CHAPTER - 02
KINEMATICS

PART I - (JEEMAIN)

QUESTIONS

SECTION - I

1. 3 $S_1 : S_2 : S_3 = 1 : 3 : 5$

2. 3 $V_{max} = \frac{1}{2} \times 11 \times 10$
$= 55$

3. 2 $v = u + \int_0^t a\,dt$
$v = u + \frac{at^2}{2}$

4. 4 $t_1 = \frac{1}{2}\sqrt{\frac{2h}{g}} = \frac{1}{2}s$
$\frac{1}{2} g t_1^2 = 5 \times \frac{1}{4} = 5/4$
$5 - \frac{5}{4} = \frac{15}{4}$ //

5. 1 $t_2 - t_1 = 4g$
$t_1 + t_2 = 8g$
$t_1 = 2, t_2 = 6.$
$h = \frac{1}{2} g t_1 t_2 = \frac{1}{2} \times 10 \times 12$
$= 60m$

6. 2

$\theta = 120$

$2\sin\frac{\theta}{2} = 2\times\frac{\sqrt{3}}{2} = \sqrt{3}$ //

7. 4

$\vec{u} = 3\hat{i}$

$\vec{a} = 1\hat{j}$

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

$\vec{v} = 3\hat{i} + 4\hat{j}$

8. 1

$\frac{4H}{R} = \tan\theta$

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

9. 3

$\vec{N}_{av} = \frac{u\cos\theta\hat{i} + u\sin\theta\hat{j} + u\cos\theta\hat{i}}{2}$

$V_{av} = \frac{\sqrt{4u^2\cos^2\theta + u^2\sin^2\theta}}{2}$

$V_{av} = \frac{u}{2}\sqrt{3\cos^2\theta + 1}$

10. 4

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

$0.5 = \frac{\sqrt{3}}{2}\times\frac{1}{\sqrt{3}} - \frac{5\times 3}{4\times u^2\times 3}\times 4$

$\frac{1}{2} = \frac{1}{2} - \frac{5}{u^2}$

$u = \infty$

11. 3

$$-H = 4\sin\theta\, T - \frac{1}{2} g T^2$$

$$-70 = 50 \times \frac{1}{2} T - 5T^2$$

$$-70 = 25T - 5T^2$$

$$T^2 - 5T - 14 = 0.$$

$$T = 7s,\ T = -2$$

12. 1

$$vt = \frac{1}{2} a t^2$$

$$t = \frac{2v}{a}$$

13. 1

$$\vec{V}_A = 25\,\hat{i}$$

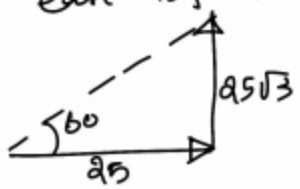
$$\vec{V}_{BA} = 25\sqrt{3}\,\hat{j}$$

$$\vec{V}_B = 25\,\hat{i} + 25\sqrt{3}\,\hat{j}$$

$V_B =$ 50 kmph

60° North of east

30° east of north



14. 1

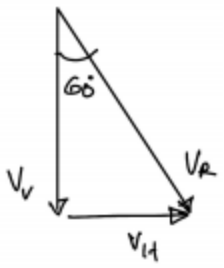
$V_H = 20$

$\frac{V_H}{V_V} = \sqrt{3}$

$V_V = \frac{20}{\sqrt{3}}$

$V_R = \sqrt{20^2 + \frac{20^2}{\sqrt{3}^2}}$

$= 20\sqrt{\frac{4}{3}} = \frac{40}{\sqrt{3}}$ //



15. 4

$\frac{V_R \cdot w}{V_{BR}} = 50\,m$

$\frac{r_R}{r_{BR}} = \frac{50}{100} = \frac{1}{2}$

SECTION - II

Numerical Type Questions

16. 3

$V_{av} = \frac{2V_1V_2}{V_1+V_2}$

$= \frac{2 \times 2.5 \times 4}{6.5}$

$= 3$

17. 9

$V = \frac{6t^2}{9} + 5t$

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

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

$= 8 + \frac{5}{2} \times 4$

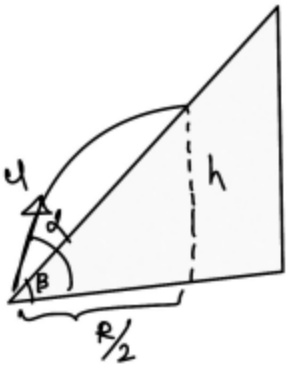
$= 8 + 10$

$= 18$

$2x = 18$

$x = 9$

18. 2



$$\frac{h}{R/2} = \tan\beta \qquad \frac{4h}{R} = \tan\alpha$$

$$\frac{2h}{R} = \tan\beta$$

$$\frac{\tan\alpha}{\tan\beta} = 2$$

19. 45

$$R = 5T^2$$

$$H = \frac{1}{8}gT^2$$

$$= \frac{10}{8}T^2$$

$$H = \frac{5}{4}T^2$$

$$H = \frac{R}{4}$$

$$\frac{4H}{R} = 1$$

$$\theta = 45^\circ$$

PART - II (JEE ADVANCED)

SECTION - III (One correct answer)

20. A

$v = an \quad a = \frac{v}{n}$

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

$S = \frac{1}{2}a(n^2 - n^2 - 4 + 4n)$

$= \frac{1}{2}a\,4\,(n-1)$

$= 2a(n-1)$

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

21.

$v = bx^{-2n}$

$a = v\cdot\frac{dv}{dx} = bx^{-2n}\, bx(-2n)x^{-2n-1}$

$= -2nb^2 x^{-4n-1}$

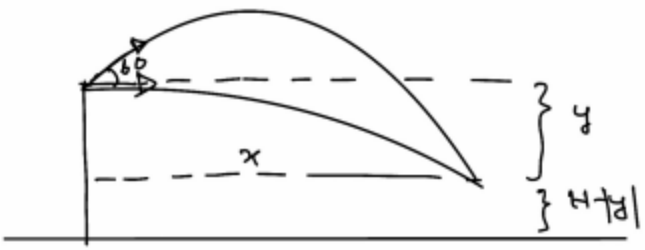
22. B

$T_a = \frac{u}{g+a} = \frac{u}{12}$

$T_a' = \frac{u}{\sqrt{g^2-a^2}} = \frac{u}{\sqrt{96}}$

$\frac{T_a}{T_a'} = \frac{\sqrt{96}}{12} = \sqrt{\frac{96}{144}} = \sqrt{\frac{8}{12}} = \sqrt{\frac{2}{3}}$

23. D



Time interval = T

$u\cos 60\, t = u(t-T)$

$\frac{ut}{2} = ut - uT$

$uT = \frac{ut}{2}$

$T = \frac{t}{2}$

$u\sin\theta\, t - \frac{1}{2}gt^2 = -\frac{1}{2}g(t-T)^2$

$u\sin\theta\, t - \frac{1}{2}gt^2 = \frac{1}{2}g\frac{t^2}{4}$

$u\sin\theta\, t = \frac{1}{2}g \times \frac{3t^2}{4}$

$5\sqrt{3} \times \frac{\sqrt{3}}{2} = \frac{8}{4} \times 10 \times t$

$t = 2s$

$x = u\cos\theta\, t = 5\sqrt{3} \times \frac{1}{2} \times 2$

$= 5\sqrt{3}$

$y = -\frac{1}{2}g \times (t-1)^2$

$y = -\frac{1}{2} \times 10 \times 1 = -5$

$H - y = 5$

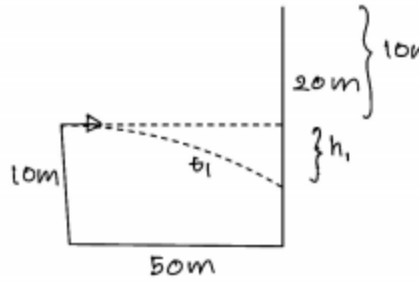
24. C

$150\sin 60 - gt = 150\cos 60$

$150 \times \frac{\sqrt{3}}{2} - 10t = 150 \times \frac{1}{2}$

$t = \frac{15}{9}(\sqrt{3}-1)$

25. A



$t_1 = 0.5s$

$h_1 = \frac{1}{2} g \times (0.5)^2$

$h_1 = \frac{1}{2} \times 10 \times \frac{1}{4}$

$= 1.25m$

$t_{fall} = \sqrt{\frac{2 \times 11.25}{10}}$

$= \sqrt{\frac{22.25}{10}}$

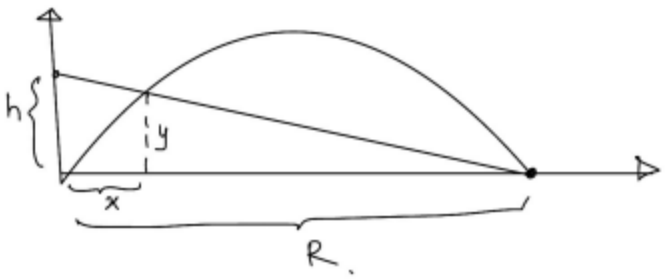
$= \sqrt{2.225}$

$= 1.5s$

$t_{fall} - t_1 = 1.5 - 0.5$

$= 1s$

26. A



$\frac{h}{R} = \frac{y}{R-x}$

$y = u\sin 45\, t - \frac{1}{2} g t^2$, $x = \frac{u}{\sqrt{2}} t$

Solving.

$h = t\sqrt{\frac{gL}{2}}$ //

27. B

$\vec{V}_M = 6\hat{i} + 8\hat{j}$, $\vec{V}_W = V_x\hat{i} + V_y\hat{j}$

$\vec{V}_{WM} = k\hat{i}$

$V_y = 8$

$\vec{V}_{M'} = 12\hat{i} + 16\hat{j}$

$\vec{V}_{WM'} = (V_x - 12)\hat{i} + (V_y - 16)\hat{j}$

$V_x - 12 = V_y - 16$

$V_x - 12 = 8 - 16$

$V_x - 12 = -8$

$V_x = 4$

$\vec{V} = 4\hat{i} + 8\hat{j}$

28. B

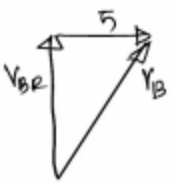
$V_{BR} = 10$

$V_R = 5$

$V_{BR} = \sqrt{125}$

$= 5\sqrt{5}$ kmph.

$= 11.2$ kmph



$t = \frac{W}{V_{BR}} = \frac{3\text{km}}{10\text{kmph}} = \frac{3}{10}$ h.

$= \frac{3}{10} \times 60$ min $=$ 18 min

SECTION - IV (More than one correct answer)

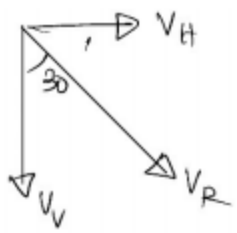
29. A

$\frac{V_H}{V_V} = \frac{1}{\sqrt{3}}$, $V_V = \sqrt{3}V_H$

$V_H = 10$ kmph.

$V_V = 10\sqrt{3}$ kmph.

$V_R = 20$ kmph



30. C

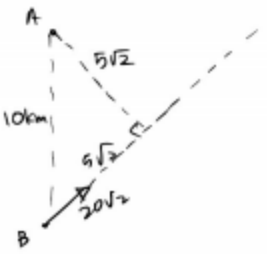
$\vec{V_A} = -20\hat{i}$

$\vec{V_B} = 20\hat{j}$

$\vec{V_{BA}} = 20\hat{i} + 20\hat{j}$

$V_{BA} = 20\sqrt{2}$

$t = \frac{5\sqrt{2}}{20\sqrt{2}} = \frac{1}{4}$



31. A,B,D

$\frac{u+\sqrt{u^2+2gH}}{g} = 12$

$\frac{-u+\sqrt{u^2+2gH}}{g} = 3$

$\frac{2\sqrt{u^2+2gH}}{g} = 15.$

$\frac{2u}{g} = 9$

$u = 45$

$\sqrt{u^2+2gH} = 75$

$45^2 + 2gH = 75^2$

$2gH = 75^2 - 45^2 = 3600$

$H = \frac{3600}{20} = 180$

$T' = \sqrt{\frac{2H}{g}} = \sqrt{\frac{2\times180}{10}} = \sqrt{36} = 6$

32. A,C,D

$x_{24} - x_0 = 2\times10 + \frac{1}{2}\times8(2+6) + \frac{1}{2}\times6\times6$

$= 20 + 32 + 18$

$= 70$

$x_{24} = -16 + 70 = 54$

$t = 18 \quad x_{18} = x_0 + 52$

$= -16 + 52 = 36$

$x_{30} = x_0 + 70 - \frac{1}{2}\times6\times(6)$

$= -16 + 52$

$= +36$

33. ABCD

$u_x = \frac{40}{2} = 20\,ms^{-1}$

$t_1 = \frac{20}{20} = 1s$

$t_2 = 3s$

$T = 4s$

$H = \frac{1}{8} g T^2 = \frac{1}{8} \times 10 \times 16$

$= 20m$

$\frac{2u_y}{g} = 4$

$u_y = 20\,ms^{-1}$

34. ACD

$\vec{u_A} = u_0\cos\theta\hat{i} + u_0\sin\theta\hat{j}$

$\vec{u_B} = -u_0\cos\theta\hat{i} + u_0\sin\theta\hat{j}$

$\vec{u}_{AB} = 2u_0\cos\theta\hat{i}$

$t = \frac{l}{2u_0\cos\theta}$

SECTION - V (Numerical Type - Upto two decimal place)

35. $V_{av} = 30\,ms^{-1}$

$\frac{u+v}{2} = 30$

$u+v = 60$

$v-u = 10$

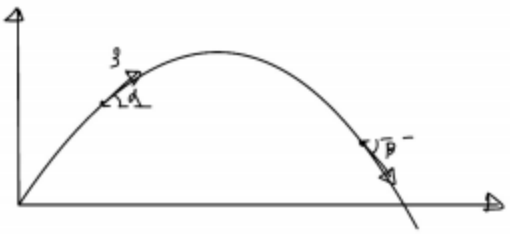
$2v = 70$

$v = 35$

$u = 25$

$25 = g \times t$, $t = 2.5$

36. 2.88 $\alpha+\beta=90$



$3\cos\alpha = 4\cos\beta$

$3\sin\beta = 4\cos\beta$

$\tan\beta = \frac{4}{3}$

$\beta = 53$

$\alpha = 37$

$KE_{min} = \frac{1}{2} \times 1 \times \left(3 \times \frac{4}{5}\right)^2 = \frac{1}{2} \times \frac{144}{25} = \frac{144}{50}$

$= \frac{14.4}{5} = 2.88\ J$

37. 2 $V_{rel} = V - V\cos 60 = \frac{V}{2}$

$t = \frac{a}{V_{rel}} = \frac{a}{V/2} = \frac{2a}{V}$

38. $\vec{V}_B = V\cos\theta\,\hat{\uparrow} + V\sin\theta\,\hat{\rightarrow}$

$\vec{V}_B = \frac{4V}{5}\hat{\uparrow} + \frac{3V}{5}\hat{\rightarrow}$

$\vec{V}_C = 13\hat{\uparrow}$

$\vec{V}_{BC} = \left(\frac{4V}{5} - 13\right)\hat{\uparrow} + \frac{3V}{5}\hat{\rightarrow}$

$t = \frac{3 \times 5}{3V}$

$t = \frac{5 \times 2}{65} = \frac{2}{13}$

$\tan\alpha = \frac{\frac{3V}{5}}{\frac{4V}{5} - 13}$

$\frac{3}{9} = \frac{3V/5}{\frac{4V-65}{5}}$

$12V - 195 = 6V$

$6V = 195$

$V = \frac{195}{6} = \frac{65}{2}$

SECTION - VI (Matrix Matching)

39. i → a, ii → b, iii → c, iv → d

$\theta = 45^\circ$

$V_x = \frac{V}{\sqrt{2}}$

$V_y = \sqrt{\frac{V^2}{2} - 2g \times \frac{h}{2}} = \sqrt{\frac{V^2}{2} - \frac{20}{2} \times \frac{V^2}{4 \times 10}}$

$V_y = \sqrt{\frac{V^2}{2} - \frac{V^2}{4}} = \frac{V}{2}$

$V_{net} = \sqrt{\frac{V^2}{2} + \frac{V^2}{4}} = \sqrt{\frac{3V^2}{4}} = \frac{\sqrt{3}V}{2}$

$\vec{V}_{av} = \frac{\frac{V}{\sqrt{2}}\hat{i} + \frac{V}{\sqrt{2}}\hat{j} + \frac{V}{\sqrt{2}}\hat{i}}{2}$

$V_{av} = \frac{V}{2}\sqrt{2 + \frac{1}{2}}$

$= \frac{V}{2}\sqrt{\frac{5}{2}}$

40. 1 → a, 2 → c, 3 → d, 4 → b

$y = Ax - Bx^2$

$y = Ax\left(1 - \frac{Bx}{A}\right)$

$R = A/B$

$H = \frac{A^2}{4B}$

$T = A\sqrt{\frac{2}{gB}}$

$\tan\theta = A$