2017 JEE Mains Physics Code A Solutions

1. From the problem

$$\frac{v_f}{v_i} = 9^3$$

Given that Density of the man remains

Constant

$\therefore$ Mass α volume

$$\Rightarrow \frac{m_f}{m_i} = 9^3$$

$$\Rightarrow \frac{(Area)_f}{(Area)_i} = 9^2$$

Stress $= \frac{Force}{Area} = \frac{mg}{A}$

$$\Rightarrow \frac{\sigma_2}{\sigma_1} = \left(\frac{m_f}{m_i}\right)\left(\frac{A_i}{A_f}\right) = \frac{9^3}{9^2} = 9$$

Key : 1

2. key : 3

As the body is thrown vertically upwards Acceleration (g) is constant and negative is quadratic equation

3. key:3

Initial kinetic energy $= \frac{1}{2} m V_o{}^2$

Final kinetic energy $= \frac{1}{8} m V_o{}^2$

$$\Rightarrow \frac{K_f}{K_i} = \frac{\frac{1}{8} m{V_o}^2}{\frac{1}{2} m{V_o}^2}$$

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

$$\Rightarrow \frac{V_f}{V_i} = \frac{1}{2} \Rightarrow V_f = \frac{V_o}{2}$$

$$-KV^2 = m.\frac{dv}{dt}$$

Integrating on both sides with proper units

$$\int_{v_0}^{Vo/2} \frac{dv}{v^2} = \int_0^{t_0} -\frac{kdt}{m}$$

$$\left(-\frac{1}{v}\right)_{v0}^{\frac{v_0}{2}} = -\frac{k}{m} t_0$$

$$K = \frac{m}{v_0 t_0} = \frac{10^{-2}}{10 \times 10}$$

= 10^{-4} **kgm** $^{-1}$

4 key 1

From Newton's second law of motion F = me

Given F = 6t

$$\Rightarrow 6t = \% \frac{dv}{dt}$$

$$\int_0^v dv = \sqrt{6t}.dt$$

On simplifying

$$v=6\left[\frac{t^2}{2}\right]_0^1$$

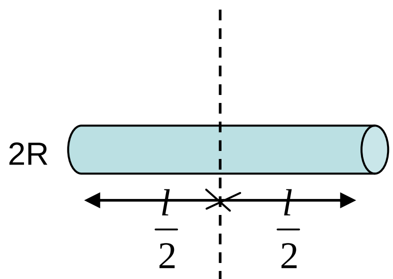
$$=3ms^{-1}$$

Work done by the

Force = change in K.E

$$=\frac{1}{2}\succ 1\times 9=4.5J$$

5. key 1



I = M . I of a uniform cylinder of length L and radius R about its perpendicular bisect or

$$=\frac{mR^2}{4}+\frac{ml^2}{12}$$

$$\Rightarrow\ I=\frac{m}{4}\left[R^2+\frac{l^2}{3}\right]$$

Let $\nu=\pi R^2 l$

$$\Rightarrow\ I=\frac{m}{4}\left[\frac{v}{\pi l}+\frac{l^2}{3}\right]$$

$$\frac{dI}{dl}=\frac{m}{4}\left[\frac{-v}{\pi l^2}+\frac{2l}{3}\right]=0$$

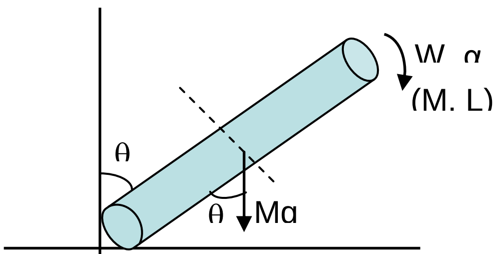
$$\frac{v}{\pi l^2}=\frac{2l}{3}\Rightarrow v=\frac{2\pi l^3}{3}$$

$$\Rightarrow \pi R^2 l = \frac{2\pi l^3}{3}$$

$$\frac{l^2}{R^2} = \frac{3}{2}$$

$$\Rightarrow \frac{l}{R} = \sqrt{\frac{3}{2}}$$

6 key 1



Torque at an angle o is

γ = (Force) perpendicular distance

γ = (Mgsin θ) $\frac{l}{2}$ -- (1)

But γ= I α -- (2)

Comparing (1) and (2)

Iα = (Mgsin θ) $\frac{l}{2}$

For a rod moment of inertia along an axis passing through ends is $I = \frac{ml^2}{3}$

$$\therefore \left(\frac{ml^2}{3}\right)(\alpha) = (mg\sin\theta)\frac{l}{2}$$

On solving

$$\alpha = \frac{3g\sin\theta}{2l}$$

7. Key 4

8. Key 2

Copper ball is not body and copper calorimeter and water are cold bodies

From principle of calorimeter

Heat lost by not body

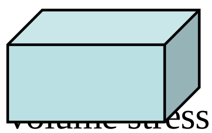
= heat gained by cold body

$\Rightarrow 100 \times 0.1 \times (t-75)$

$= 100 \times 0.1 \times 45 + 170 \times 1 \times 45$

On solving $t = 885°C$

9 key 1



$$\text{Bulk modulus} = \frac{\text{volume stress}}{\text{volume strain}}$$

$$K = \frac{\Delta p}{-\left(\frac{\Delta v}{v}\right)}$$

$$\Rightarrow \frac{\Delta v}{v} = \frac{p}{k} \qquad \text{-- (1)}$$

But $v = v_0[1 + r\Delta t]$

$$\frac{\Delta v}{v_0} r\Delta t \qquad \text{-- (2)}$$

From (i) and (ii)

$$\frac{P}{k} = r\Delta t \Rightarrow \Delta t = \frac{9}{rK}$$

$$\boxed{\Delta t = \frac{P}{3\alpha k}}$$

10 key 3

Let molar heat capacity of the gas at constant pressure = C_p

Molar heat capacity of the gas at constant volume = C_v

$C_p - C_v = R$

Let C_p and C_v are the specific heats of the gas at constant pressure and constant volume

$\therefore MC_p - MC_v = R$

$$C_p - C_v = \frac{R}{M}$$

Fro hydrogen $a = \frac{R}{2}$

For nitrogen $b = \frac{R}{28}$

$$\therefore \boxed{Q = 14b}$$

11 key 4

From ideal gas equation PV = nRT

Where n = number of mores

$\therefore n_1$ = Initial number of mores

$\Rightarrow P_1V_1 = n_1 RT_1$

$$\Rightarrow n_1 = \frac{p_1v_1}{RT_1} = \frac{10^5 \times 30}{8.3 \times 290}$$

$$= 1.24 \times 10^3$$

n_2 = Final number of mores

$$= \frac{p_1v_1}{RT_1} = \frac{10^5 \times 30}{8.3 \times 300}$$

$$= 1.20 \times 10^3$$

Change of number of molecules = $(n_2 - n_1) \times N_A$

$= (1.20 \times 10^3 - 1.24 \times 10^3) \times 6.023 \times 10^{23}$

$= -2.5 \times 10^{25}$

12. Key 4

Kinetic energy of a

Particle executing S.H.M

Is $K.E. = \frac{1}{2} m A^2 w^2 \cos^2 wt$

$\therefore At \quad 0, \frac{T}{2}, T$ K.E is Maximum

$At \frac{T}{4}, \frac{3T}{4}$ K.E is Zero

13 key 3

When the velocities approach velocity of light then the motion is called

Relativistic

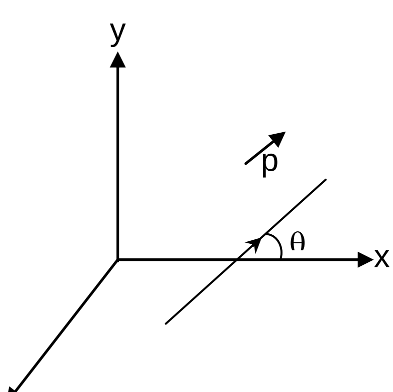
$$\nu = \nu_0 \sqrt{\frac{c+v}{c-v}}$$

Where v = relative speed of approach

$$\Rightarrow \nu = 10 \sqrt{\frac{c + \frac{c}{2}}{c - \frac{c}{2}}} = 10\sqrt{3}$$

= 17.3 GHZ

14. Key 3



Let $\overline{p}$ is the dipole moment of the electric dipole

$\therefore$ From the figure

$$\overline{p} = P\cos\theta\hat{i} + p\sin\theta\hat{j}$$
$$\overrightarrow{E}_1 = E\hat{i}$$

Torque $= \overline{\text{T}}_1 = \overline{P}_1 \times \overline{E}_1$

$$= PE\sin\theta(-\hat{k}) \qquad \text{--(1)}$$

$$\overrightarrow{E}_2 = \sqrt{3}E_1\hat{i}$$
$$\overline{T}_2 = \left(P\cos\theta\hat{i} + p\sin\theta\hat{j}\right) \times \sqrt{3}E_1\hat{j}$$
$$= \sqrt{3}PE_1\cos\theta\hat{k} --- (2)$$

But given $\overline{T}_1 = -\overline{T}_1$ -- (3)

$\therefore$ From (1), (2) and (3)

$\theta = 60°$

15 key 4

Capacitors of 1 μF in parallel with 4 such branches in series

$\therefore$ Number of capacitors

Required = 8 × 4 = 32

16 key 3

In a steady state, flow of current through capacitor will be zero

$\therefore$ r and r_2 resistors are in series

$$\therefore i = \frac{E}{r + r_2}$$

$$v_c = i \times r_2 = \frac{Er_2}{r + r_2}$$

$$\therefore \nu = cv_c = \frac{cEr_2}{r + r_2}$$

17 key 4

The potential difference in each loop is zero

$\therefore$ Current does not flow

18 key 1

Time period of the given magnet =

$$T = 2\pi\sqrt{\frac{I}{MB}}$$

$$= \frac{2\pi}{10} \times 1.06$$

But for 10 oscillations

T = 10 T = 2π × 5 1.06 = 6.65 Secord

19. Key 1

i_g = current through galvanometer = 5×10^{-3} A

G = 15 Ω

Let the resistance

Connected in series is R

$\therefore$ V = i_g (R+G)

10 = 5×10^{-3} (R + 15)

On solving R = 1.985×10^{3} Ω

20. Key 3

From feraday's laws

$$E = \left|\frac{d\phi}{dt}\right|$$

But E = iR

$$\therefore iR = \frac{d\phi}{dt}$$

$$\int d\phi = R\int idt$$

$\therefore$ Magnitude of change in flux = R × area under Current and time graph

$$= 100 \times \frac{1}{2} \times \frac{1}{2} \times 10$$

$$= 250 \text{ weber}$$

21. Key 1

In x-ray tube

$$\lambda_{\min} = \frac{hc}{ev}$$

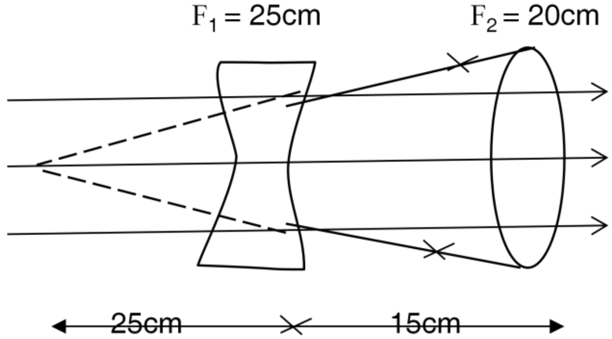
Taking l_n on both sides

$$l_n \lambda_{\min} = l_n\left(\frac{hc}{e}\right).\ln v$$

$\therefore$ We can conclude that slope is negative

Intercept on y-axis is positive

22. Key 1



For converging lens

u = -40 cm which is equal to 2f

$\therefore$ We can conclude that image is real and forms at a distance of 40cm from converging lens

23. Key 2

For light of walk length

$$\lambda_1 = 650nm$$

$$y = \frac{n\lambda_1 D}{d}$$

For light of wavelength

$$\lambda_2 = 520nm$$

$$y = \frac{m\lambda_1 D}{d}$$

$$\therefore \frac{n}{m} = \frac{\lambda_2}{\lambda_1} = \frac{4}{5}$$

For λ_1

$$y = \frac{n\lambda_{1D}}{d} = 7.8mm$$

24. Key 2

Given $m_1 = m$, $m_2 = \frac{m}{2}$

$$v_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)v_1 + \left(\frac{2m_2}{m_1 + m_2}\right)v_2$$

$$= \frac{v}{3} \quad \Rightarrow P_1 = \frac{m\,v}{3}$$

Similarly $v_2 = \frac{4\,v}{3}$

$$P_2 = \frac{m}{2}\left[\frac{4\,v}{3}\right] = \frac{2m\,v}{3}$$

From de – Broglie hypothesis

$$\lambda = \frac{h}{mv}$$

$$\frac{\lambda_A}{\lambda_B} = \frac{P_2}{P_1} = 2:1$$

25 KEY 4

$$E = h\nu = \frac{hc}{\lambda}$$

$$\Rightarrow \lambda_1 = \frac{uc}{E}, \lambda_2 = \frac{hc}{(E/3)}$$

$$\therefore \frac{\lambda_1}{\lambda_2} = \frac{1}{3}$$

26. Key 2

From low of disintegrations $N = N_0 e^{-\lambda t}$

$$\therefore \frac{N_0 = N_0 e^{-\lambda t}}{N_0 e^{-dt}} = 0.3$$

$$\Rightarrow e^{-\lambda t} = \frac{1}{1.3}$$

$$\Rightarrow e^{\lambda t} = 1.3$$

Taking $\log_e$ or *l*n on both sides

$\therefore$ λt = ln 1.3

$$\left(\frac{\ln 2}{T}\right)t = \ln 1.3$$

$$\Rightarrow t = T\left[\frac{\log(1.3)}{\log 2}\right.$$

27. In common emitter configuration for n-p-n transistor, the input- voltage and output voltage are out of phase.

$\therefore$ Phase difference = 180°

28. Key 1

Modulated wave has frequency range

$$= w_c a \pm w_m$$

$\therefore$ since $w_c >> w_m$

Hence w_m is excluded

29. Key 2

In a balanced Wheatstone bridge, the null point remains unchanged even it cell and galvanometer are interchanged

30. Key 2

Given $T = \frac{rhg}{2} \times 10^3 N/m$

From small approximation method

$$\frac{\Delta T}{T} \times 100 = \frac{\Delta D}{D} \times 100 + \frac{\Delta h}{h} \times 100$$

[As ‘g’ is constant]

$$= \frac{0.01}{1.25} \times 100 + \frac{0.01}{1.45} \times 100$$

= 1.5% [Approximately]