Solutions to JEE MAIN – 7 Gen-1 |JEE – 2024

PHYSICS

SECTION-1

1.(D) $h = \dfrac{2T\cos\theta}{R\rho g}$

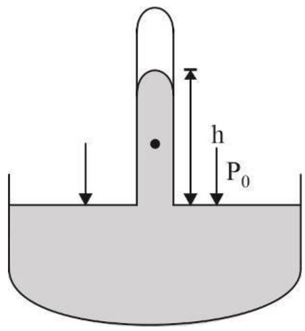
Since surface tension and density of liquid B is double of liquid A, so height remain same.

2.(B) $P_0 = (\rho g h) = 10^5\,Pa$

So, Pressure at x

$= P_0 - \rho g\dfrac{h}{5} = \dfrac{4}{5}\rho g h$

$= 0.8 \times 10^5\,Pa$



3.(C) $\lambda T_1 = 2\lambda T_2$

$T_1 = 2T_2$

Same radiant power $e\sigma(4\pi r_1^2)T_1^4 = e\sigma(4\pi r_2^2)T_2^4$; $\dfrac{r_1}{r_2} = \dfrac{1}{\sqrt{2}}$

4.(A) $a^3\rho_b g = 0.3 \times a^3 \times \rho_\omega g$ … (i)

$a^3\rho_b g + mg = a^3 \times \rho_\omega g$ … (ii)

$\Rightarrow \quad m = \rho_\omega \times 0.7 \times a^3 = 10^3 \times 0.0875 \quad = 87.5\,kg$

5.(C) Considering both boat as system

$F_0 = \eta(A_1 + A_2)\dfrac{V}{H}$ …(i)

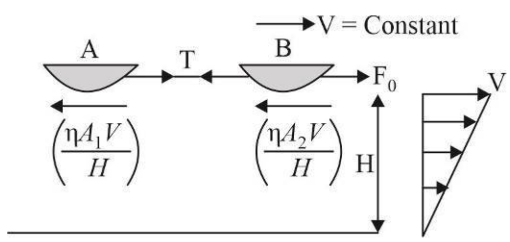
Now, F.B.D. of boat A

$T = \eta\dfrac{A_2 V}{h}$ …(ii)

From equation (i) and (ii)

$\dfrac{T}{F_0} = \dfrac{A_1}{A_1 + A_2}$

$T = \dfrac{A_1 F_0}{A_1 + A_2}$



6.(C) Pressure at centroid of area; $P = \rho g\left(\dfrac{1}{2}\right)$

Force due to liquid $= P \times Area \quad = \left(\dfrac{\rho g}{2} \times 1 \times 1\right) = \left(\dfrac{\rho g}{2}\right)$

Net torque w.r.t. hinge = 0

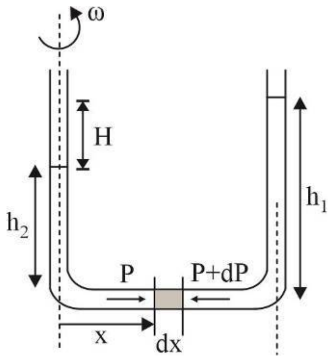
So, $\left(\dfrac{\rho g}{2}\right)\left(\dfrac{1}{2} - \dfrac{1}{3}\right) = F \times \dfrac{1}{2} \Rightarrow F = \dfrac{\rho g}{6}$

7.(B) $(P + dP) - P = \rho(a) \cdot dx$

$$= \int_{\rho g h_2}^{\rho g h_1} dP = \rho \cdot w^2 \int_{x=0}^{x=l} x dx$$

$$\Rightarrow \rho g(h_2 - h_2) = \frac{\rho w^2 l^2}{2}$$

$$\Rightarrow H = \frac{w^2 l^2}{2g}$$



8.(A) For polytropic process, $PV^x =$ constant

$$C = C_V + \frac{R}{1-x}$$

$$C = \frac{3}{2}R + \frac{R}{1-3} \qquad = \frac{3}{2}R - \frac{R}{2} = R$$

9.(B) $(K_{molecule}) = \frac{f}{2}kT$

$$\frac{K_1}{K_2} = \frac{f_1 T_1}{f_2 T_2} = \frac{3}{5} \times \frac{350}{300} = 7:10$$

10.(B) $W = \int Pdv = nR\Delta T = \frac{1}{2} \times 8.310 \times 70 = 291 J$

11.(D) Isothermal process $\Rightarrow$ T = constant.

$\Delta U = 0$

$\Rightarrow$ Internal energy is constant.

$$\Rightarrow \quad Q = W = nRT_0 \ell n\left(\frac{V_2}{V_1}\right) \qquad \Rightarrow \qquad Q = + \Rightarrow V_2 > V_1$$

Gas will do positive work.

12.(B) Given : Cross section area is same of all blocks (A)

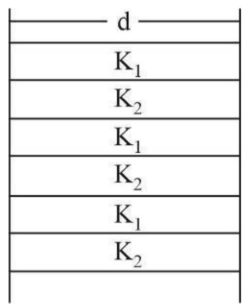
All blocks are in parallel

So, $\frac{1}{R_{net}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} + \frac{1}{R_5} + \frac{1}{R_6}$

$$\Rightarrow \frac{1}{R_{net}} = \frac{K_{eq} A_{net}}{d} = \frac{K_1 A_1}{d} + \frac{K_2 A_2}{d} + ... + \frac{K_6 A_6}{d}$$

$$\Rightarrow K_{eq}(6A) = K_1 A + K_2 A + K_1 A + K_2 A + K_1 A + K_2 A$$

$$\Rightarrow K_{eq} = \frac{K_1 + K_2}{2}$$



13.(C) On heating, photographic enlargement takes place so, x, r & t increases but θ remains same.

14.(C) According to Newton's law of cooling

Rate of colling $\propto$ mean temperature difference

Initial mean temperature difference $= \frac{70 + 60}{2} - \theta_0 = 65 - \theta_0$

Where θ_0 is surrounding temperature.

Finally, mean temperature difference $= \dfrac{60+50}{2} - \theta_0 = 55 - \theta_0$

In 2nd case mean temperature difference decreases. So, it takes more time to cool

15.(A) $P_A + h\rho g + l\rho a = P_B$

$P_B - P_A = (hg + la)\rho$

16.(A) When liquid level is at a height *h*, ejection speed of water is

$$v = \sqrt{2gh} \qquad [\text{as } a << A]$$

Water jet crossed the wall when $x = v\sqrt{\dfrac{2y}{g}}$

$$\Rightarrow \quad x = \sqrt{2gh}\sqrt{\frac{2y}{g}} \quad \Rightarrow \quad h = \frac{x^2}{4y}$$

By continuity equation we use

$$-\frac{dh}{dt}A = a\sqrt{2gh} \quad \Rightarrow \quad \int_H^h \frac{dh}{\sqrt{h}} = -\frac{a}{A}\sqrt{2g}\int_0^t dt$$

$$\Rightarrow \quad 2(\sqrt{H} - \sqrt{h}) = \frac{a}{A}\sqrt{2g}\,t \quad \Rightarrow \quad t = \frac{A}{a}\sqrt{\frac{2}{g}}\left(\sqrt{H} - \sqrt{\frac{x^2}{4y}}\right)$$

17.(C) $V_{rms} = \sqrt{\dfrac{3RT}{M}} \Rightarrow \dfrac{(V_{rms})_2}{(V_{rms})_1} = \sqrt{\dfrac{T_2}{T_1}} \quad \Rightarrow \quad \dfrac{(V_{rms})_2}{(V_{rms})_1} = \sqrt{\dfrac{(527+273)K}{(-73+273)K}} = \dfrac{2}{1}$

$KE_{Translation} = \dfrac{3}{2}nRT$ and $PV = nRT$

So, $KE_{Translation} \neq PV$

18.(C) $\dfrac{X-273}{373-273} = \dfrac{X-32}{212-32}$

$\Rightarrow \dfrac{X-273}{100} = \dfrac{X-32}{180}$

$\Rightarrow 18X - 273 \times 18 = 10X - 320$

$\Rightarrow 8X = 4594 \qquad \Rightarrow X = 574.25$

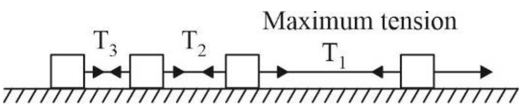
19.(D) Gravitation potential energy = Energy required to melt ice

$mgh = mL_f$

$10 \times h = 80 \times 4.2 \times 1000$

$\Rightarrow h = 33.6\,km$

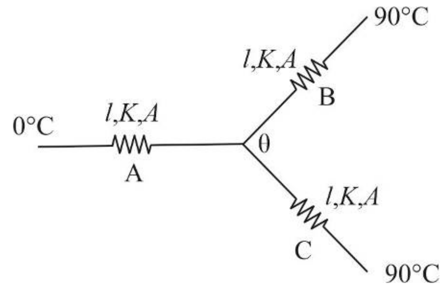
20.(B)



$T_3 < T_2 < T_1$

SECTION-2

1.(6) $\dfrac{\theta-0}{\left(\dfrac{l}{KA}\right)}+\dfrac{\theta-90}{\left(\dfrac{l}{KA}\right)}+\dfrac{\theta-90}{\left(\dfrac{l}{KA}\right)}=0$



$\Rightarrow\ \theta+\theta-90+\theta-90=0$

$\Rightarrow\ 3\theta=180°C$

$\Rightarrow\ [\theta=60°C]$

$\dfrac{\theta}{10}=\dfrac{60}{10}=6$

2.(2) Let θ be temperature at which clock gives correct reading. T be time period at θ

$(\theta-15)\alpha\dfrac{T}{2}=5$ …(i)

$(30-\theta)\alpha\dfrac{T}{2}=10$ …(ii)

Dividing equation (ii) by (i) we get

$30-\theta=2(\theta-15)$

$\Rightarrow\ \theta=20$

So, $\theta=20=10X\ \Rightarrow\ X=2$

3.(1) Let original drop radius be R final drop radius be r

$\dfrac{4}{3}\pi R^3=1000\dfrac{4}{3}\pi r^3$

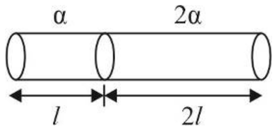
$R=10r$

$\dfrac{U_f}{U_i}=\dfrac{T\times1000\times4\pi r^2}{T\times4\pi R^2}=1000\dfrac{r^2}{R^2}=10$

$x=1$

4.(2) Let $\Delta\theta$ be the change in temperature,

$l\alpha\Delta\theta+(2l)(2\alpha)\Delta\theta=(3l)[\alpha_{eq})\Delta\theta$



$\Rightarrow\ \alpha+4\alpha=3\alpha_{eq}$

$\Rightarrow\ \alpha_{eq}=\dfrac{5\alpha}{3}=\dfrac{m}{n}\alpha\quad\Rightarrow\ m-n=5-3=2$

5.(5) $y=\dfrac{Fl}{A\Delta l}$; $\quad\Delta l=\dfrac{l}{Ay}F$

$\dfrac{l}{Ay}=1$; $\quad\dfrac{0.628}{\pi\dfrac{(4\times10^{-3})^2}{4}\times4}=1$

$y=\dfrac{0.628\times10^6}{\pi\times4}$; $\quad y=5\times10^4\ N/m^2$

6.(2) Heat is given in the process $A \rightarrow B \;\&\; B \; to \; C$

Total heat given $= \int_A^B CdT + \int_B^C CdT$

= Area under $A - B - C$

$= 2 \times$ area under $A - B$

$= 2 \times \frac{1}{2}(1.5R + 3R) \times 50$

= 225 R

= 1870 J

= 1.9 kJ

7.(4) $\Delta A = \left(10 \times \frac{1}{10} \times 2\right) cm^2 \;\; = 2\,cm^2$

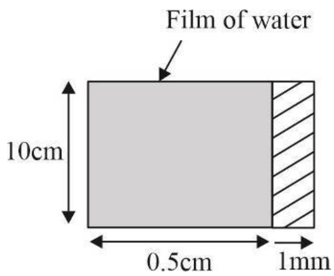
$T = 0.072\,N / m^2$

Work done $= T \times \Delta A$

$= 0.072 \times 2 \times 10^{-4}$

$= 144 \times 10^{-7}\,J \;\; = (36 \times 4) \times 10^{-7}\,J$

So, $m = 4$



8.(4) $PV^x =$ constant

$C = C_v + \frac{R}{1-x}$; $\qquad 2R = \frac{3}{2}R + \frac{R}{1-x}$

$\frac{R}{2} = \frac{R}{1-x}$ $\qquad$ So, $x = -1$

$\frac{P}{V} =$ constant

If volume doubled pressure will also be doubled hence temperature becomes 4 times.

9.(4) $\eta = \frac{T_H - T_L}{T_H}$; $\qquad 0.5 = \frac{600 - T_L}{600}$

$T_L = 300\,K$ [Sink]

$0.7 = \frac{T - 300}{T}$ $\qquad \therefore \; T = 1000\,K$

$\therefore$ Increase in temperature $= 1000 - 600 = 400K$

10.(3) No change of temperature

So $(n_1 + n_2)_i = (n_1 + n_2)_f$; $\frac{P_1V_1}{RT} + \frac{P_2V_2}{RT} = \frac{PV_1}{RT} + \frac{PV_2}{RT}$

So $P = \frac{P_1V_1 + P_2V_2}{V_1 + V_2}$ $\qquad = \frac{(4P_0)(3V) + (1.5P_0)(2V)}{5V}$

$= 3P_0 = IP_0$ (given) $\qquad$ So $I = 3$