WS-10 9th integrated

sp. heat

Thank

(1)

(1)

$Q = 30$ k cal $\rightarrow$ $m = 15$ kg $\quad d\theta = (40-20) = 20°C$

Thermal capacity $= \frac{dQ}{d\theta} = \frac{30 \text{ kcal}}{20}$

$= 1.5$ kcal/°c

(2)

$m = 20 \times 10^{-3}$ kg : $v = 210$ m/s

Energy $= \frac{1}{2} m v^2 = \frac{1}{\cancel{2}} \times \overset{10}{\cancel{20}} \times 10^{-3} \times (210)^2$

$= 10 \times 10^{-3} \times (210)^2 \Rightarrow 441000 \times 10^{-3}$

$= 441$ J

1 cal = 4.2 J.

$\therefore$ Energy in cal = 105 cal

(3)

Given $\frac{r_1}{r_2} = \frac{2}{3}$: $\frac{s_1}{s_2} = \frac{3}{4}$: $\frac{d_1}{d_2} = \frac{4}{5}$

water equivalent $w = ms = d \times vol \times s = d \times \frac{4\pi}{3} \times r^3 \times s$

$\frac{w_1}{w_2} = \frac{d_1}{d_2} \times \left[\frac{r_1}{r_2}\right]^3 \times \frac{s_1}{s_2} = \frac{\cancel{4}}{5} \times \left[\frac{2}{3}\right]^3 \times \frac{3}{\cancel{4}} = \frac{8}{5 \times 27 9} \times \cancel{3}$

$= \frac{8}{45}$

(4)

$v = 42$ m/s   K.E is converted into heat

According to Joule's law

$$W = J Q$$

$$\Rightarrow \frac{1}{2} m v^2 = J\ Q.$$

Here due to K.E of bullet, the temp rising

$$\therefore\ Q = m s\, d\theta.$$

$$\Rightarrow \frac{1}{2} \cancel{m} v^2 = J\, \cancel{m} s\, d\theta$$

$$\Rightarrow d\theta = \frac{v^2}{2 J s} = \frac{(42)^2}{2 \times 1263 \times 1}$$

$$= 0.69 \simeq 0.7^\circ C$$

(5)

$m = 21$ kg   : $v = 20\,kmph = 20 \times \frac{5}{18}\ m/s = \frac{100}{18}\ m/s$

$\mu = 0.05$ $t = 1\,hr = 3600$ sec.

$$\text{work done} = F \times \text{displacement}$$

$$= \mu m g \times v \times t.$$

$$= 0.05 \times 21 \times 10 \times \frac{100}{18} \times 3600$$

$$= \cancel{500 \times 10}\ \ 5 \times 420000$$

This work done $\frac{W}{J} = Q. = \cancel{500}\ \times$

$$\Rightarrow \frac{5 \times 420000}{4200} = Q \Rightarrow Q = 500\,J$$

(6)

Given height from which lead dropped $h = 210\,m$

50% of striking Energy converted into heat

ie $\frac{50}{100} \times P.E = Q$

$\Rightarrow \frac{1}{2} \times \overset{mgh}{\cancel{\frac{1}{2}mv^2}} = ms\,d\theta$

[Here due to the conversion of P.E into heat there is rise in temperature of the lead]

$\Rightarrow \frac{1}{2} \overset{gh}{\cancel{m}\cancel{v^2}} = \cancel{m}s\,d\theta$ [$s = 0.03$ kcal/kg $= 0.03 \times 4200$ J/kg]

$\Rightarrow \frac{1}{2} \times \frac{gh}{Js} = d\theta$

$\Rightarrow d\theta = \frac{1}{2} \times \frac{10 \times 210}{4200 \times 0.03} = \frac{2100}{2 \times \cancel{4200} \times 3 \times 10^{-2}}$

$\Rightarrow \frac{100}{4 \times 3} = \frac{25}{3}\,^{\circ}C$

(7)

$m = 2\,kg$; $v = 2\,m/s$; $\mu = 0.3$ $t = 5\,sec$

work done $= f\,s \Rightarrow \mu mg\,(v \times t)$

$= 0.3 \times 2 \times 9.8 \times 2 \times 5 = 0.6 \times 98$

$= 58.8$.

heat Produced $= \frac{W}{J}$ [Joule's law]

$= \frac{58.8}{4.2} = 14\,J$

(8)

$Q = 270$ kcal $\quad t = 1$ hr. $\quad ; L = 540$ cal/gm

$= 270 \times 10^3$ cal

Here heat is converted into water

$\therefore \quad Q = mL$

$\Rightarrow m = \frac{Q}{L} = \frac{270 \times 10^3}{540} = \frac{1}{2} \times 10^3$ gm

$= 0.5 \times 10^3$ gm

$= 0.5$ kg

(9)

$m = 0.1$ kg $\; ; h_1 = 10m \; ; h_2 = 7m. \; ; S = 0.1$ kcal/kg

$= 0.1 \times 4200$ J/kg

here loss of P.E converted in heat Energy

$\Rightarrow mg[h_1 - h_2] = dQ.$

and heat energy is used to rise the temperature

$\Rightarrow \cancel{m}g[h_1 - h_2] = \cancel{m}sd\theta \qquad [S = \frac{1}{m}\frac{dQ}{d\theta}]$

$\Rightarrow g[h_1 - h_2] = sd\theta$

$\Rightarrow d\theta = \frac{g[h_1 - h_2]}{s} = \frac{10 \times [10 - 7]}{0.1 \times 4200}$

$= \frac{100 \times 3}{4200} = \frac{3}{42} = \frac{1}{14} = 0.07°C$

(10)

Force of friction = 100 N ; $m = 1\,kg$; $s = 600\,J/kg\,K$

distance = 30 m

work done by friction = friction × displacement

$= 100 \times 30$

$= 3000\,J$

This $\frac{\text{work done}}{J} = dQ$ [heat produced from Joule's law]

$\Rightarrow dQ = \frac{3000}{1}$ — we know $s = \frac{1}{m}\frac{dQ}{d\theta}$

$\Rightarrow ms\,d\theta = 3000$ — $\Rightarrow dQ = ms\,d\theta$

$\Rightarrow 1 \times \cancel{600} \times d\theta = \cancel{3000}^{5}$

$d\theta = 5^\circ C$

(16)

(i) Given

Angular velocity $\omega = 180$ rpm ; $m = 180\,gm = 180 \times 10^{-3}\,kg$

$\frac{d\theta}{dt} = 0.5^\circ/sec$. $S_{steel} = 420\,J/sec$.

$dQ = ms\,d\theta = 180 \times \frac{4200}{4.2} \times 0.5 \times 10^{-3}$

$= 9$ cal/sec.

work done $= Q \times J \Rightarrow 9 \times 4.2$ cal/sec

$= 37.8$ cal/sec

$= 37.8\,W$

(17)

Given 0.1% of ice melts on reaching ground

let 'm' be the mass of ice

$m' =$ mass of ice melts on reaching ground

$= 0.1\%\, m$

$= \frac{0.1}{100} \times m = \frac{1}{1000} m.$

Here loss of P.E converted into heat energy.

$L_{ice} = 80$ cal/gm ; $J = 4.2$ J/cal.

$\therefore$ P.E $= dQ$ $\left[L_i = \frac{dQ}{m'} \quad dQ = m'L \right]$

$\Rightarrow m'gh = m'L$

$\Rightarrow \frac{m}{1000} \times 10 \times h = \frac{m}{1000} \times 80 \times 4.2.$

$\Rightarrow \frac{h}{1000} = 8 \times 4.2$

$\Rightarrow h = 8 \times 4.2 \times 10^3$

$= 33.6 \times 10^3$

$= 33.6$ km

(17)

let velocity of the bullet be v.

Given $K.E = 20$ cal $[1 \text{ cal} = 4.2 J]$

$= 20 \times 4.2 J$

$= 84 J$

mass of bullet $= 4.2$ gm $= 4.2 \times 10^{-3}$ kg

$\therefore \quad K.E = \frac{1}{2} m v^2$

$\Rightarrow \frac{1}{2} m v^2 = 84$

$\Rightarrow \frac{1}{\cancel{2}} \times \cancel{4.2}^{2.1} \times 10^{-3} \times v^2 = 84$

$\Rightarrow \cancel{21} \times 10^{-4} \times v^2 = \cancel{84}\ 4$

$v^2 = 4 \times 10^2$

$\Rightarrow v = \sqrt{4 \times 10^2} = 200$ m/s

L Task

Jee main level

(1)

$m = 200$ gm $= 200 \times 10^{-3}$ kg ; $Q = 252 J$; $d\theta = 10°C$

Thermal capacity $= \frac{dQ}{d\theta} = \frac{252}{10} = 25.2$ J/K

(2)

Given

(2)

Given $\frac{S_1}{S_2} = \frac{2}{3}$; $\frac{d_1}{d_2} = \frac{6}{5}$.

we know that thermal capacity = mS

$\Rightarrow C = d \times vol \times S$

$\Rightarrow \frac{C}{vol} = d \times S$

$\therefore \frac{[\frac{C}{V}]_1}{[\frac{C}{V}]_2} = \frac{d_1}{d_2} \times \frac{S_1}{S_2} = \frac{\cancel{6}^2}{5} \times \frac{2}{\cancel{3}}$

$= \frac{4}{5}$.

(3)

$m = 300$ gm ; $h = 3$ m. ; $g = 9.8\ m/s^2$

$= \cancel{300}$, 300×10^{-3} kg

According to Joule's law $W = JQ$

$\Rightarrow Q = \frac{W}{J} = \frac{mgh}{J} = \frac{300 \times 9.8 \times 3 \times 10^{-3}}{4200}$

$= 2.1$ cal

(4)

$V = 420$ m/s. $S_{lead} = 0.03$ cal/gm°c $= 0.03 \times 4200$ J/kg°c

loss of K.E = heat produced

$\Rightarrow \frac{1}{2} m v^2 = dQ$ $\left[s = \frac{1}{m} \frac{dQ}{d\theta} \right]$

$\Rightarrow \frac{1}{2} m v^2 = m s\, d\theta$

$\Rightarrow d\theta = \frac{v^2}{2s} = \frac{(420)^2}{2 \times 0.03 \times 4200} = \frac{700}{2} = 350°c$

$\cancel{2} \times 0.03 \times 4200$ $\qquad$ $\cancel{42} \times 0.03$

5

Given $\quad v = 100\ m/s \ ; \quad S = 100\ J/kg\ k.$

Given Total k.E converted into heat

$\Rightarrow \frac{1}{2} m v^2 = dQ \qquad \left[S = \frac{1}{m} \frac{dQ}{d\theta} \right]$

$\Rightarrow \frac{1}{2} \cancel{m} v^2 = \cancel{m} s\, d\theta$

$\Rightarrow d\theta = \frac{v^2}{2s} = \frac{[100]^{\cancel{2}}}{2 \times \cancel{100}} = \frac{100}{2} = 50\ ^\circ k.$

6

$\frac{m_A}{m_B} = \frac{1}{2} \quad : \quad \frac{S_A}{S_B} = \frac{2}{3}$

we know $\quad d\theta = \frac{gh}{S J}$

$\Rightarrow \frac{d\theta_1}{d\theta_2} = \frac{h_1}{h_2} \times \frac{S_2}{S_1} = 1 \times \frac{\cancel{3}}{\cancel{3}} = \frac{\cancel{3}}{\cancel{2}} \quad \frac{2}{3}$

7

$\frac{d_1}{d_2} = \frac{3}{4}$; $\frac{S_1}{S_2} = \frac{4}{3}$

Thermal capacity = m s

$C = \text{density} \times \text{vol} \times S$

$\Rightarrow \frac{C}{Vol} = d \times S$

$\Rightarrow \frac{\left[\frac{C}{V}\right]_1}{\left[\frac{C}{V}\right]_2} = \frac{d_1}{d_2} \times \frac{S_1}{S_2}$

$= \frac{3}{4} \times \frac{4}{3}$

$= \frac{1}{1}.$

8

$d_A = 0.5$ gm/c.c ; $d_B = 0.6$ gm/c.c

$V_A = 8$ lit $V_B = 10$ lit

we know   heat capacity = $m \times S$

$C = d \times vol \times S$

C = constant.

$\frac{S_A}{S_B} = \frac{d_B}{d_A} \cdot \frac{V_B}{V_A}$

$= \frac{0.6}{0.5} \times \frac{10}{8}$

$= \frac{\cancel{6}\,3}{\cancel{5}} \times \frac{\cancel{10}\,2}{\cancel{8}\,\cancel{4}\,2}$

$= \frac{3}{2}.$

9

let m be the original mass.

mass melted $m' = 75\% \, m$; $L_{ice} = 80$ cal/gm $= 80 \times 10^3$ cal/kg $= 80 \times 10^3 \times 4.2$ J/kg

loss of P.E = Heat energy

$\Rightarrow mgh = dQ$ $\quad \left[L = \frac{dQ}{m} \right.$

$\Rightarrow mgh = m' L_{ice}$ $\quad \left. m'L = dQ \right]$

$\Rightarrow \cancel{m} \times 10 \times h = \frac{75}{100} \cancel{m} \times \cancel{80}^{8} \times 10^3 \times 4.2$

$\Rightarrow h = \frac{3}{\cancel{4}} \times \cancel{8}^{2} \times 4.2 \times 10^3$

$= 25.2 \times 10^3 = 25.2$ km

10

$m = 0.42$ kg ; $V = 200$ m/s.

Given Thermal Energy $Q =$ k.E

$\Rightarrow JQ = \frac{1}{2} m v^2$

$= \frac{1}{2} (0.42)(200)^2$

$\Rightarrow 0.42 \times \frac{\cancel{40000}^{2}}{\cancel{2}}$

$\Rightarrow Q = \frac{0.42 \times 20000}{J}$ cal

$\Rightarrow \frac{0.42 \times 20000}{4.2}$ cal

$= \underline{2 \text{ k cal}}$

Scanned with OKEN Scanner

16

(i) $h = 500m$;

we know that

rise in temperature $d\theta = \frac{gh}{JS}$

$\Rightarrow d\theta = \frac{9.8 \times 500}{4200} = \frac{\cancel{490}^{49}}{42} = 1.16°C$

(ii)

$m_{\omega} = 100$ kg

$L = \frac{dQ}{m} = S\,d\theta = 4200 \times 1.16$

$\simeq 4900 J/k.$