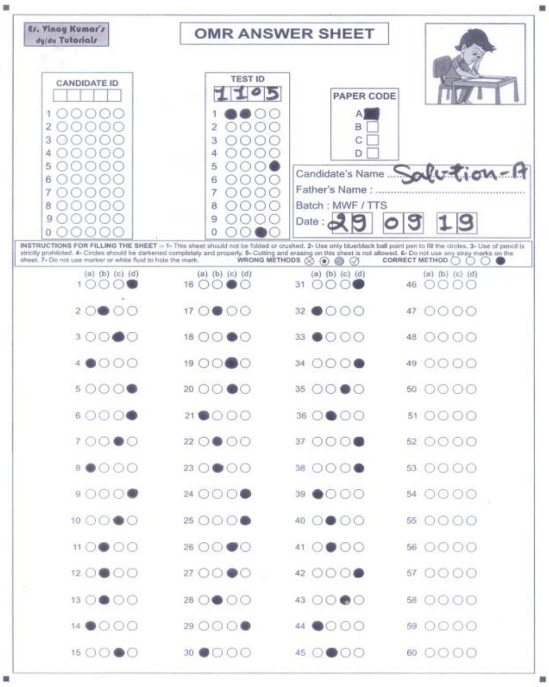
SET-A



Q1. $S=(2t-3)^5 \Rightarrow \dfrac{ds}{dt}=5(2t-3)^4\times 2$

$\Rightarrow v=10(2t-3)^4$

$\dfrac{dv}{dt}=10\times 4(2t-3)^3\times 2 \Rightarrow a=80(2t-3)^3$

$a_{t=2}=80\times(2\times2-3)^3=80\times1=80\ m/s^2$

Q2. $a=-r\omega^2\sin\omega t \Rightarrow \dfrac{dv}{dt}=-r\omega^2\sin\omega t$

$\Rightarrow dv=-r\omega^2\sin\omega t\ dt$

$\Rightarrow \int_0^v dv=-r\omega^2\int_0^t \sin\omega t\ dt$

$\Rightarrow [v-0]=-r\omega^2\left[\dfrac{-\cos\omega t}{\omega}\right]_0^t$

$\Rightarrow v=r\omega[\cos\omega t]_0^t \Rightarrow v=r\omega[\cos\omega t-\cos 0]$

$\Rightarrow v=r\omega[\cos\omega t-1]$

Q3. $v=k\sqrt{s}$ ….. (1) $\Rightarrow \dfrac{ds}{dt}=k\sqrt{s}$

$\Rightarrow \dfrac{ds}{\sqrt{s}}=k\,dt \Rightarrow \int_0^s s^{-1/2}ds=k\int_0^t dt$

$\Rightarrow \left[\dfrac{s^{1/2}}{1/2}\right]_0^s=k[t]_0^t \Rightarrow 2\sqrt{s}=kt$

$\Rightarrow \sqrt{s}=\dfrac{k}{2}t$ ….. (2)

From eq. (1) & (2) $v=k\sqrt{s} \Rightarrow v=k\left(\dfrac{k}{2}\cdot t\right)$

$\Rightarrow v=\dfrac{1}{2}k^2t$

Q4. $v=3t^2 \Rightarrow \dfrac{ds}{dt}=3t^2$

$\Rightarrow \int_0^s ds=\int_0^t(3t^2)\,dt \Rightarrow s=\left[\dfrac{3t^3}{3}\right]_0^t$

$\Rightarrow s=t^3$ ….. (1) $\Rightarrow t=s^{1/3}$

$v=3t^2 \Rightarrow \dfrac{dv}{dt}=6t$

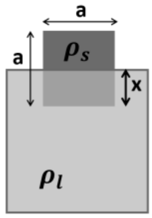
$\Rightarrow a=6t$ ….. (2)

From eq. (1) & (2) $\Rightarrow a=6t \Rightarrow a=6\,s^{1/3}$

$a_{s=8}=6\times8^{1/3}=6\times2=12\ m/s^2$

Q5.

Sol:



$U=mg \Rightarrow a^2\,x\,\rho_l\,g=a^3\,\rho_s\,g$

$\Rightarrow x=\dfrac{\rho_s}{\rho_l}a \Rightarrow \dfrac{dx}{x}=\dfrac{d\rho_s}{\rho_s}-\dfrac{d\rho_l}{\rho_l}+\dfrac{da}{a}$

$\Rightarrow \dfrac{dx}{x}=-\gamma_s\Delta t-(-\gamma_l)\Delta t+\alpha_s\Delta t$

$\Rightarrow \dfrac{dx}{x}=(-\gamma_s+\gamma_l+\alpha_s)\Delta t$

$\Rightarrow \dfrac{dx}{x}=(-3\alpha_s+\gamma_l+\alpha_s)\,\Delta t \Rightarrow \boldsymbol{\dfrac{dx}{x}=(\gamma_l-2\alpha_s)\,\Delta t}$

Q6. **Sol.**

$PV=\mu RT$ (V constant, RT constant) $\Rightarrow P\propto\mu \Rightarrow \dfrac{P_{mix}}{P_{H_2}}=\dfrac{\mu_{mix}}{\mu_{H_2}}$

$\Rightarrow \dfrac{P_{mix}}{P_{H_2}}=\dfrac{\mu_{O_2}+\mu_{H_2}}{\mu_{H_2}}$

$\Rightarrow \dfrac{10}{P_{H_2}}=\dfrac{\frac{8}{32}+\frac{2}{2}}{\frac{2}{2}} \Rightarrow \dfrac{10}{P_{H_2}}=\dfrac{\frac{1}{4}+1}{1} \Rightarrow \dfrac{10}{P_{H_2}}=\dfrac{5}{4}$

$\Rightarrow P_{H_2}=8\ atm$

Q7. **Sol.**

$PV=\mu RT \Rightarrow PV=\dfrac{M}{M_o}RT \Rightarrow P\propto MT \Rightarrow M\propto\dfrac{P}{T}$

$\Rightarrow \dfrac{M_f}{M_i}=\dfrac{P_f}{P_i}\times\dfrac{T_i}{T_f} \Rightarrow \dfrac{M_f}{12}=\dfrac{P/3}{P}\times\dfrac{300}{400} \Rightarrow \dfrac{M_f}{12}=\dfrac{1}{3}\times\dfrac{3}{4} \Rightarrow M_f=3$

$\Delta M=M_f-M_i$ $=12-3=9$gm

Q8. **Sol:**

$\mu_i=\mu_f$

$\dfrac{PV}{RT}+\dfrac{PV}{RT}=\dfrac{P'V}{RT}+\dfrac{P'V}{RT/4} \Rightarrow 2P=P'+4P' \Rightarrow 5P'=2P$

$\Rightarrow \boldsymbol{P'=2P/5}$

Q9. **Sol:**

$$v_{rms} = \sqrt{\frac{3RT}{M_o}} \quad \Rightarrow v_{H_2} = \sqrt{\frac{3RT_{H_2}}{M_{o_{H_2}}}} \;\;\text{.........(1)}$$

$$\Rightarrow v_{N_2} = \sqrt{\frac{3RT_{N_2}}{M_{o_{N_2}}}} \;\;\text{.........(2)}$$

Equating (1) and (2): $\Rightarrow v_{H_2} = v_{N_2}$

$$\Rightarrow \sqrt{\frac{3RT_{H_2}}{M_{o_{H_2}}}} = \sqrt{\frac{3RT_{N_2}}{M_{o_{N_2}}}} \quad \Rightarrow \sqrt{\frac{T_{H_2}}{M_{o_{H_2}}}} = \sqrt{\frac{T_{N_2}}{M_{o_{N_2}}}}$$

$$\Rightarrow \frac{T_{H_2}}{M_{o_{H_2}}} = \frac{T_{N_2}}{M_{o_{N_2}}}$$

$$\Rightarrow \frac{T_{H_2}}{2} = \frac{273+7}{28} \qquad \Rightarrow \frac{T_{H_2}}{2} = \frac{280}{28}$$

$$\Rightarrow \frac{T_{H_2}}{2} = 10 \quad \Rightarrow \boldsymbol{T_{H_2} = 20\,K}$$

Q10. **Sol:**

Both the gases have same temperature in the mixture

$$K.E._{trans.} = \frac{3}{2}\frac{M}{M_o}RT \quad \Rightarrow K.E. \propto \frac{M}{M_o}$$

$$\frac{N_2}{O_2} \Rightarrow \frac{KE_1}{KE_2} = \frac{M_1}{M_2} \times \frac{M_{o_2}}{M_{o_1}} = \frac{7}{4} \times \frac{32}{28} = 2$$

Q11.

Sol:

$$U = U_{H_2} + U_{He}$$

$$\Rightarrow U = f_{O_2}\left[\frac{1}{2}\mu_{H_2}RT\right] + f_{He}\left[\frac{1}{2}\mu_{He}RT\right]$$

$$\Rightarrow U = 5\left[\frac{1}{2} \times 3 \times RT\right] + 3\left[\frac{1}{2} \times 5 \times RT\right]$$

$$\Rightarrow U = 7.5RT + 7.5RT \Rightarrow U = 15RT$$

Q12. $\rho_{t2} = \rho_{t1}\,(1 - \alpha\,\Delta t)$

$$\Rightarrow\; 0.992 = 0.998\;[1 - \alpha\,(40-20)]$$

$$\Rightarrow\; 1 - 20\,\alpha = \frac{0.992}{0.998} \;\Rightarrow\; 20\,\alpha = 1 - \frac{0.992}{0.998}$$

$$\Rightarrow\; 20\,\alpha = \frac{0.998 - 0.992}{0.998} \;\Rightarrow\; 20\,\alpha = \frac{0.006}{0.998}$$

$$\Rightarrow\; \alpha = 3 \times 10^{-4} = 0.0003\; per\,^oC$$

Q13. $L_{measured} = L_{actual}\;(1 - \alpha\,\Delta t)$

$$25 = L_{actual}\;[1 - \alpha\,(0-20)]$$

$$\Rightarrow\; 25 = L_{actual}\;[1 + 20\,\alpha]$$

$$\Rightarrow\; L_{actual} = \frac{25}{1 + 20\,\alpha} < 25$$

Q14. $\Delta l = l\,\alpha\,\Delta t$

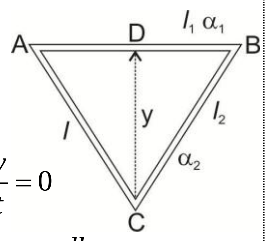
$$= 10 \times 1.1 \times 10^{-5} \times 50 = 5.5 \times 10^{-3}\,m$$

= 5.5 mm

Q16. Expansion depends only on linear dimensions (for given material and temperature rise) which are same for both the rods hence their expansions are also same

Q17. $\dfrac{\Delta I}{I} = 2\,\alpha\,\Delta t \;\Rightarrow\; \Delta I = 2\,\alpha\,\Delta t$

Q18. $y^2 = l_2^2 - l_1^2$



$$\Rightarrow\; 2y\frac{dy}{dt} = 2l_2\frac{dl_2}{dt} - 2l_1\frac{dl}{dt}$$

$y \Rightarrow$ does not change $\Rightarrow \dfrac{dy}{dt} = 0$

$$0 = 2l_2\frac{dl_2}{dt} = 2l_1\frac{dl_1}{dt} \;\Rightarrow\; l_2\frac{dl_2}{dt} = l_1\frac{dl}{dt}$$

$$\Rightarrow\; l_2(\alpha_2 l_2) = l_1(\alpha_1 l_1)$$

$$\Rightarrow\; \alpha_2\,l_1^2 = \alpha_2\,l_2^2 \;\;\ldots\ldots(1)$$

$$l_2 = 2l_1 \;\;\ldots\ldots(2)$$

$\Rightarrow$ from eq. (1) & (2) $\Rightarrow\; \alpha_1\,(l_1)^2 = \alpha_2\,(2l_1)^2$

$$\Rightarrow\; \alpha_1\,l_1^2 = 4\alpha_2\,l_1^2 \;\Rightarrow\; \alpha_1 = 4\alpha_2$$

Q19. $\Delta l_1 = \alpha_a\,l_1\,\Delta t \;\;\ldots\ldots.\,(1)$

$$\Delta l_2 = \alpha_s\,l_2\,\Delta t \;\ldots\ldots.\,(2)$$

$$\Delta l_1 = \Delta l_2 \;\Rightarrow\; \alpha_a\,l_1\,\Delta t = \alpha_s\,l_2\,\Delta t$$

$$\Rightarrow\; \alpha_a\,l_1 = \alpha_s\,l_2 \;\Rightarrow\; \frac{l_1}{l_2} = \frac{\alpha_s}{\alpha_a}$$

$$\Rightarrow\; \frac{l_1}{l_1 + l_2} = \frac{\alpha_s}{\alpha_s + \alpha_a}$$

Q21. $l_1\,\gamma_1 = l_2\,\gamma_2 \;\Rightarrow\; 133 \times 0.000026 = l_2 \times 0.000182$

$$\Rightarrow\; l_2 = \frac{133 \times 26}{182} = 19cm$$

Q22. Velocity is minimum at t = 5 sec where the acceleration changes its nature

v_{min} = u + (area of graph for t = 5 sec.)

$$= 30 + \left[\frac{1}{2} \times (-10) \times 5\right] = 30 - 25$$

= 5 m/s

Q24. $v_B = \tan 37^o = \dfrac{3}{4} = 0.75\,m/s\;\;(+)$

$$v_A = \tan 53^o = \frac{4}{3}\,m/s = 1.33\;\;(-)$$

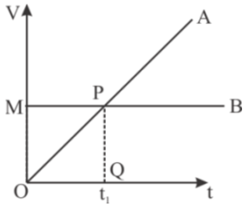
$$v_{BA} = v_B - v_A$$

$$= 0.75 - (-1.33) = 2.08\,m/s$$

Q26. **(a)** slope of graph A is constant $\Rightarrow$ acc. is constant

(b) slope of graph B is zero $\Rightarrow$ acc. is zero therefore velocity is constant

(c) In t_1 time the distance travelled by A = Area MPQO



In t_1 the distance travelled by B = area OPQ.

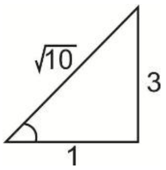
Area OPQ < Area MPQO

i.e. the distance traveled are different for A & B hence they can not cross each other at t_1.

Q27. Parabolic graph at axis – v.

Q28. $\tan\theta = 4\dfrac{11}{R} \Rightarrow \tan\theta = 4\times\dfrac{\frac{3}{4}R}{R}$

$\Rightarrow \tan\theta = \dfrac{3}{1}$



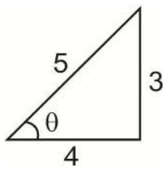
$\sin\theta = \dfrac{3}{\sqrt{10}}$

$\cos\theta = \dfrac{1}{\sqrt{10}}$

$$R = \frac{2u^2\sin\theta\cos\theta}{g} = \frac{2u^2}{g}\times\frac{3}{\sqrt{10}}\times\frac{1}{\sqrt{10}}$$

$$\Rightarrow R = \frac{2u^2}{g}\times\frac{3}{10} \Rightarrow R = \frac{3u^2}{5g}$$

Q29. $\tan\theta = 4\dfrac{H}{R} \Rightarrow \tan\theta = 4\times\dfrac{3}{16} = \dfrac{3}{4}$



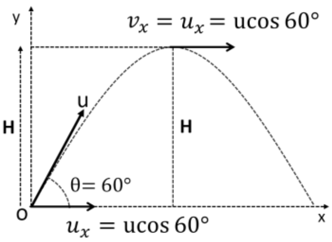
$\Rightarrow \sin\theta = \dfrac{3}{5}$

$$H = \frac{u^2\sin^2\theta}{2g} \Rightarrow 3 = \frac{u^2\times\left(\frac{3}{5}\right)^2}{2g}$$

$$\Rightarrow 3 = \frac{u^2\times 9}{50g} \Rightarrow u^2 = \frac{50g}{3} = \frac{500}{3}$$

$$\Rightarrow u = \sqrt{\frac{500}{3}} = 10\sqrt{\frac{5}{3}}\ m/s$$

Q30. **Sol:**



$l = (mv_x)H$

$= m\,u_x\dfrac{u_y^2}{2g}$

$= mu\cos 60° \times \dfrac{(u\sin 60°)^2}{2g}$

$= mu\,\dfrac{1}{2}\times\dfrac{\left(u\frac{\sqrt{3}}{2}\right)^2}{2g} = \dfrac{1}{2}mu\dfrac{3u^2}{8g} = \boldsymbol{\dfrac{3mu^3}{16g}}$

Q31. **Sol:**

$y = u_y t + \dfrac{1}{2}a_y t^2$

$= (+12)\,5 + \dfrac{1}{2}(-10)\times 5^2$

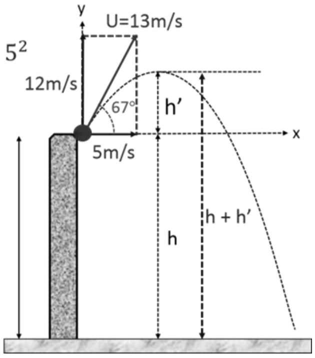
= 60 - 125 ⇨ y = - 65

⇨ h = 65

$h' = \dfrac{u_y^2}{2g}$ ⇨ $h' = \dfrac{12^2}{2\times 10}$

⇨ $h' = \dfrac{144}{20} = 7.2m$

⇨ h + h′= 65 + 7.2 = 72.2m



Q32.
Sol:

$y = 10x - 5x^2$

at (R, 0)

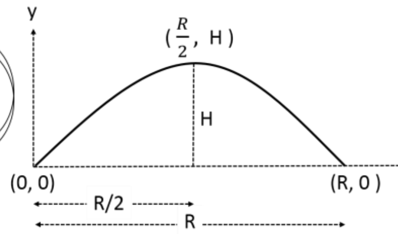
$x = R$

$y = 0$

⇨ $0 = 10R - 5R^2$

⇨ $10R = 5R^2$

⇨ $R = \dfrac{10}{5} = 2m$



$y = 10x - 5x^2$

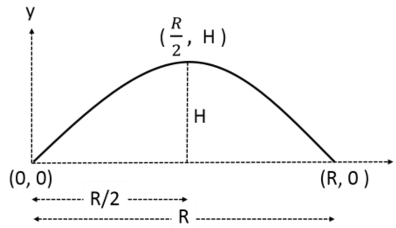
at $(\frac{R}{2}, H)$

$x = \dfrac{R}{2} = \dfrac{2}{2} = 1m$

$y = H$

$H = 10\times 1 - 5\,(1)^2$

⇨ $H = 5m$



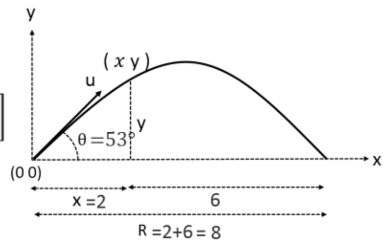
Q33. **Sol:**

$y = x\tan\theta\left[1 - \dfrac{x}{R}\right]$

$= 2\tan 53^o\left[1 - \dfrac{2}{8}\right]$

$= 2\times\dfrac{4}{3}\left[1 - \dfrac{1}{4}\right]$

$= 2m$



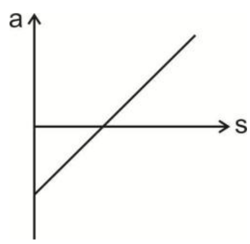
Q34. The equation of the given v/s graph

$\Rightarrow\ v = -ms + c$ ....(1)

differentiating the equation with time $\Rightarrow$

$\dfrac{dv}{dt} = -m\dfrac{ds}{dt} + 0$

$\Rightarrow\ a = -mv$ ....(2)



from eq. (1) & (2)

$\Rightarrow$ a = - m (- ms + c)

$\Rightarrow$ a = m^2s – mc

$\Rightarrow$ straight line with positive slope and negative intercept.

Q35. For turning point $\frac{ds}{dt}=0$

$\Rightarrow \frac{d}{dt}(2t^3-9t^2+12t)=0$

$\Rightarrow 6t^2-18t+12=0$

$\Rightarrow t^2-3t+2=0 \Rightarrow t^2-2t-t+2=0$

$\Rightarrow t(t-2)-(t-2)=0 \Rightarrow (t-1)(t-2)=0$

$\Rightarrow t=1\text{sec}$ and 2 sec.

Q36. Average speed $=\frac{\text{distance}}{\text{duration}}=\frac{\text{Area v / t graph}}{\text{duration}}$

$=\frac{\frac{1}{2}\times 2\times 10+2\times 10}{4}=\frac{30}{4}=7.5\, m/s$

Q37. $s^2=2t+1 \Rightarrow 2s\frac{ds}{dt}=2 \Rightarrow sv=1$

$\Rightarrow v=\frac{1}{s} \Rightarrow v=s^{-1}$ ……..(1)

$\Rightarrow \frac{dv}{dt}=-1s^{-2}\frac{ds}{dt} \Rightarrow a=-\frac{v}{s^2}$ ……..(2)

From eq. (1) & (2)

$\Rightarrow a=-\frac{\frac{1}{s}}{s^2} \Rightarrow a=-\frac{1}{s^3} \Rightarrow a\propto\frac{1}{s^3}$

Q38. $t_1+t_2=\frac{2u_y}{g} \Rightarrow 2+4=\frac{2u_y}{10}$

$\Rightarrow u_y=30\, m/s$

$\tan 37^o=\frac{u_y}{u_x} \Rightarrow \frac{3}{4}=\frac{30}{u_x} \Rightarrow u_x=40\, m/s$

$R=\frac{2u_xu_y}{g}=\frac{2\times 40\times 30}{10}=240\, m$

Q39. $y=\frac{1}{\sqrt{3}}x-\frac{1}{12}x^2$ ……….(1)

$y=\frac{u_y}{u_x}x-\frac{1}{2}g\frac{x^2}{u_x^2}$ ……..(2)

Comparing eq. (1) & (2)

$\Rightarrow \frac{u_y}{u_x}=\frac{1}{\sqrt{3}} \Rightarrow \tan\theta=\frac{1}{\sqrt{3}}$

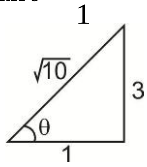
$\Rightarrow \theta=30^o$

Q40. $v_y=gt \Rightarrow v_y=10\times 8=80\, m/s$

$v_x=u_x \Rightarrow v_x=60\, m/s$

$v=\sqrt{v_x^2+y_y^2}=\sqrt{60^2+80^2}=100\, m/s$

Q41. $\frac{PE_P}{KE_P}=\tan^2\theta \Rightarrow \frac{9}{1}=\tan^2\theta \Rightarrow \tan\theta=\frac{3}{1}$



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

$\Rightarrow R=\frac{2\times 10^2\times\frac{3}{\sqrt{10}}\times\frac{1}{\sqrt{10}}}{10}=6m$

Q42. $h=\frac{1}{2}g\left(\frac{x}{u_x}\right)^2 \Rightarrow h=\frac{1}{2}\times 10\times\left(\frac{16}{80}\right)^2$

$\Rightarrow h=\frac{1}{2}\times 10\times\left(\frac{1}{5}\right)^2=\frac{1}{5}m=\frac{1}{5}\times 100\, cm$

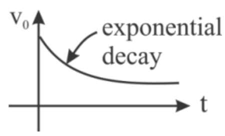
= 20 cm

Q44. $a\propto v \Rightarrow a=-kv\,(retardation)$

$\Rightarrow \frac{dv}{dt}=-kv \Rightarrow \frac{dv}{v}=-kdt$

$\Rightarrow \int_{v_0}^{v}\frac{dv}{v}=-\int_0^t kdt \Rightarrow \ln\frac{v}{v_0}=-kt$

$\Rightarrow \frac{v}{v_0}=e^{-kt} \Rightarrow v=v_0e^{-kt}$

$\Rightarrow$ 

Q45. $u_x=v_x \Rightarrow 8\cos 60^o=v\cos 37^o$

$\Rightarrow 8\times\frac{1}{2}=v\times\frac{4}{5} \Rightarrow v=5\, m/s$