$= 5\times 0.16 = 0.8$ kgm²

WS-16 For 9th class
Specific heat
7 task

① Given

$n_1 = 1 ; n_2 = 1$

For Monoatomic gas $C_{V_1} = \frac{3R}{2}$

For Diatomic gas $C_{V_2} = \frac{5R}{2}$.

∴ Molar specific heat for mixture

$$C_V = \frac{n_1 C_{V_1} + n_2 C_{V_2}}{n_1 + n_2}$$

$$C_V = \frac{1\times\frac{3R}{2} + 1\times\frac{5R}{2}}{1+1} = 2R$$

② From Given $m = 20$ gm $d\theta = 10°C$

no. of moles $n = \frac{m}{M} = \frac{20}{4} = 5$

From defination $C_V = \frac{1}{m}\frac{dQ}{d\theta}$

$$\Rightarrow dQ = nC_V d\theta$$

$$= 5\times\frac{3R}{2}\times 10$$

$$= 5\times\frac{3}{2}\times 8.3\times 10$$

$$= 600 J.$$

③ For diatomic gas $C_p = \frac{7}{2}R$

Given $R = 2$ cal/mole k

$$C_p = \frac{7}{2}\times 2 = 7$$

$$C_V = \frac{5}{2}\times R = \frac{5}{2}\times 2 = 5.$$

④ Given $C_p = 7.2$ cal/mol °C ; $d\theta = 20-10 = 10°C$

$R = 8.3$ J/mol k (or) 2 cal/mole k

From $C_p - C_V = R$

$\Rightarrow C_V = C_p - R$

$= 7.2 - 2$

$= 5.2$ cal/mol °C.

From def $C_V = \frac{1}{n}\frac{dQ}{d\theta}$

$\Rightarrow dQ = nC_V d\theta$

$= 5\times 5.2\times 10$

$= 260$ cal

⑤ $\frac{C_p}{C_V} = \gamma \Rightarrow C_p = \gamma C_V$

Also $C_p - C_V = R$

$\Rightarrow \gamma C_V - C_V = R$

$\Rightarrow (\gamma - 1)C_V = R$

$\Rightarrow C_V = \frac{R}{\gamma - 1}$.

⑥ Given $n = 5$

$d\theta = 120 - 100 = 20°C$

$\Rightarrow \cancel{du = nC_V d\theta}$

$du = 200$ J

$$C_V = \frac{1}{n}\frac{du}{d\theta} = \frac{1}{5}\times\frac{200}{20} = 2 \text{ J/mole k}$$

(7) Given $C_p - C_v = 5000 \rightarrow (1)$

$\frac{C_p}{C_v} = 1.6 \Rightarrow C_p = 1.6 C_v \rightarrow (2)$

From (1) & (2) we get

$\Rightarrow 1.6 C_v - C_v = 5000$

$\Rightarrow 0.6 C_v = 5000$

$\Rightarrow C_v = \frac{5000}{0.6} = 8333.33 \ J/kg\,k.$

$C_p = 1.6 \times 8333.33$

$= 13,333.3 J/kg\,k$

(8) Given $\frac{C_p}{C_v} = 1.4$

$C_v = 20.8 \ J/\text{mole}\,k$

$C_p = 1.4 C_v.$

$C_p = 1.4 \times 20.8$

$= 29.12 \ J/\text{mole}\,k$

(or) $= 6.93 \ cal/\text{mole}\,k$

(9) $m_1 = m \quad S_1 = S \quad \theta_1 = T$

$m_2 = \frac{m}{2} \quad S_2 = 2S \quad \theta_2 = 2T$

$\theta_{mix} = \frac{m_1 S_1 \theta_1 + m_2 S_2 \theta_2}{m_1 S_1 + m_2 S_2}$

$= \frac{mST + \frac{m}{2}(2S)(2T)}{mS + \frac{m}{2}(2S)}$

$\Rightarrow \frac{mST + 2mST}{mS + mS}$

$\theta_{mix} = \frac{3mST}{2mS} = \frac{3T}{2}.$

(10) Given Diatomic gas

$C_v = \frac{5}{2} R ; \ C_p = \frac{7}{2} R$

$\frac{C_p}{C_v} = \frac{\frac{7}{2}R}{\frac{5}{2}R} = \frac{7}{5}$

$\therefore \frac{C_v}{C_p} = \frac{5}{7}.$

$dU = \text{constant}$

Because

$T = \text{constant}.$

(16) $V_1 = 25$ lit ; $V_2 = 75$ lit

$P = 2\,atm = 2 \times 10^5 \ N/m^2$

$1 \text{ lit} = 10^{-3} m^3$

$dW = P(V_2 - V_1)$

$= 2 \times 10^5 (75 - 25) \times 10^{-3}$

$\Rightarrow 100 \times 10^5 \times 10^{-3}$

$\Rightarrow 10 \ kJ.$

(17) At constant volume

$dQ = dU$

$C_v = 24 \ J/\text{mole}\,k.$

$dT = 30 - 10 = 20°C$

$C_v = \frac{1}{n} \frac{dQ}{d\theta} = \frac{1}{n} \frac{dU}{d\theta}$

$dU = n C_v d\theta$

$= 1 \times 24 \times 20$

$dU = 480 J$

2 Task

(1) $m = 10\,gm ; \ H = 8\,cal$

$\Rightarrow H = mS$

$\Rightarrow S = \frac{H}{m} = \frac{8}{10} = 0.8 \ cal/gm$

(2) $m_1 = 5\,kg ; \ m_2 = 5\,kg$

$\theta_2 = 10°C$

$\theta_1 = -10°C$

$S_{ice} = S_{water}$

$\theta_{mix} = \frac{m_1 S_1 \theta_1 + m_2 S_2 \theta_2}{m_1 S_1 + m_2 S_2}$

$\Rightarrow \theta_{mix} = \frac{5 \times 1 \times (-10) + 5(1)(10)}{5 \times 1 + 5 \times 1}$

$\Rightarrow \theta_{mix} = \frac{-50 + 50}{10} = \frac{0}{10} = 0°C$

(3) $m_c = 50\,gm ; \ m_w = 10\,gm$

$d\theta_c = 10°C \quad d\theta_w = ?$

Given $dQ_c = dQ_w$

$\Rightarrow m_c S_c d\theta_c = m_w S_w d\theta_w$

$\Rightarrow 50 \times 420 \times 10 = 10 \times 4200 \times d\theta_w$

$\therefore d\theta_w = 5°C$

(4) $dV = 0.25 m^3, \ P = 10^3 N/m^2$

$dW = P dV$

$= 10^3 \times 0.25$

$\Rightarrow 250 J$

(6) $m_w = 100 ; \ m_m = 1000\,g$

$S_w = 1 \ cal/gm°C$ Given

$dQ_m = dQ_w$

$\Rightarrow m_m S_m d\theta_m = m_w S_w d\theta_w$

$\Rightarrow 1000 \ S_m = 100 \times 1$

$\Rightarrow S_m = 0.1 \ cal/gm°C$

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(7) Given $V_1 = 100$ CC.

$V_2 = 250$ CC

$P = 2atm = 2\times10^5 N/m^2$

$dV = V_2 - V_1 = 250 - 100$

$= 150$ CC $= 150\times10^{-6} m^3$

$dw = P\,dV$

$= 2\times10^5 \times 150\times10^{-6}$

$\Rightarrow 30J$

(8) Given $C_p - C_v = 4150$

$\frac{C_p}{C_v} = 1.4 \Rightarrow C_p = 1.4 C_v$

$\Rightarrow 1.4C_v - C_v = 4150$

$\Rightarrow 0.4\, C_v = 4150$

$\Rightarrow C_v = \frac{4150}{0.4}$

$\Rightarrow C_v = 10375$

(9) Given $C_p = 1.005$ ~~kJ~~ $/kg\,k$

$C_v = 0.718$ J/kg k.

From $C_p - C_v = r$

$\Rightarrow 1.005 - 0.718 = r$

$\Rightarrow r = 0.287$ kJ/kg k

(10) Given $C_v = 0.3122$ kJ

From $C_p - C_v = r$; $M = 39.95$

$R = 8.314$ kJ/m k

$\Rightarrow C_p = r + C_v = \frac{R}{m} + C_v$.

$\Rightarrow C_p = \frac{8.314}{39.95} + 0.3122$

$= 530.3$ J/kg k

(15) Given $C_p = 0.245$ cal/g°c.

$C_v = 0.165$ cal/g°c.

From

$C_p - C_v = R$

$= 0.245 - 0.165 = R$

$\Rightarrow R = 0.08$ cal/gm °c

$= 0.08 \times 4.2 \times 10^7$ erg/gm°c.

$= 3.36\times10^6$ erg/gm°c.

(16) $m = 1gm$; $V_1 = 1cm^3$, $V_2 = 1671\,cm^3$

$P = 1\,atm = 10^5\,N/m^2$

$\therefore dw = P\,dV$

$= 10^5(V_2 - V_1)$

$\Rightarrow 10^5(1671 - 1)\times10^{-6}$

$= 1670\times10^5$ ~~5~~ $\times10^{-6}$

$= 167J$

(17) (i) $C_{p_{mix}} = \frac{n_1 C_{p_1} + n_2 C_{p_2}}{n_1 + n_2} = \frac{1\times\frac{5R}{2} + 1\times\frac{7R}{2}}{1+1}$

$C_{p_{mix}} = \frac{\frac{5R}{2} + \frac{7R}{2}}{2} = \frac{12R}{4} = 3R$

(ii) $C_v = \frac{n_1 C_{v_1} + n_2 C_{v_2}}{n_1 + n_2} = \frac{1\times\frac{3R}{2} + 1\times\frac{5R}{2}}{1+1}$

$C_v = \frac{\frac{3R}{2} + \frac{5R}{2}}{2} = \frac{8R}{4} = 2R.$

(iii) $\gamma = \frac{C_p}{C_v} = \frac{3R}{2R} = \frac{3}{2}$

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