KINEMATICS

1. The average speed

$$= \frac{\frac{2x}{5} + \frac{3x}{5}}{\frac{2x/5}{v_1} + \frac{3x/5}{v_2}} = \frac{5v_1v_2}{3v_1 + 2v_2}.$$

2. Average speed is given by

$$v_{av} = \frac{2v_0(v_1 + v_2)}{2v_0 + v_1 + v_2}$$

$$= \frac{2\times 3(4.5+7.5)}{(2\times 3)+4.5+7.5} = 4 \text{ m/s}$$

3. $V = \alpha\sqrt{x} \Rightarrow \frac{dx}{dt} = \alpha\sqrt{x} \Rightarrow \frac{dx}{\sqrt{x}} = \alpha dt$

Integrating, $\int_{x=0}^{x} x^{-1/2}dx = \int_{t=0}^{t} \alpha\, dt$

$$2\sqrt{x} = \alpha t \Rightarrow \sqrt{x} = \alpha t/2$$

Put this value of $\sqrt{x}$ in the original given eq^n.

$V = \alpha\sqrt{x} = \alpha(\alpha.t/2) = \alpha^2 t/2$

$\therefore$ $V \propto t$

4. $\alpha = \frac{v_{max}}{t_1}$; $\beta = \frac{v_{max}}{t_2}$ $\therefore$ $\frac{\beta}{\alpha} = \frac{\frac{v_{max}}{t_2}}{\frac{v_{max}}{t_1}} = \frac{t_1}{t_2}$ ....(i)

$V^2_{max} = 2\alpha x_1$ $\qquad V^2_{max} = 2\beta x_2$

$x_1 = \frac{V^2_{max}}{2\alpha}$ $\qquad x_2 = \frac{V^2_{max}}{2\beta}$ $\qquad \frac{x_1}{x_2} = \frac{\beta}{\alpha}$ ...(ii)

Now $\boxed{\frac{x_1}{x_2} = \frac{t_1}{t_2}}$ So $\boxed{\frac{x_1}{x_2} = \frac{t_1}{t_2} = \frac{\beta}{\alpha}}$

5. For uniformly accelerated motion, the x must be quadratic in t. So,

$t^2 = \frac{x-a}{b}$ or $x = a + bt^2$

6. $s_1 = \frac{1}{2}a(10)^2$ and $s = \frac{1}{2}a(20)^2 = 4s_1$

$\therefore$ $s_2 = s - s_1 = 3s_1$

7. Velocity changes from v_1 to v_2 in time $t_1 + t_2$, so

$$a = \frac{v_2 - v_1}{t_1 + t_2}.$$

Similarly $a = \frac{v_3 - v_2}{t_2 + t_3}$

Thus $\left(\frac{v_2 - v_1}{t_1 + t_2}\right) = \left(\frac{v_3 - v_2}{t_2 + t_3}\right)$

8. $0 = u^2 - 2a\, s \quad \Rightarrow \quad s = \frac{u^2}{2a}$

$\therefore \quad \frac{s_1}{s_2} = \frac{u_1^2}{u_2^2} = \frac{u^2}{(4u)^2} = \frac{1}{16}$

9. For first 1m of fall,

$1 = \frac{1}{2}gt_1^2, \quad \therefore \quad t_1 = \sqrt{\frac{2}{g}}$

For 2m of fall,

$2 = \frac{1}{2}gt^2, \quad \therefore \quad t = \sqrt{\frac{4}{g}},$

$\therefore \quad t_2 = t - t_1 = \sqrt{\frac{4}{g}} - \sqrt{\frac{2}{g}} = (\sqrt{2}-1)\sqrt{\frac{2}{g}}$

For 3 m of fall,

$3 = \frac{1}{2}gt^2, \quad \therefore \quad t = \sqrt{3}\sqrt{\frac{2}{g}},$

$\therefore \quad t_3 = t - t_2 = (\sqrt{3}-\sqrt{2})\sqrt{\frac{2}{g}}.$

10. If h is the height of the building, then

$v_A^2 = v^2 + 2gh$

and $v_B^2 = (-v)^2 + 2gh$

Clearly $v_A = v_B$.

11. $\left(\frac{v}{2}\right)^2 = v^2 - 2g\times 3$

$\therefore \quad v = \sqrt{8g}.$

If h is the further height, then

$$0 = \left(\frac{v}{2}\right)^2 - 2gh$$

$\therefore \quad h = \frac{v^2}{8g} = \frac{8g}{8g} = 1 \text{ m}.$

12. $h = ut_1 - \frac{1}{2}gt_1^2$

Also $h = ut_2 - \frac{1}{2}gt_2^2$

After simplify above equations, we get

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

13. $0 + \frac{a_1}{2}(2\times 5 - 1) = 0 + \frac{a_2}{2}[2\times 3 - 1]$

$\therefore \quad \frac{a_1}{a_2} = \frac{5}{9}.$

14. $h_1 = \frac{1}{2} \times 10 \times 5^2 = 125$ m

$h_2 = \frac{1}{2} \times 10 \times 3^2 = 45$ m

$\therefore \quad h = h_1 - h_2 = 80$ m.

15. $\frac{dv}{dt} = at \quad$ or $\quad \int_0^v dv = \int_0^t (at)\,dt$

$\therefore \quad v = u + \frac{at^2}{2}$

16. $\frac{v_A}{v_B} = \frac{\tan 30°}{\tan 60°} = \frac{1/\sqrt{3}}{\sqrt{3}} = \frac{1}{3}$

17. Effective acceleration in ascending lift = (g + a)

$t = \sqrt{\frac{2h}{g+a}} = \sqrt{\frac{2 \times 9.5}{32+6}}$

$t = \sqrt{\frac{2 \times 9.5}{38}} = \frac{1}{\sqrt{2}}$ sec

18. The maximum acceleration will occur in the duration 30 s to 40 s. So

$a = \frac{v_2 - v_1}{t_2 - t_1} = \frac{60-20}{40-30} = 4\ m/s^2$.

19. It is the $\vec{s} - t$ graph of a body projected upward. It has uniform acceleration downward.

20. The distance, $s = \frac{vT}{2}$

Also, $m = \frac{v}{T}$, $\quad \therefore \quad T = \frac{v}{m}$.

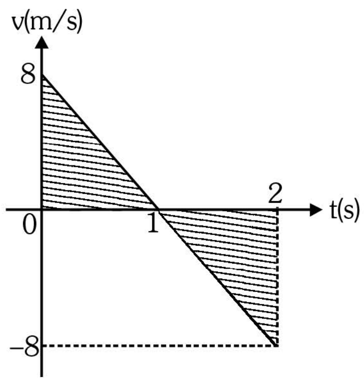
Now $\quad s = \frac{v^2}{2m}$.

21. Area of (v–t) curve = displacements

$x = 2 + 8t - 4t^2$

v	8	0	–8
t	0	1	2

$v = \frac{dx}{dt} = 8 - 8t$



Distance travelled from t = 0 to t = 2 sec

$= \frac{1}{2} \times 1 \times 8 + \frac{1}{2} \times 1 \times 8 = 4 + 4 = 8$ m

22. The height h is covered in time interval t = 1 s to t = 2s or t = 5s to t = 6s.

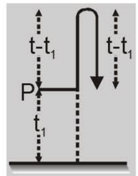
At maximum height t = 3.5 sec.

h between t_5 & t_6 is

$h = \frac{1}{2} a(6-3.5)^2 - \frac{1}{2} a(5-3.5)^2$

$= \frac{1}{2} \times 7.5(6.25) - \frac{1}{2}(7.5)(1.5)^2 = 15$ m

23. $t_{asc} = \frac{u}{g}$



$\therefore$ time for upward journey from this particular point

$= (t_{asc} - t_1) = \left[\frac{u}{g} - t_1\right]$

$\therefore$ total time $= 2\left[\frac{u}{g} - t_1\right]$

24. Let downwards direction is +ve

$h = -ut_1 + \frac{1}{2} g t_1^2 \quad \ldots\ldots (1)$

$h = ut_2 + \frac{1}{2} g t_2^2 \quad \ldots\ldots. (2)$

Multiplying eq^n. (1) by t_2 and eq^n. (2) by t_1

$ht_2 = -ut_1t_2 + \frac{1}{2} g t_1^2 t_2 \quad \ldots\ldots.. (3)$

$ht_1 = ut_2t_1 + \frac{1}{2} g t_2^2 t_1 \quad \ldots\ldots. (4)$

adding eq^n. (3) & (4)

$ht_1 + ht_2 = \frac{1}{2} g t_1^2 t_2 + \frac{1}{2} g t_2^2 t_1$

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

$\Rightarrow h = \frac{1}{2} g t_1 t_2 \ldots\ldots\ldots (5)$

for free fall when u = 0, then

$h = \frac{1}{2} g t^2 \ldots\ldots. (6)$

From eq^n. (5) & (6)

$\frac{1}{2} g t^2 = \frac{1}{2} g t_1 t_2 \Rightarrow t = \sqrt{t_1 t_2}$

25. $v = \beta x^{-4n}$

so $\frac{dv}{dx} = -4n\beta x^{-4n-1}$

Now $a = v\frac{dv}{dx} = (\beta x^{-4n})(-4n\beta x^{-4n-1})$

$\Rightarrow a = -4n\beta^2 x^{-8n-1}$

26. $x = \frac{1}{t+10} \Rightarrow v = \frac{dx}{dt} = -\frac{1}{(t+10)^2}$

Acceleration, $a = \frac{dv}{dt} = \frac{2}{(t+10)^3} \Rightarrow a \propto (\text{velocity})^{3/2}$

28. $x = 50 + 12t - t^3$

$v = \frac{dx}{dt} = 0 + 12 - 3t^2$

for $v = 0 \Rightarrow 12 - 3t^2 = 0$

$\Rightarrow t^2 = 4 \Rightarrow t = 2$ sec

$\Rightarrow x_{t=0} = 50$ m

$x_{t=2s} = 50 + 12 \times 2 - (2)^3 = 66$

distance travelled $= x_{t=2} - x_{t=0} = 66 - 50 = 16$ m

29. Instantaneous velocity $= \frac{ds}{dt}$ = slope of s–t curve.

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

$\frac{120}{100} = 0 + \frac{a}{2}(12-1)$

$a = \frac{6\times 2}{5\times 11}$

$a = 0.218\ m/s^2$

32. Average velocity $= \frac{x_f - x_i}{t} = \frac{0-0}{t} = 0$

33. Area of (v–t) curve = displacement (height)

$$= \frac{1}{2}\times 120\times 1000 = 60{,}000m = 60km$$

34. Acceleration is always downward i.e. positive so slope of v – t curve will always be positive

Hence correct option (3)

36. Area under a-t graph gives the change in velocity during given time interval.

$\therefore \upsilon_{max} = \frac{1}{2}\times 5\times 6 = 15$ m/s

Since initial velocity = 0

$\therefore$ Maximum speed of the particle = 15 m/s

37. If v_1 and v_2 are the velocities, then

$(v_1 - v_2)\times 20 = (100 + 100)$ ....(i)

and $(v_1 + v_2)\times 10 = (100 + 100)$ ....(ii)

After solving above equations, we get

$v_1 = 15$ m/s and $v_2 = 5$ m/s.

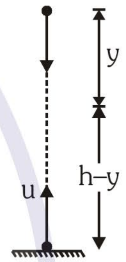
38. $v_A = u - gt$ and $v_B = gt$.

$v_A - v_B = (u - gt) - gt = u - 2gt$.

39. If u is the velocity of projection,

then $0 = u^2 - 2g(4h)$

$\therefore u = \sqrt{8gh}$



Now $y = \frac{1}{2}gt^2$ ...(i)

and $h - y = ut - \frac{1}{2}gt^2$ ...(ii)

From above equations, we have

$$t = \frac{h}{u} = \frac{h}{\sqrt{8gh}} = \sqrt{\frac{h}{8g}}$$

40. For maximum velocity, a = 0

and so, $0 = b - cx$ or $x = b/c$.

Now, $v\frac{dv}{dx} = b - cx \Rightarrow \int_0^v v\,dv = \int_0^x (b-cx)dx$

$\frac{v^2}{2} = bx - \frac{cx^2}{2} = b\times\frac{b}{c} - \frac{c(b/c)^2}{2}$ or $v = \frac{b}{\sqrt{c}}$

41. $s = \frac{1}{2}ft_1^2; \quad \therefore \quad t_1 = \sqrt{\frac{2s}{f}}$

$v_{max} = ft_1 = f\sqrt{\frac{2s}{f}} = \sqrt{2fs}$.

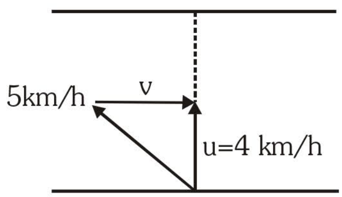
Thus $5s = \frac{1}{2}[[t + 3t_1) + t]\times v_{max}$

or $5s = \frac{1}{2}(2t + 3t_1)\times v_{max}$

or $5s = \frac{1}{2}\left(2t + 3\sqrt{\frac{2s}{f}}\right)\times\sqrt{2fs}$

$\therefore s = \frac{1}{2}ft^2$

42. $u = \dfrac{1}{1/4} = 4$ km/h



$\therefore \quad v = \sqrt{5^2 - 4^2} = 3$ km/h

43. $\vec{v}_m = 2\hat{i} + 3\hat{j}$ m/s

$\vec{v}_{rm} = -4\hat{j}$ m/s

$\vec{v}_{rm} = \vec{v}_r - \vec{v}_m$

$-4\hat{j} = \vec{v}_r - (2\hat{i} + 3\hat{j})$

$\vec{v}_r = 2i - \hat{j}$

Now for downward motion

$\vec{v}_{rm} = \vec{v}_r - \vec{v}_m = 2\hat{i} - \hat{j} + (2\hat{i} + 3\hat{j}) = 2\hat{i} - \hat{j} + 2\hat{i} + 3\hat{j}$

$\vec{v}_{rm} = 4\hat{i} + 2\hat{j} \Rightarrow |\vec{v}_{rm}| = \sqrt{20} = 2\sqrt{5}$ m/s

44. $v_C = 20$ km/hr EAST

$v_{TC} = 20\sqrt{3}$ km/hr NORTH

$\vec{v}_{TC} = \vec{v}_T - \vec{v}_C$

$\vec{v}_T = \vec{v}_{TC} + \vec{v}_C$

$\vec{v}_T = 20\sqrt{3}\hat{j} + 20\hat{i}$

$|\vec{v}_T| = \sqrt{1200 + 400} = 40$ m/s

$\tan\theta = \dfrac{20\sqrt{3}}{20}$

$\tan\theta = \sqrt{3}$

$\theta = 60°$

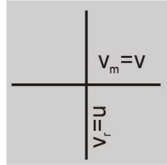
45. $t = \dfrac{d}{v + v\cos 90} = \dfrac{d}{v}$

46. $t = \dfrac{d}{v - v\cos 120}$

$\dfrac{d}{v - \dfrac{v}{2}} = \dfrac{d}{\dfrac{v}{2}}$

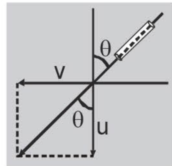
$= \dfrac{2d}{v}$

47. $\vec{v}_{rm} = \vec{v}_r - \vec{v}_m$



$\Rightarrow \quad \vec{v}_{rm} = -u\hat{j} - v\hat{i}$

$\Rightarrow \quad \tan\theta = \dfrac{v}{u}$



$\Rightarrow \quad \theta = \tan^{-1}\left(\dfrac{v}{u}\right)$

48. The velocity upstream is (4 – 2) km/hr and downstream is (4 + 2) km/hr.

$\therefore$ Total time taken $= \dfrac{2}{2} + \dfrac{2}{6} = \dfrac{4}{3}$ h

= 80 minutes

49. Let v = speed of buses travelling between A and B

The relative speed of bus going from A to B w.r.t. cyclist = (v – 20) km hr^{-1}

and relative speed of bus goint from B to A w.r.t. cyclist = (v + 20) km hr^{-1}

in time T, distance covered by bus = vT

when bus and cyclist are in same direction then

$\dfrac{vT}{v - 20} = 18$ min ....(1)

when bus and cyclist are in opposite direction then

$\dfrac{vT}{v + 20} = 6$ min ....(2)

dividing eq (1) by eq (2) $\dfrac{v+20}{v-20} = \dfrac{18}{6} = 3$

$\Rightarrow \quad v = 40$ km/h

putting value v in eq (1) $\dfrac{40 \times T}{40 - 20} = 18$ min

$\Rightarrow \dfrac{40}{20} T = 18$ min $\Rightarrow T = 9$ min

51. At t = 0 let the man's position be the origin.

$\therefore x_p = 0$

The bus door is then at $x_B = 6.0$ m.

The equation of motion for the man is

Distance covered by person in time t to access the door is $x_p = 4t$

Distance covered by bus in time t is

$$x_B = \frac{1}{2} \times 1.2t^2 = 0.6t^2$$

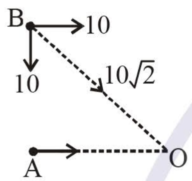
and also

$x_p - x_B = 6$

$4t - 0.6t^2 = 6$

t = 2.3 s & 4.4 sec.

The man shall access the door at 2.3 sec.

52. 

$$|\vec{v}_{BA}| = \sqrt{10^2 + 10^2} = 10\sqrt{2}\text{ kmph}$$

distance OB = 100 cos45° = $50\sqrt{2}$ km

Time taken to reach the shortest distance between

$$A \,\&\, B = \frac{50\sqrt{2}}{|\vec{v}_{BA}|} = \frac{50\sqrt{2}}{10\sqrt{2}}$$

t = 5 hrs.

53. For two particles to collide, the direction of the relative velocity of one with respect to other should be directed towards the relative position of the other particle

i.e. $\frac{\vec{r}_1 - \vec{r}_2}{|\vec{r}_1 - \vec{r}_2|} \rightarrow$ direction of relative position of 1 w.r.t. 2.

& $\frac{\vec{v}_2 - \vec{v}_1}{|\vec{v}_2 - \vec{v}_1|} \rightarrow$ direction of velocity of 2 w.r.t. 1

so for collision of A & B

$$\frac{\vec{r}_1 - \vec{r}_2}{|\vec{r}_1 - \vec{r}_2|} = \frac{\vec{v}_2 - \vec{v}_1}{|\vec{v}_2 - \vec{v}_1|}$$

54. $x_P(t) = at + bt^2$ $\qquad x_Q(t) = ft + t^2$

$v_P = a + 2bt$ $\qquad v_Q = f + 2t$

as $v_P = v_Q$

$$a + 2bt = f + 2t \Rightarrow t = \frac{f - a}{2(1 - b)}$$

55. $V_1 \rightarrow$ velocity of Priya

$V_2 \rightarrow$ velocity of escalator

$\ell \rightarrow$ distance

$$t = \frac{\ell}{V_1 + V_2} = \frac{\ell}{\frac{\ell}{t_1} + \frac{\ell}{t_2}} = \frac{t_1 t_2}{t_1 + t_2}$$

57. At the highest point of trajectory, the acceleration is equal to g.

58. $$R_1 = \frac{u^2 \sin(2 \times 15°)}{g} = \frac{u^2}{2g}$$

and $$R_2 = \frac{u^2 \sin(2 \times 45°)}{g} = \frac{u^2}{g}$$

$\therefore \quad R_2 = 2R_1 = 2 \times 1.5 = 3$ km

59. $$1960 = \frac{1}{2} \times 9.8 \times t^2$$

$\therefore \quad t = 20$ s

Now $AB = ut = \left(600 \times \frac{5}{18}\right) \times 20 = 3333$ m.

60. The vertical components of the velocities must be equal so.

$$v_1 \sin 30° = v_2 \text{ or } \frac{v_2}{v_1} = \frac{1}{2}$$

61. The boy velocity = horizontal velocity of the ball = u cos θ.

62. Let u is the velocity of projection, then

$$R_{max} = \frac{u^2}{g} = d \text{ or } u = \sqrt{gd}$$

Let h is the height upto which ball rise, then

$$0 = u^2 - 2gh \text{ or } h = \frac{u^2}{2g} = \frac{gd}{2g} = \frac{d}{2}$$

63. $u_y = u \sin\theta$

$$y = u_y t - \frac{1}{2}gt^2 \text{ or } 5 = (25 \sin\theta) \times 2 - \frac{1}{2} \times 10 \times 2^2$$

$$\therefore \quad \sin\theta = \frac{1}{2} \quad \text{or} \quad \theta = 30°.$$

64. $$R = \frac{2u_x u_y}{g} = \frac{2 \times 10 \times 20}{10} = 40 \text{ m}$$

65. Time of motion,

$$t = \frac{x}{u_x} = \frac{80}{30} = \frac{8}{3}\text{s}$$

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

$$u_y = \frac{8}{3} \times \frac{10}{2}$$

$$u_y = \frac{40}{3} \text{ m/s}$$

66. $H = \dfrac{u^2 \sin 45^\circ}{2g} = \dfrac{u^2}{4g} \Rightarrow R = \dfrac{u^2}{g} = 4H$

67. $\Delta P = 2\ mu \sin\theta$

68. $$H_1 = \frac{u^2 \sin^2\theta}{2g}$$

and $$H_2 = \frac{u^2 \sin^2(\pi/2 - \theta)}{2g} = \frac{u^2\cos^2\theta}{2g}$$

$$H_1H_2 = \frac{u^2\sin^2\theta}{2g} \times \frac{u^2\cos^2\theta}{2g}$$

$$= \frac{(u^2 2\sin\theta\cos\theta)^2}{16g^2} = \frac{R^2}{16}$$

$\therefore \quad R = 4\sqrt{H_1H_2}$.

69. $\vec{v} = a\hat{i} + b\hat{j} \Rightarrow u\cos\theta = a$ and $u \sin\theta = b$

$R = 2H_{max}$

$\tan\theta = \dfrac{b}{a}$ also $\dfrac{u^2\sin 2\theta}{g} = \dfrac{2u^2\sin^2\theta}{2g}$

$\Rightarrow \quad \tan\theta = 2$

$\therefore \quad \dfrac{b}{a} = 2 \quad \Rightarrow \quad b = 2a$

70. For same range $\theta_1 + \theta_2 = 90^\circ$

$$\theta_1 = \frac{\pi}{3}\text{rad} = 60^\circ$$

$\therefore \quad \theta_2 = 90^\circ - \theta_1 = 30^\circ$

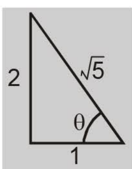
$$y_1 = \frac{u^2\sin^2 60^\circ}{2g} = \frac{u^2 \times 3}{2g \times 4} \Rightarrow \frac{u^2}{8g} = \frac{y_1}{3}$$

$$y_2 = \frac{u^2 \sin^2 30^\circ}{2g} = \frac{u^2 \times 1}{2g\times 4} = \frac{y_1}{3}$$

71. $R = 2H \quad \Rightarrow \quad \tan\theta = \dfrac{4H}{R} = \dfrac{4}{2} = 2$

$$R = \frac{2v^2}{g}\sin\theta\cos\theta$$

$$R = \frac{2v^2}{g} \times \frac{2}{\sqrt{5}} \times \frac{1}{\sqrt{5}} = \frac{4v^2}{5g}$$



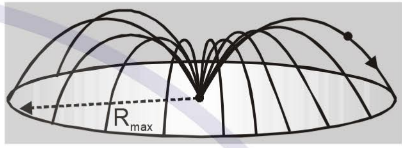
72. R is same at an angle θ and (90° - θ)

$$t_1 = \frac{2u\sin\theta}{g} \ \&\ t_2 = \frac{2u\sin(90-\theta)}{g} = \frac{2u\cos\theta}{g}$$

$$t_1t_2 = \frac{2u\sin\theta}{g} \times \frac{2u\cos\theta}{g} = \frac{u^2 2\sin\theta\cos\theta}{g} \times \frac{2}{g}$$

$\Rightarrow \quad t_1t_2 = \dfrac{2R}{g} \quad \Rightarrow \quad t_1t_2 \propto R$

73. $R_{max} = \dfrac{u^2}{g}$



area $= \pi R_{max}^2 = \pi\left[\dfrac{u^2}{g}\right]^2$

74. $t = \sqrt{\dfrac{2\times 20}{g}} = 2$ sec

$x = v_x t \Rightarrow v_x = \dfrac{4}{2} = 2$m/s

75. $v_x = 10\hat{i}$

$v_y = -10\hat{j} \quad t = 1.5$ sec. $a = -g\hat{j} = -10\hat{j}$

$(\vec{u}_y) = -10\hat{j} - (-10\hat{j}) \times (1.5)$

$\Rightarrow \quad \vec{u}_y = 5\ \hat{j}$

$\vec{u} = 10\hat{i} + 5\hat{j} \quad \Rightarrow |\vec{u}| = 5\sqrt{5}$ m/s

76. $u_{x_1}t + u_{x_2}t = x$

$$\left[\frac{u}{\sqrt{3}}\cos 30^\circ + u\cos 60^\circ\right]t = x$$

$$\left[\frac{u}{\sqrt{3}} \times \frac{\sqrt{3}}{2} + \frac{u}{2}\right]t = x \quad \Rightarrow \quad t = \frac{x}{u}$$

77. $\vec{v} = \vec{u} + \vec{a}t = (3\hat{i} + 4\hat{j}) + (0.4\hat{i} + 0.3\hat{j}) \times 10$

$= 7\hat{i} + 7\hat{j}$

or $\quad v = \sqrt{7^2 + 7^2} = 7\sqrt{2}$ unit

78. $$x = \frac{1}{2}\times 6 \times 4^2 = 48 \text{ m}$$

and $\quad y = \dfrac{1}{2} \times 8 \times 4^2 = 64$ m

$\therefore \quad s = \sqrt{x^2 + y^2} = \sqrt{48^2 + 64^2} = 80$ m

$u = 0$, $\vec{a} =$ const. so path is straight line

79. $\vec{R} = 2\sin(2\pi t)\ \hat{i} + 2\cos 2\pi t\ \hat{j}$

$$\vec{v} = \frac{d\vec{R}}{dt} = 4\pi\cos 2\pi t\,\hat{i} - 4\pi\sin 2\pi t\,\hat{j}$$

$$|\vec{v}| = 4\pi\sqrt{2}\ \text{m/s}$$

80. $\vec{r} = \cos\omega t\ \hat{x} + \sin\omega t\ \hat{y}$

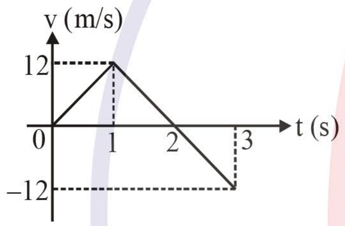
$$\Rightarrow \vec{v} = \frac{d\vec{r}}{dt} = -\omega\sin\omega t\ \hat{x} + \omega\cos\omega t\ \hat{y}$$

$$\Rightarrow \vec{a} = \frac{d\vec{v}}{dt} = -\omega^2\cos\omega t\ \hat{x} - \omega^2\sin\omega t\ \hat{y} = -\omega^2\vec{r}$$

$\vec{a}$ is directed towards the origin.

Also $\vec{r}.\vec{v} = 0$ hence $\vec{r} \perp \vec{v}$

82. $0 < t < 1s$: velocity increases from 0 to 12 m/s
$1 < t < 2s$: velocity decreases from 12 to 0 m/s but car continues to move forward
$2 < t < 3s$: since field strength is same $\Rightarrow$ same acceleration $\therefore$ car's velocity increases from 0 to 12 m/s



Distance travelled in first second

$$S = \left(\frac{u+v}{2}\right)t = \left(\frac{0+12}{2}\right)(1) = 6\text{m}$$

Total distance = 9 m so average speed = $\frac{18\text{m}}{3\text{s}} = 6\text{m/s}$

Displacement = 3m so average velocity = $\frac{6\text{m}}{3\text{s}}$ = 2 m/s

83. $v = At + Bt^2 \Rightarrow \frac{ds}{dt} = At + Bt^2$

$$\Rightarrow \int_0^s ds = \int_2^3 (At + Bt^2)dt$$

$$\Rightarrow s = \frac{A}{2}(3^2 - 2^2) + \frac{B}{3}(3^3 - 2^3) = \frac{5A}{2} + \frac{19B}{3}$$