12.**	(B)	**13.**	(B)	**14.**	(C)
15.	(D)	**16.**	(A)	**17.**	(A)	**18.**	(B)	**19.**	(A)	**20.**	(A)	**21.**	40
22.	45	**23.**	3	**24.**	125	**25.**	5	**26.**	2	**27.**	10	**28.**	8
29.	5	**30.**	4										

SOLUTIONS

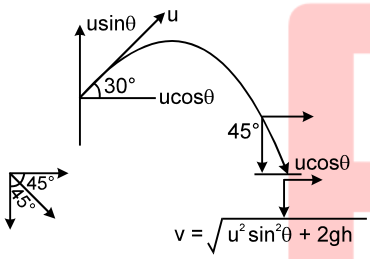
1. (C)

Sol. Using $v = \sqrt{u^2 + 2gh}$

$v = \sqrt{u^2 \sin^2\theta + 2gh}$ (vertical comp. when striking)

Now $\tan 45° = 1$

$$u\cos\theta = \sqrt{u^2\sin^2\theta + 2gh}$$



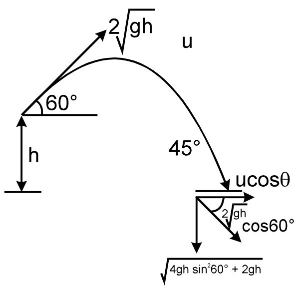
$u^2\cos^2\theta = u^2\sin^2\theta + 2gh$ .....(1)

$u^2\left(\frac{3}{4} - \frac{1}{4}\right) = 2gh$

$u^2 = 4gh$

$u = 2\sqrt{gh}$

$$\tan\theta = \frac{V_\perp}{V_H} = \frac{\sqrt{4gh.\frac{3}{4} + 2gh}}{2\sqrt{gh} \times \frac{1}{2}} = \frac{\sqrt{5gh}}{\sqrt{gh}} = \sqrt{5}$$



2. (B)

Sol. $S_n = u + \frac{a}{2}(2n - 1)$

$\frac{7}{16}h = \frac{g}{2}(2n - 1)$ ...(1)

$h = \frac{1}{2}gn^2$ ...(2)

$h = \frac{1}{2}gt^2 = \frac{1}{2} \times 10\ (4)^2 = 80$ m

$h' = \frac{1}{2} \times 10\ (2 \times 4 - 1) = 35$ m

$\Rightarrow \frac{h'}{h} = \frac{35}{80} = \frac{7}{16}$

dividing equatiuon (1) by equation (2)

$\frac{7}{16} = \frac{2n-1}{n^2}$

$\Rightarrow 7n^2 = 32n - 16$

$\Rightarrow 7n^2 - 32n + 16 = 0$

$\Rightarrow (7n - 4)(n - 4) = 0$

$n = \frac{4}{7}, 4$

3. (C)

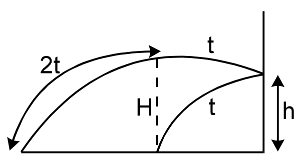
Sol. In this condition velocity and acceleration both are perpendicular w.r.t. ground.
So path on ground will be parabolic.

4. (C)

Sol. : $H = \frac{1}{2}g(2t)^2 = 2gt^2$ ....(1)

$h = H - \frac{1}{2}gt^2$ ....(2)

By (1) & (2)



$h = H - \frac{H}{4} = \frac{3H}{4}$

5. (D)

Sol. Given,

$\alpha = ae^{-\alpha t} + be^{\beta t}$

So, velocity $v = \frac{dx}{dt}$

$= -a\alpha e^{-at} + b\beta e^{\beta t}$

$= A + B$

where, $A = -a\alpha e^{-at}$, $B = b\beta e^{\beta t}$

The value of term $A = -a\alpha e^{-at}$ decreases and of term $B = b\beta e^{\beta t}$ increase with increase in time, As result, velocity goes on increasijng with time,

6. (A)

Sol. $v_A = \frac{80}{\sqrt{2}}\hat{i} + \frac{80}{\sqrt{2}}\hat{j}$

$V_B = \frac{60}{\sqrt{2}}\hat{i} + \frac{60}{\sqrt{2}}\hat{j}$

$v_{AB} = v_A - v_B = \frac{20}{\sqrt{2}}\hat{i} + \frac{140}{\sqrt{2}}\hat{j}$

angle made be with north

$\tan\theta = \frac{20}{140}$

$\theta = \tan^{-1}\left(\frac{1}{7}\right)$

7. (D)

Sol. Time of flight of projectile depends on vertical component of velocity and not on the horizontal component. Collision of the stone with the vertical wall changes only the horizontal component of velocity of stone. Thus the total time of flight in absence of wall is also T = 1 + 3 = 4sec

T = 1 + 3 = 4sec

$\therefore \quad \frac{2u_y}{g} = 4 \qquad$ or $u_y = 20$ m/s

or $H_{max} = \frac{u_y^2}{2g} = \frac{400}{20} = 20$ metres.

8. (D)

Sol. **key Idea :** As bodies are dropped from a certain height, their initial velocities are zereo i. e., u = 0. For free fall from a height u = 0 (initial velocity). From second equation of motion

$h = ut + \frac{1}{2}gt^2 \quad$ or $\quad h = 0 + \frac{1}{2}gt^2$

$\therefore \quad \frac{h_1}{h_2} = \left(\frac{t_1}{t_2}\right)^2$

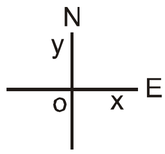
Given $h_1 = 16$ m, $h_2 = 25$m

$\therefore \quad \frac{t_1}{t_2} = \sqrt{\frac{h_1}{h_2}} = \sqrt{\frac{16}{25}} = \frac{4}{5}$

NOTE : Time taken by the object in falling does not depend on mass of object.

9. (C)

Sol.



$\vec{V}_1 = 10\hat{i}$,

$\vec{V}_2 = v\sin 30\hat{i} + v\cos 30\hat{j} = \frac{\upsilon}{2}\hat{i} + \frac{\upsilon\sqrt{3}}{2}\hat{j}$

$\vec{V}_2 - \vec{V}_1 = \left(\frac{V}{2} - 10\right)\hat{i} + \frac{\upsilon\sqrt{3}}{2}\hat{j} = \frac{\upsilon\sqrt{3}}{2}\hat{j}$

$\therefore \quad \frac{V}{2} - 10 = 0 \quad$ or $\quad \upsilon = 20$

10. (A)

Sol. $\frac{R^2}{8h} + 2h = \frac{\left(\frac{u^2 2\sin\theta\cos\theta}{g}\right)^2}{\frac{8\times u^2\sin^2\theta}{2g}} + 2\frac{u^2\sin^2\theta}{2g}$

$= \frac{u^2}{g}$ (max . horizontal Range)

11. (A)

Sol. From relation

$h = ut + \frac{1}{2}gt^2 \qquad$ (with u = 0)

we have $h = \frac{1}{2}gt^2 \quad \Rightarrow \quad t$

$= \sqrt{\left(\frac{2h}{g}\right)} \propto \sqrt{h} \quad \therefore$

$\frac{t_1}{t_2} = \sqrt{\frac{h_1}{h_2}}\sqrt{\left(\frac{h}{2h}\right)} = \frac{1}{\sqrt{2}}$

12. (B)

Sol. Velocity of the boat in still water : $V = \frac{16}{2} = 8$ Km/hr

Velocity of boat along upstream = V – u = 8 – 4 = 4 Km/hr

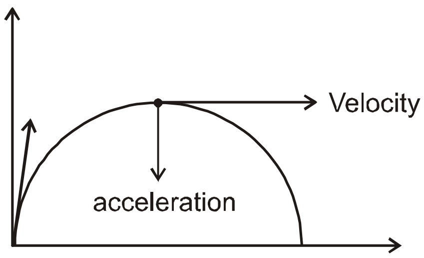
Velocity of boat along downstream = V + u = 8 + 4 = 12 Km/hr.

Total time during upstream and donwstream.

$t = \frac{8}{4} + \frac{8}{12} = \frac{8}{3} = 2$ hrs 40 min.

13. (B)

Sol.



As the figure implies, velocity acts in horizontal direction and acceleration due to gravity acts in vertical direction. So, angle between them 90º.

14. (C)

Sol. $v^2 = u^2 + 2a\,s$

$$0 = \left(50 \times \frac{5}{18}\right)^2 + 2a \times 6$$

$a = -16\ m/s^2$ (a = retardation)

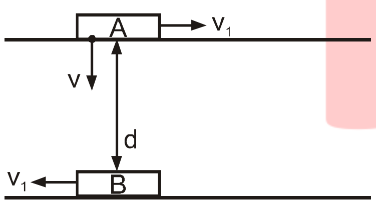
Again $v^2 = u^2 + 2as$

$$0 = \left(100 \times \frac{5}{18}\right)^2 \times 16 \times 2 \times s$$

$$s = \frac{(100 \times 5)^2}{18 \times 10 \times 32} = 24m$$

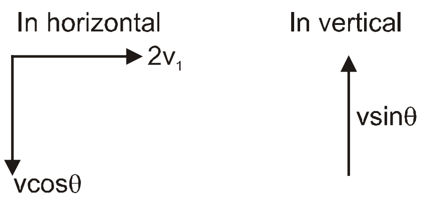
15. (D)

Sol.



velocity of particle w.r.t. B

Let particle is projected at angle θ with horizontal



So, path observed by B is parabolic (projectile motion).

16. (A)

Sol. For maximum range

$R = \frac{u^2}{g}$ $\Rightarrow$ $u^2 = gR$

$u^2 = 16{,}000 \times 10 \Rightarrow$ $u = 4 \times 100$

u = 400 m/sec

17. (A)

Sol. $24 = u \times 4 + \frac{1}{2} a (4)^2$

$6 = u + 2a$ .... (1)

$88 = u \times 8 + \frac{1}{2} a (3)^2$

$11 = u + 4a$ .... (2)

$2a = 5$ $\Rightarrow$ $a = \frac{5}{2}$

From (1) $6 = u + 2\left(\frac{5}{2}\right) \Rightarrow u = 1\ m/s$

18. (B)

Sol. With respect to lift initial speed = v_0

acceleration = – 2g

displacement = 0

$\therefore S = ut + \frac{1}{2}at^2,\ 0 = v_0T' + \frac{1}{2} \times 2g \times T'^2$

$\therefore T' = \frac{v_0}{g} = \frac{1}{2} \times \frac{2v_0}{g} = \frac{1}{2}T$

19. (A)

Sol. $x \propto t^3$

$x = kt^3$

$V = \frac{dx}{dt} = 3kt^2$

$a = \frac{dv}{dt} = 6kt \Rightarrow a \propto t$

20. (A)

Sol. Relative displacement of glass window w.r.t. cyclist is 20 cm time taken = 1 sec.

So, relative velocity of glass window w.r.t. cyclist

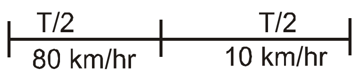
$= \frac{20}{1}$ cm/sec. = 0.2 m/sec.

21. 40

Sol. $R_{max} = \frac{u^2 \sin 90^\circ}{g} = \frac{20^2}{10} = 40\,m$

22. 45

Sol.



average speed $<v> = \frac{\text{Total distance}}{\text{Total time}} = \frac{60}{T} = 60$

$60 = 80\,\frac{T}{2} + 10 \times \frac{T}{2}$

$60 = (40 + 5)\,T$

$T = \frac{60}{45}$ km/hr

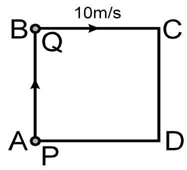
$,<v> = \frac{60}{60} \times 45 = 45$ km/hr

23. 3

Sol. a = 8 m

They meet when Q displace 8 × 3 m more that p $\Rightarrow$ relative displacement

= relative velocity × time.



8 × 3 = (10 – 2) t t = 3 sec

Ans. 3 sec

24. 125

Sol. $T = \frac{2u\sin\theta}{g} = 10$

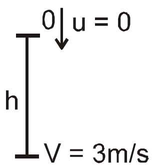
$R = \frac{u^2 \sin 2\theta}{g} = 50$ m

$H = \frac{(u\sin\theta)^2}{2g} = \frac{(5g)^2}{2g} = \frac{25g^2}{2g} = \frac{25g}{2}$

H = 125 m

25. 5

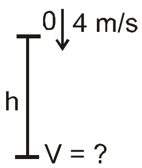
Sol.



$V^2 = u^2 + 2gh$

$(3)^2 = 0 + 2 \times 10 \times h$

2gh = 9 .... (1)



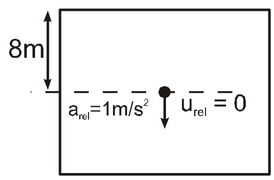
$V^2 = u^2 + 2gh$

$V^2 = (4)^2 + 9$

$V^2 = 25 \Rightarrow V = 5$ m/s

26. 2

Sol. Relative to lift initial velocity and acceleration of coin are 0 m/s and 1 m/s² downward



$\therefore \quad 2 = \frac{1}{2}(1)\ t^2$ or t = 2 second

27. 10

Sol. x = 6t $y = 8t - 5t^2$

$\frac{dx}{dt} = 6$ $\frac{dy}{dt} = 8 - 10t$

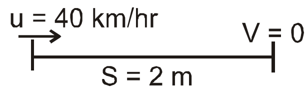
at t = 0

$V_x = 6$ m/sec $V_y = 8$m/sec

$V = \sqrt{V_y^2 + V_x^2} = \sqrt{8^2 + 6^2} = 10$ m/sec

28. 8

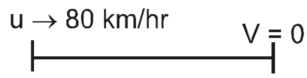
Sol. **Case - I**



$V^2 = u^2 + 2\,as \Rightarrow 0 = \left(40 \times \frac{5}{18}\right)^2 - 2a$

(2) $\Rightarrow a = \frac{(40 \times 5)^2}{(18)^2 \times 4}$

Case - II



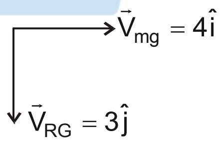
$V^2 = u^2 - 2a\,.\,S \Rightarrow 0$

$= \left(80 \times \frac{5}{18}\right)^2 - 2\left(\frac{40 \times 5}{18}\right)^2 \times \frac{1}{4} \times S$

$\Rightarrow \frac{64 \times 2}{16} = 8$ m

29. 5

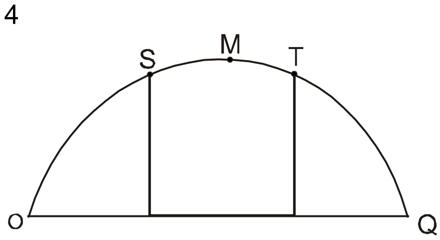
Sol. $\vec{V}_{RG} = 3\hat{j} - 4\hat{i}$



$V_{RG} = 5$ km/sec.

30. 4

Sol.



$t_{(OS)} = 1$ sec

$t_{(OT)} = 3$

or $t_{(ST)} = t_{(OT)} - t_{(OS)} = 3 - 1 = 2$ sec

$\therefore \quad t_{(SM)} = \frac{1}{2}\, t_{(ST)} = 1$ sec.

$\therefore \quad t_{(OM)} = t_{(OS)} + t_{(SM)} = 1 + 1 = 2$sec.

$\therefore$ Time of flight = 2 × 2 = 4 sec. **Ans. "C"**