JEE MAIN SEP 2020 (MEMORY BASED) | 4th Sep. SHIFT-1

Note: The answers are based on memory based questions which may be incomplete and incorrect.

1. Dimensional formula of thermal conductivity will be :

(1) $M^1 L^1 T^{-3} \theta^{-1}$ (2) $M^0 L^1 T^{-1} \theta^{-1}$ (3) $M^1 L^0 T^{-1} \theta^{-1}$ (4) $M^1 L^1 T^0 \theta^{-1}$

Ans. (1)

Sol. As $\left(\frac{d\theta}{dt}\right) = KA\left(\frac{dT}{dx}\right)$

$\Rightarrow K = \left(\frac{d\theta}{dt}\right)\frac{1}{A}\left(\frac{dx}{dT}\right)$

$K = \left(\frac{M^1L^2T^{-3}}{L^2}\right)\frac{L}{Q}$

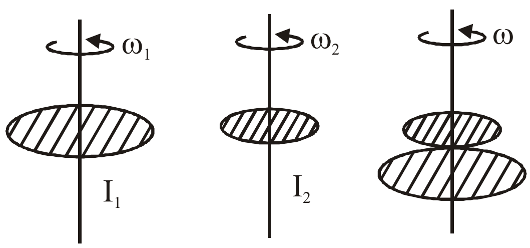
$K = M^1 L^1 T^{-3} \theta^{-1}$

2. Two disc of radius R and $\frac{R}{2}$ are made of identical mass. Disc of radius R rotates with speed of ω and disc of radius $\frac{R}{2}$ is at rest. Now both disc are placed coaxially. Find percentage loss of kinetic energy when they rotates with same angular velocity.

(1) 10 (2) 20 (3) 30 (4) 40

Ans. (2)

Sol.



Angluar momentum conservation

$I_1\omega_1 + I_2\omega_2 = (I_1 + I_2) \times \omega f$

$\frac{MR^2}{2} \times \omega + 0 = \left(\frac{MR^2}{2} + \frac{M}{2}\left(\frac{R}{2}\right)^2\right)\omega f$

$$\omega_f = \frac{4}{5}\omega$$

Final K.E.

$$K_f = \frac{1}{2}\left(\frac{MR^2}{2} + \frac{MR^2}{8}\right)\frac{16}{25}\omega^2$$

$$K_f = \frac{MR^2\omega^2}{5}$$

$$K_i = \frac{1}{2}\left(\frac{MR^2}{2}\right)\omega^2 = \frac{MR^2\omega^2}{4}$$

Percentage loss in kinetic energy

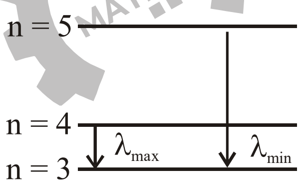
$$\%loss = \frac{\frac{MR^2\omega^2}{4} - \frac{MR^2\omega^2}{5}}{\frac{MR^2\omega^2}{4}} \times 100 = 20\%$$

3. For Lyman series $\lambda_{max} - \lambda_{min} = 340Å$, Find the same for paschen series ?

(1) 11,802Å (2) 13,802Å (3) 12,502Å (4) 10,000Å

Ans. ()

Sol.



For Lyman series

$$\frac{1}{\lambda_{min}} = R\left(1 - \frac{1}{\infty}\right) = R$$

$$\Rightarrow \lambda_{min} = \frac{1}{R}$$

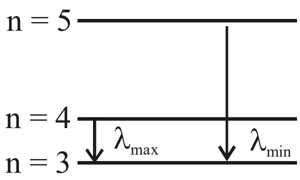
$$\Rightarrow \lambda_{max} = R\left(1 - \frac{1}{R}\right) = \frac{3R}{4}$$

$$\Rightarrow \lambda_{max} = \frac{4}{3R}$$

$$\lambda_{max} - \lambda_{min} = \frac{4}{3R} - \frac{1}{R} = \frac{1}{3R} = 340 A^o$$

$$\Rightarrow \frac{1}{R} = (340 \times 3)\, A^o \qquad ....(i)$$

Also her paschem



$$\frac{1}{\lambda_{max}} = R\left(\frac{1}{9} - \frac{1}{16}\right) = \frac{7R}{16 \times 9}$$

$$\frac{1}{\lambda_{min}} = R\left(\frac{1}{9} - \frac{1}{\infty}\right) = \frac{R}{9}$$

$$(\lambda_{max} - \lambda_{min}) = \frac{16 \times 9}{7R} - \frac{9}{R} = \frac{81}{7R}$$

$$\text{so } \lambda_{max} - \lambda_{min} = \left(\frac{81}{7} \times 340 \times 3\right) = \frac{82620}{7} A^o \qquad ....\text{(from eqn (i))}$$

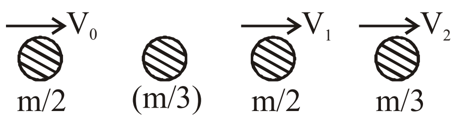
$= 11802.05\ A^o$

4. A body of mass $\frac{m}{2}$ moving with velocity v_0 collides elastically with another mass of $\frac{m}{3}$. Find % change in KE of first body ?

(1) 32% (2) 96% (3) 34% (4) 80%

Ans. (2)

Sol.



Pi = Pf

$$\Rightarrow \frac{m}{2}V_0 + 0 = \frac{m}{2}V_1 + \frac{m}{3}V_2$$

$$\Rightarrow \frac{V_0}{2} = \frac{V_1}{2} + \frac{V_2}{3}$$

$$\Rightarrow 3V_1 + 2V_2 = 3V_0$$

$$\Rightarrow 3V_1 + 2V_1 = V_0$$

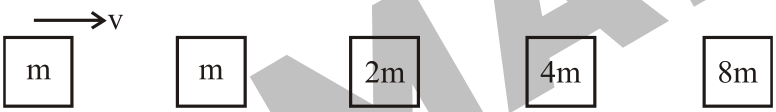
for first body

$$KE_i = \frac{1}{2}\left(\frac{m}{2}\right)\left(V_0^2\right) = \frac{1}{4}mV_0^2$$

$$KE_f = \frac{1}{2}\left(\frac{m}{2}\right)\left(\frac{V^0}{5}\right)^2 = \frac{1}{100}mV_0^2$$

$$\% \text{ loss} = \frac{K_i - K_f}{k_f} \times 100\% = 96\%$$

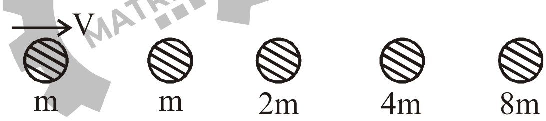
5. A body of mass m moving with velocity 'v' collides with shown masses respectively. Find loss in KE after the last collision. Consider all collision completely inelastically ?



(1) 85.5 (2) 90.2 (3) 93.75 (4) 88.5

Ans. (3)

Sol.



Ist colliscon

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

$$KE_f = \frac{1}{2}(16\,m)\left(\frac{v}{16}\right)^2$$

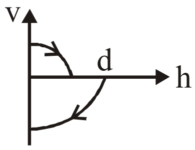
$$= \frac{1}{32}mv^2$$

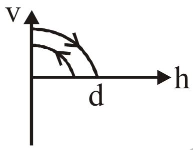
$$mv = 16mv \Rightarrow V^1 = \frac{V}{16}$$

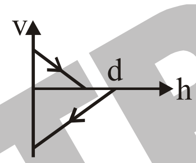
$$\% \text{ loss} = \frac{\frac{1}{2}mv^2 - \frac{1}{32}mv^2}{\left(\frac{1}{2}mv^2\right)} \times 100$$

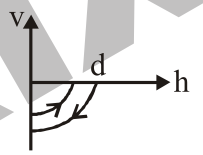
$$= \left(\frac{15}{16} \times 100\right)\% = 93.75\%$$

6. A ball is dropped vertically from a height d above the ground. It hits the ground and bounces up vertically to a height d/2. Neglecting subsequent motion and air resistance, its velocity 'v' varies with the height 'h' above the ground as –

(1) 

(2) 

(3) 

(4) 

Ans. (1)

Sol. (i) For uniformly accelerated/deaccelerated motion

$v^2 = u^2 \pm 2\,gh$

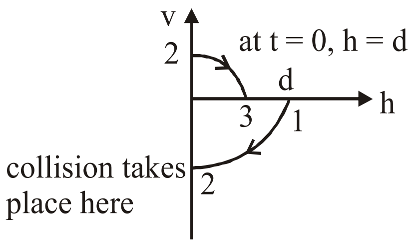
i.e. v – h graph will be a parabola (because equation is quadratic).

(ii) Initially velocity is downwards (–ve) and then after collision it reverses its direction with lesser magnitude. i.e. velocity is upwards (+ve). Graph (A) satisfies both these conditions.

Therefore, correct answer is (A)

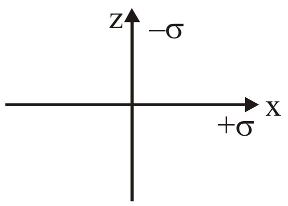
Note that time t = 0 corresponds to the point on the graph where h = d

Next time collision takes place at 3.

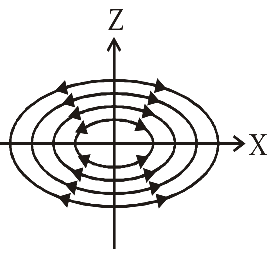


1→ 2 : V increases downwards
At 2 → velocity changes its direction
2 → 3 V decreases upwards

7. Two infinitely large charged planes having uniform surface charge density $+\sigma$ and $-\sigma$ placed along x–y plane and y z plane respectively as shwon in the figure. Then the nature of electric lines of forces in x–z plane is given by :



(1)



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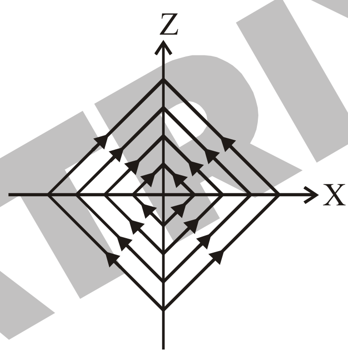

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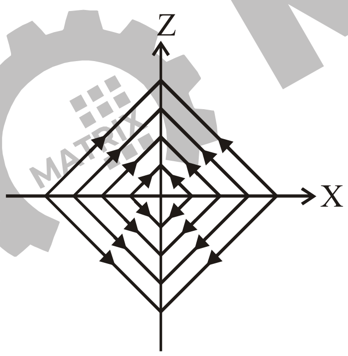
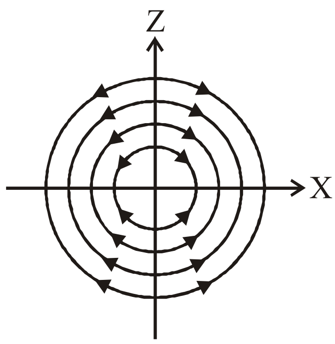


(4)



Ans. (3)

Sol. The electric field intensity due to each uniformly charged infinite plane is uniform. The electric field intensity at points A, B, C and D due to plane 1, plane 2 and both planes are given by E_1, E_2 and E as shown in figure 1. Hence the electric lines of forces are as given in figure 2.

8. Gravitational field intensity is given by $E=\dfrac{Ax}{(A^2+X^2)^{3/2}}$ then find out potential at x.

(Assume potential at infinity = 0)

(1) $-\dfrac{2A}{\sqrt{A^2+X^2}}$ (2) $-\dfrac{A}{\sqrt{A^2+X^2}}$ (3) $-\dfrac{A}{3\sqrt{A^2+X^2}}$ (4) $-\dfrac{3A}{\sqrt{A^2+X^2}}$

Ans. (2)

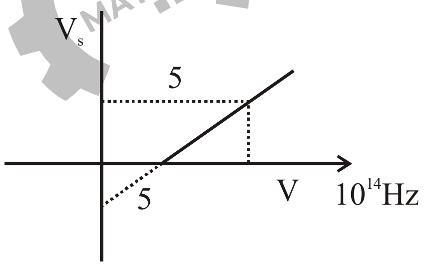
Sol. $E=\dfrac{Ax}{\left(A^2+x^2\right)^{\frac{3}{2}}}=-\dfrac{dv}{dx}$

$$\Rightarrow \int_0^v dv=-\int_\infty^x A\frac{x}{\left(A^2+x^2\right)^{\frac{3}{2}}}dx$$

$$\Rightarrow V=\left[\frac{A}{\sqrt{A^2+x^2}}\right]_\infty^x=\left[\frac{A}{\sqrt{A^2+x^2}}-0\right]$$

$$V=\frac{A}{\sqrt{A^2+x^2}}$$

9. Graph between stopping potential and frequency of light as shown in figure.



(1) 4.01 (2) 2.01 (3) 5.01 (4) 2.04

Ans. (2)

Sol. From graph when $V_0=\times 10^{14}$ Hz, $V_s=0$

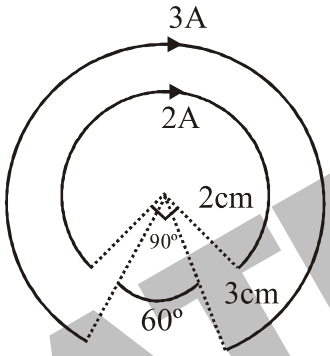
So $hV_0=\phi$

$$\Rightarrow \phi=\frac{\left(6.6\times10^{-34}\right)\times\left(5\times10^{14}\right)}{\left(1.6\times10^{-19}\right)}eV$$

$\phi = 2.01$ eV

10. Two concentric circular current carrying arc of radius $R_1 = 4$cm and $R_2 = 2$cm and direction of current in both arc are shown in figure. Find the ratio of magnetic field $\left(\frac{B_1}{B_2}\right)$ at centre produced by both arc.

(Where B_1 and B_2 are magnetic field due to arc of radius R_1 and R_2 respectively)



(1) $\frac{6}{5}$ (2) $\frac{5}{6}$ (3) $\frac{3}{4}$ (4) $\frac{4}{3}$

Ans. (1)

Sol. $B_{center} = \frac{\mu_0 I}{u\pi R}\theta$

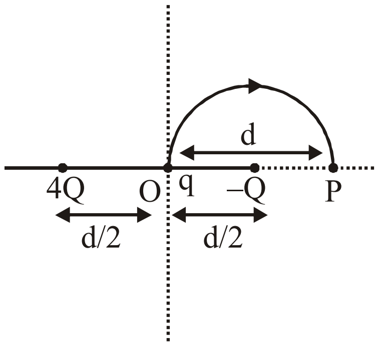
When $\theta_1 = 360 - 90 = 270^o$ When $\theta_2 = 300^o$

$I_1 = 2A$ $I_2 = 3A$

$R_1 = 2cm$ $R_2 = 4cm$

$$\frac{B_1}{B_2} = \frac{I_1}{I_2}\frac{\theta_1}{\theta_2}\frac{R_2}{R_1} = \frac{6}{5}$$

11. Find change in potential energy from origin to point P of charge q moving on the path as shown in figure.



(1) $-\frac{10KQ}{3d}$ (2) $-\frac{13KQ}{3d}$ (3) $-\frac{13KQ}{d}$ (4) $-\frac{16KQ}{3d}$

Ans. (4)

Sol. At O

$$V_0 = \frac{K(4Q)}{\left(\frac{d}{2}\right)} + \frac{K(-Q)}{\left(\frac{d}{2}\right)}$$

$$V_0 = \frac{8KQ}{d} - \frac{2KQ}{d} = \frac{6KQ}{d}$$

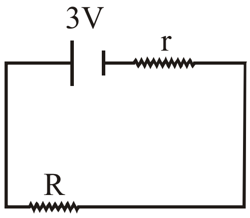
$$V_p = \frac{K(4Q)}{\left(\frac{3d}{2}\right)} + \frac{K(-Q)}{\left(\frac{d}{2}\right)}$$

$$V_p = \frac{8KQ}{3d} - \frac{2KQ}{d} = \frac{2}{3}\frac{KQ}{d}$$

$$\Delta V = \text{Change in potential} = V_p - V_o = \left(\frac{2}{3} - 6\right)\frac{KQ}{d} = -\frac{16}{3}\frac{KQ}{d}$$

Change in potentcal energy $\Delta V = -\frac{16}{3}\frac{K\theta q}{d}$

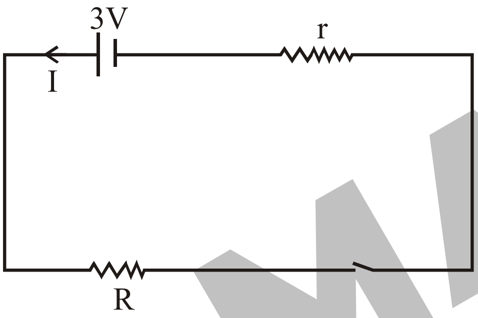
12. Terminal voltage of cell (emf = 3V & internal resistance = r) is equal to 2.5V and rate of heat loss in R is given by 0.5 watt, then find power loss in internal resistance.



(1) 0.3 (2) 0.5 (3) 0.1 (4) 1

Ans. (3)

Sol.



Given

$V_R = 2.5V$ also $\frac{V_R}{V_r} = \frac{IR}{Ir} \Rightarrow \frac{R}{r} = \frac{2.5}{0.5} = 5 \Rightarrow R = 5r$

$\Rightarrow V_r = 0.5V$

Rate Heat Loss across R, $(P_R) = I^2R = 0.5$

Power loss arcoss r = Pr = I^2r

$$\Rightarrow \frac{P_R}{P_r} = \frac{R}{r} = 5$$

$$\Rightarrow P_r = \frac{P_R}{5} = 0.1 \text{ wats}$$

13. Correct order of wavelength will be :

(1) Radio waves > microwaves > visible rays > X–rays

(2) Microwaves > Radio waves > Visible rays > X – rays

(3) X–rays > Radio waves > Microwaves > Visible rays

(4) X–rays > Radio waves > Visible rays > Microwaves

Ans. (1)

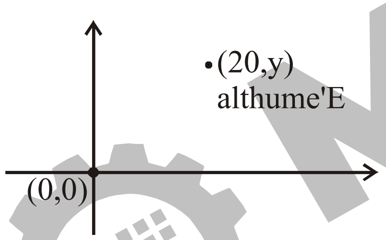
Sol. Part of theory

14. A particle at origin (0, 0) moving with initial velocity u = 5 m/s $\hat{j}$ and acceleration a = $10\hat{i}+4\hat{j}$. After 't' time it reaches at position (20, y) then find 't' and 'y' :

(1) t = 2, y = 18 (2) t = 4, y = 16 (3) t = 6, y = 12 (4) t = 8, y == 10

Ans. (1)

Sol.



$\vec{u} = 5\,m/sec\,\hat{j}$ $\vec{a} = 10\hat{i} + 4\hat{j}$

X direction

$x = 0 + \frac{1}{2} \times 10 \times t^2$

$20 = \frac{1}{2} \times 10\ 5\ t^2$

t = 2 sec

y direction

$y = 5\times 2 + \frac{1}{2} \times 4(2)^2$ ....(Put t = 2 sec.)

y = 18

15. Distance between trough and crest of a wave is 1.5 m while distance between two troughs is 5m. Which of the following wavelengths are possible.

(1) $\frac{1}{2},\frac{1}{4},\frac{1}{6},$........ (2) 1, 2, 3, ... (3) $\frac{1}{1},\frac{1}{3},\frac{1}{5},$........ (4) 1, 3, 5, ...

Ans. (3)

Sol. Trough to crest distance

$1.5 = (2n_1 + 1)\frac{\lambda}{2}$ .... (1)

Trough to trough distance

$5 = (n_2\lambda)$ .... (2)

from (1) and (2)

$\frac{1.5}{5} = \frac{2n_1+1}{2(n_2)}$

$3n_2 = 10n_1 + 5$

n_1 and n_2 should be integers

(1) $n_1 = 1, n_2 = 5, \lambda = 1$

(2) $n_1 = 4, n_2 = 15, \lambda = \frac{1}{3}$

(3) $n_1 = 7, n_2 = 25, \lambda = \frac{1}{5}$

16. Intensity of plane polarized light is 3.3 W/m. Area of plane 3×10^{-4} m^2 and polarizer rotates with 10π rad/sec. Energy transmitted in 1 complete cycle :

(1) 4.95×10^{-4} (2) 3.95×10^{-4} (3) 2.95×10^{-4} (4) 6.95×10^{-4}

Ans. (1)

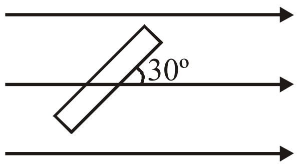
Sol. Avg energy = $I_0 A \times (< \cos^2\theta >)$

[for one cycle] $\rightarrow < \cos^2\theta > = \frac{1}{2}$

$= 3.3 \times 3 \times 10^{-4} \times \frac{1}{2}$

$= \frac{9.9}{2} \times 10^{-4} = 4.95 \times 10^{-4}$

17. A bar magnet experience torque 0.018 N–m when placed in uniform magnetic field, B = 0.06 T and makes 30º angle with the magnetic field as shown in figure. Find out work done by external force if magnet rotates from minimum potential energy to maximum potential energy.



(1) 0.036 J (2) 0.018 J (3) 0.072 J (4) 0.36 J

Ans. ()

Sol. $\tau = MB \sin\theta$

$0.018 = M \times 0.06 \times \sin 30^\circ$

$M = \frac{0.018}{0.06 \times \frac{1}{2}}$

$M = 0.06$ A–m^2

for $U_{min} \Rightarrow \theta = 0^\circ$

$U_{min} = -MB \cos 0^\circ = -MB$

for $U_{max} \Rightarrow \theta = 180^\circ$

$U_{max} = -MB(-1) = MB$

$W = \Delta U = U_{max} - U_{min}$

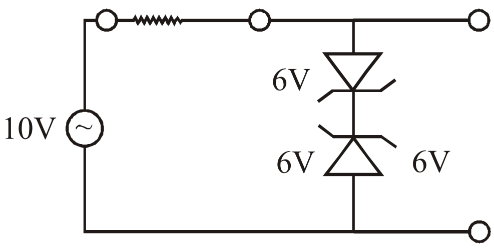
$W = MB - (-MB)$

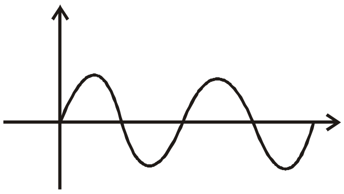
$= 2\,MB$

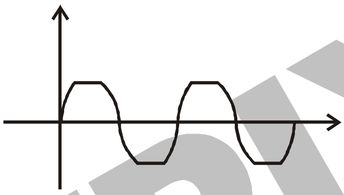
$= 2 \times 0.06 \times 0.6$

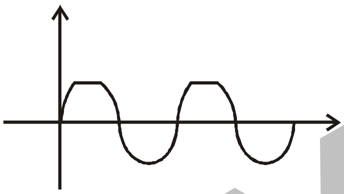
$= 0.072$ J

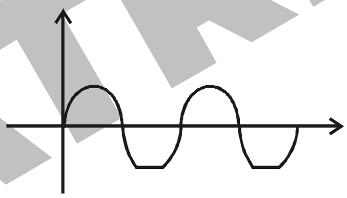
18. Correct graph of voltage across zener diode will be



(1) 

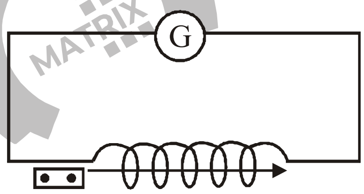
(2) 

(3) 

(4) 

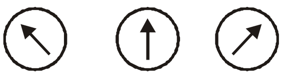
Ans. (2)

Sol. Part of theory

19. 

A bar magent moves with constant velocity as shown in figure through a coil. Which of the following option is correctly represent the deflection of needle in Galvanometer.

(1) 

(2) 

(3) 

(4) 

Sol. first ϕ increases $\rightarrow$ so current flow

then ϕ remaining constant $\rightarrow$ No current

then ϕ decreases $\rightarrow$ current flow

20. Match the type of gas with its 'r' from the following table & choose the possible alternative (at room Temperature)

(A) Mono-atomic (P) $\frac{7}{5}$

(B) Tri-atomic (Linear) (Q) $\frac{9}{7}$

(C) Di-atomic (R) $\frac{4}{3}$

(D) Tri-atomic (Non-Linear) (S) $\frac{5}{3}$

(1) A$\rightarrow$S, B$\rightarrow$P, C$\rightarrow$Q, D$\rightarrow$R

(2) A$\rightarrow$P, B$\rightarrow$S, C$\rightarrow$Q, D$\rightarrow$R

(3) A$\rightarrow$S, B$\rightarrow$P, C$\rightarrow$P, D$\rightarrow$R

(4) A$\rightarrow$S, B$\rightarrow$P, C$\rightarrow$P, D$\rightarrow$P

Ans. (3)

Sol. $r = \frac{f+2}{f}$, where f is degree of freedom

$f = 3$ for mono–atomic $\Rightarrow r = \frac{5}{3}$ $\quad$ $A \rightarrow S$

$f = 5$ for di–atomic $\Rightarrow r = \frac{7}{5}$ $\quad$ $C \rightarrow P$

$f = 5$ for tri–atomic $\Rightarrow r = \frac{7}{5}$ $\quad$ $B \rightarrow P$

(Linear)

$f = 6$ for tri–atomic $\Rightarrow r = \frac{8}{6} = \frac{4}{3}$ $\quad$ $D \rightarrow R$

(non-Linear)

21. In compound microscope final image formed at 25 cm from eyepiece lens. Length of tube is 20 cm. Given that $f_0 = 1$ cm, m = 100. Find focal length of eyepiece lens.

Ans. 06.25

Sol. $M = \left(\frac{V_0}{u_0}\right)\left(1+\frac{D}{fe}\right)$ When final image is formed at the closed distance is maximum strain condition.

$$m = \frac{L}{f_0}\left(1+\frac{D}{fe}\right)$$

Given $100 = \frac{20}{1}\left(1+\frac{25}{fe}\right)$

fe = 6.25 cm

22. 0.1 mole of a gas at 200 K is mixed with 0.05 mole of same gas at 400K. If final temperature is equal to $10T_0$, then find the value of T_0.

Ans. 22.66

Sol. $U_i = U_f$

$$\frac{f}{2}n_1RT_1 + \frac{f}{2}n_2RT_2 = \frac{f}{2}(n_1+n_2)RT_f$$

$n_1T_1 + n_2T_2 = (n_1+n_2)T_f$

$\Rightarrow 0.1 \times 200 + 0.05 \times 400 = (0.1 + 0.05)\ T_f$

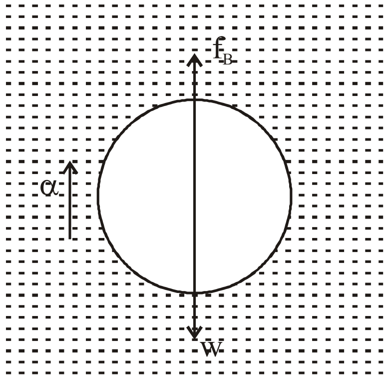
also $T_f = 10T_0 = 266.67$

$T_0 = 26.66$

23. An air bubble inside a lake is rising up with an acceleration $a = 9.8\ cm/sec^2$. The radius of bubble, $R = 1$ cm & has air of mass m filled inside it find mass (in gm) of air. (if $\rho_w = 1000\ kg/m^3$ & $g = 9.8\ m/s^2$).

Ans. 4.147 gm

Sol.



$f_B = \rho_w V g$

$W = mg$

for 2^{nd} Law $\Rightarrow f_B - w = ma$

$\Rightarrow \rho_w Vg - mg = ma \qquad \Rightarrow a = \left(\frac{\rho_w V}{m} - 1\right) g$

$$\Rightarrow a = \left(\frac{1000 \times \frac{4}{3} \times \pi \times 10^{-6}}{m}\right) 9.8$$

$$\Rightarrow \frac{0.098}{9.8} = \frac{4}{3}\frac{\pi}{m} \times 10^{-3} - 1 \qquad \Rightarrow \frac{4\pi}{3m} \times 10^{-3} = 1.01$$

$$\Rightarrow m = \frac{4\pi}{3 \times 1.01} \times 10^{-3}$$

$m = 4.147$ gm

24. In an ideal colorimeter, 100gm ice at 0ºC mixed with 200 gram water at 25ºC. It finally m gram of ice melts and final temperature of mixture becomes 0ºC then find m (In gram).

Ans. 62.5

Sol. by using calorimetry principle,

$200 \times 1 \times (25-0) = m \times 80$

$5000 = m \times 80$

m = 62.5 gram