EXERCISE – IV

TOUGH SUBJECTIVE PROBLEMS

1. upper : U Total volume = V

lower : L $F = mg/A$

U $P = \dfrac{R \times 300}{\frac{4}{5}V} = \dfrac{1500}{4}\left(\dfrac{R}{V}\right)$

$= 375\,\dfrac{R}{V}$ ......(1)

L $P + F = \dfrac{R \times 300}{\frac{V}{5}}$

$= 1500\,\dfrac{R}{V}$ ......(2)

latter $P' = \dfrac{RT}{\frac{2}{3}V} = \dfrac{3RT}{2V}$ U ......(3)

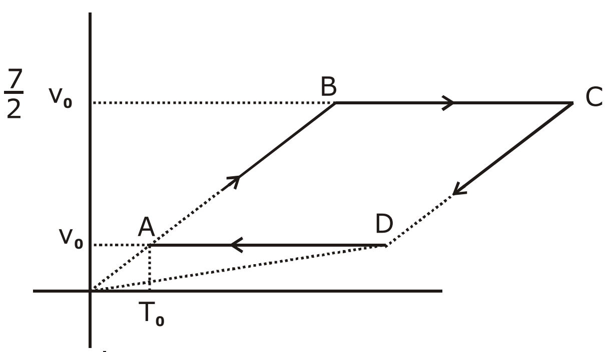
$P' + F = \dfrac{RT}{\frac{V}{3}} = \dfrac{3RT}{2V}$ L ......(4)

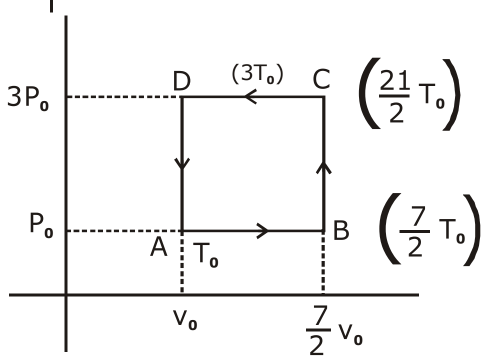
(1) & (2) $F = (1500 - 375)\,\dfrac{R}{V} = 1125\,\dfrac{R}{V}$

(4) give $\dfrac{3RT}{2V} + 1125\,\dfrac{R}{V} = \dfrac{3RT}{V}$

$1125 + \dfrac{3T}{2} \Rightarrow T = \dfrac{1125 \times 2}{3} = 750$

2. $f = 6$ & $C_v = 3R$ & $C_P = 4R$ & $r = \dfrac{4}{3}$





work Area $= -(3P_0 - P_0)\left(\dfrac{7}{2}V_0 - V_0\right)$

$= -2P_0 \times 2.5V_0 - = -5P_0V_0$

Heat is absorbed in AB & BC

$U_{AB} = nC_p\,\Delta T = n \times \dfrac{8}{2}R\left(\dfrac{7}{2}T_0 - T_0\right)$

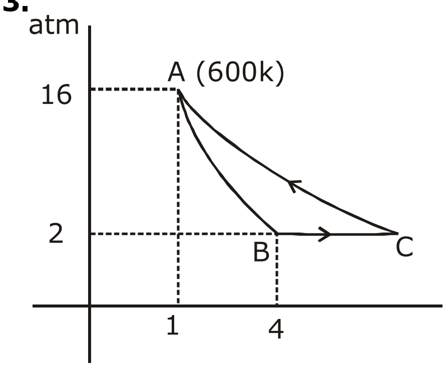
$= 4nR \times \left(\dfrac{5}{2}T_0\right) = 10\,nRT_0 = 10\,P_0V_0$

$U_{BC} = n_Cv\,\Delta T = n \times 3R\left(\dfrac{21}{2} - \dfrac{7}{2}\right)T_0$

$= 21\,n\,RT_0 = 21\,P_0V_0$

Total $= Q = 31\,P_0V_0$

3.



$r = 1.5$

$C_v = 2R$

$C_P = 3R$

(a) AB & adia , more –v slope

(b) $P_AV_A^r = P_BV_B^r$

$16\quad 16(1)^{3/2} = P_B\,(4)^{3/2} = 8\,P_8$

$\boxed{P_B = 2}$

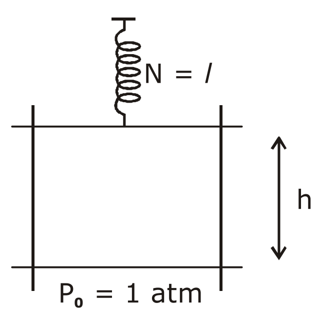
(c) $T_C = 600$ K and $P_AV_A = P_CV_C$

$16 \times 1 = 2 \times v_c \Rightarrow v_c = 8$

$T_B = \dfrac{T_A}{2} = 300\,K$

(d) $v_c = 8$ litre

4.



$P_{ga} = P_0$

latter resting gas

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$= \frac{h}{2} + \frac{h}{16} = \frac{h}{2} + \frac{h}{16} = \frac{9}{16}h$

$F_{sp} = KX = 3700 \times \frac{h}{16}$,

$P_{sp} = \frac{kx}{A} = \frac{3700 \times h}{16 \times 27 \times 10^{-4}}$

$\Rightarrow P_{sp} = \frac{370}{432} \times 10^5 h$

$P_1 v_1^r = P_2 v_2^r$

$10^5 \times h^{1.5} =$

$\left[(10^5 + \left(\frac{370}{432} h \times 10^5\right)\right] \quad \left(\frac{9}{16}h\right)^{1.5}$

$1 = \frac{432 + 3700h}{432} \times \frac{27}{64}$

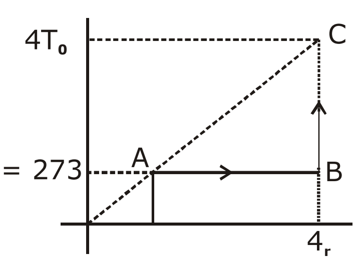
$432 + 370\ h = 432 \times \frac{64}{27}$

$370\ h = 432 \left(\frac{64}{27} - 1\right) = 432 \times \frac{37}{27}$

$h_2 = \frac{432}{270} = 1.6$ m

& $T_2 = \left(\frac{P_2 V_2}{P_1 V_1}\right) T_1 = 364$ K

5.



n = 2

n = ?

u = 27.7 kJ

u = QAB + QBC

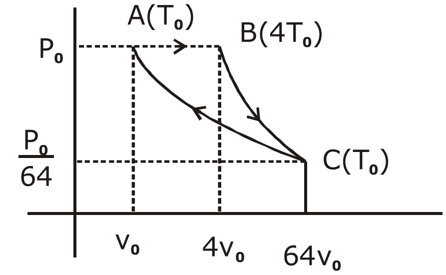
$= nRT_0 \ln \left(\frac{4v}{v}\right) + nC_v (4T_0 - T_0)$

$= 4RT_0 \ln 2 + 6C_v T_0$

$= 4RT_0 \ln 2 + 3fRT_0 = 27700$

$= f = 3.14$ & $r = \frac{f+2}{f} = 1.63$

6. Let



$r = 1.5$

$R_p = 3R$

$C_v = 2R$

$P_A V_A = P_C V_C \Rightarrow P_0 V_0 = P_C V_C$

$P_B V_B^r = P_C V_C^r{}_r \qquad P_0(4v_0)^{1.5} = P_C V_C^{1.5}$

$\frac{(4v_0)^{1.5}}{v_0} = \frac{v_c^{1.5}}{v_c}$

$\Rightarrow 8v_0^{1.5} = v_c^{0.5}$

$v_c = 64v_0$

$\Rightarrow P_0 V_0 = P_C V_C \Rightarrow P_C \times 64\ v_0 = P_0 V_0$

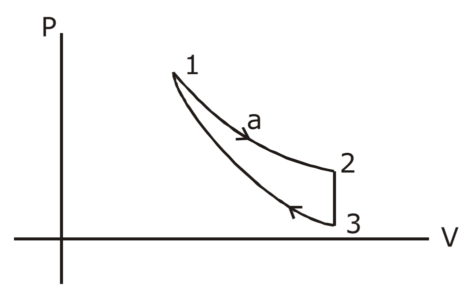
$P_C = P_0/64$

$Q_{AB} = nC_p \Delta T = n \times 3R \times (3T_0) = 9\ P_0 V_0$

$Q_{CA} = nRT_0 \ln 64 = nRT \ln 2 = 6P_0 V_0 \ln$

$\eta = 1 - \frac{2}{3} \ln 2 = \frac{3 - 2\ln 2}{3}$

7. 1–2 adiabatic
2-3 isochoric
3-1 isothermal



Q = mL
= 8000 cal

8. $2mnv^2 \cos^2\theta$

9. (a) W = area under AD

$W = \frac{1}{2} (P_A + P_0)(V_0 - V_A)$

$= \frac{1}{2} (1.6 \times 10^5)(1.1 \times 10^{-3})$

$= 0.8 \times 1.1 \times 10^2 = 88$

(b) $W_{ADC} = W_{AD} + W_{DC}$

$8 > W_{CD} = -3$

$3 = \frac{1}{2} (P_B + P_D)(V_D - V_C)$

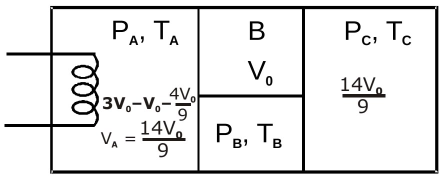
$= \frac{1}{2} (0.9 \times 10^5)(1.3 - V_C) \times 10^{-3}$

$6 = 90 \times (1.3 - V_C)$

$V_c = 1.3 - \frac{80}{90} = 1.3 - \frac{1}{15} = \grave{}1.223\, l$

(c) = –85

10. In final situation



In section C

$\Delta Q = 0$ (adialeatei)

$\Rightarrow PV^r = C$

$\Rightarrow P_t = \frac{27}{8}P_0 = P_C$

Section B is at rest and teusios in rod is iutivial

$\Rightarrow P_A = \frac{27}{8}P_0$

in section A

$\Rightarrow PV = nRT$

$\Rightarrow \frac{PV}{T} = C$

$$\frac{\frac{27}{8}P_0 \times \frac{14V_0}{9}}{17} = \frac{P_0V_0}{T_0}$$

$\Rightarrow T_A = \frac{21}{4}T_0 = T_C$

for TC

PV = nRT

$\Rightarrow \frac{PV}{T}$ = const

$T_C = \frac{9}{2}T_0$

(C) $\Delta Q = \Delta U + \Delta W$

$\Delta W = (\Delta U)$ in C

(D) Work done ley gas in B is zero

11. When vibration as removed

$\gamma = 1 + \frac{2}{f} = 1 + \frac{2}{6} = \frac{4}{3}$

and $\gamma' = \frac{\gamma}{1.2} = \frac{4}{3} \times \frac{10}{12} = \frac{10}{9}$

$\frac{10}{9} = 1 + \frac{2}{f}$

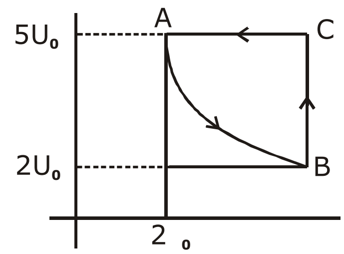
$\frac{2}{f'} = \frac{10}{9} - 1 = \frac{1}{9}$

f' = 18 = 6 + (3n – 6)

3n = 18

$\Rightarrow$ n = 6

12.

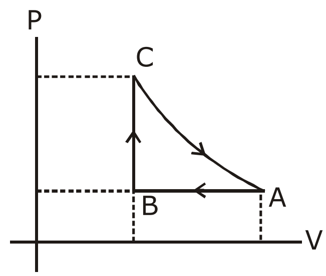


BA $U\rho_0$ = constant

$\frac{f}{2}nRT\left(\frac{m}{v}\right) = \text{constant} > \frac{T}{v} = \text{constant}$

P = Constant

(a)



(b) Q = W(cyclic)

$= W_{AB} + W_{BC} + W_{CA}$

$= W_{AB} + W_{CA}$

$W_{AB} = -\frac{20P_0U_0}{3M} \times \left(\frac{M}{230} - \frac{M}{530}\right) = -2V_0$

$W_{CA} = nRT\, ln\, \frac{V_A}{V_C}$

$= P_AV_A\, ln\, \frac{5}{2}$

$= \frac{10}{3}\ln\frac{5}{2}$

13. $P \alpha \frac{1}{T}$

$\frac{nRT}{V} \times \frac{1}{T} = v \times T^2$

when ever $v \times T^n$

$C = C_v + xR$

$C = C_v + 2R = \frac{3}{2}R + 2R = \frac{7}{2}R$

(ii) $W = Q - \Delta U$

$= nC\,\Delta T - nCv\,\Delta T$

$= n\Delta T\,(C - C_v)$

$= 2 \times (T_2 - T_1)\,(2R)$

$= 4R\,(T_2 - T_1)$

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14. $U = a\sqrt{v}$

$\frac{f}{2}nRT = a\sqrt{v} = T^2 \times v$

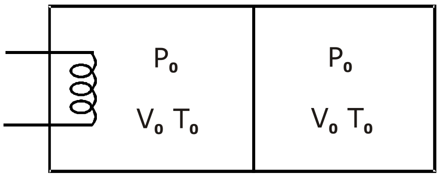
$C = C_V + xR = \frac{5}{2}R + 2R = \frac{a}{2}R$

(a) $Cl = nC\,\Delta T$

$U = nC_V\,\Delta T$

$\frac{Cl}{U} = \frac{C}{C_V} = \frac{a/2}{5/2} = \frac{9}{5}\;\frac{9}{5}\;\; U = 180$

$w = Q - \Delta U = 803$



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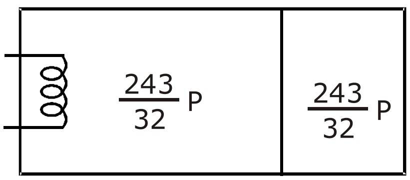


$P^{1-r}\,T^r = \text{cons}$

$$P_0^{-2/3}T_0^{5/3}\left(\frac{243}{32}P_0\right)^{-2/3}T^{5/3}$$

$\Rightarrow\; T = \frac{9}{4}T_0$

and $PV^r = \text{cons}$

$$P_0V_0^{5/3} = \left(\frac{243}{32}P_0\right)V^{5/3}$$

$\Rightarrow\; v = \frac{8}{27}V_0$ for reff pall

$$V_1 = 2V_0 - \frac{8V_0}{27} = \frac{46}{27}V_0$$

$$\left(\frac{PV}{T}\right)_r = \left(\frac{PV}{T}\right)_f$$

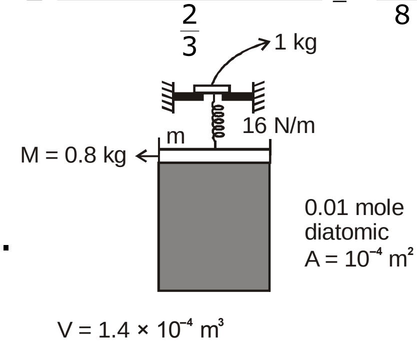
$$\Rightarrow\; \frac{P_0V_0}{T_0} = \frac{243}{32}P_0 \times \frac{46}{27}V_0$$

$$\Rightarrow\; T = \frac{207}{16}T_0$$

$$W = \frac{P_1V_1 - P_2V_2}{\gamma - 1}$$

$$= \frac{P_0V_0 - \frac{243}{32}P_0 \times \frac{8}{27}V_0}{\frac{2}{3}} = -\frac{158}{8}$$

16.



(a) $P = P_0 + \frac{mg}{A}$

$= 10^5 + \frac{0.8 \times 10}{10^{-4}} = 1.8 \times 10^5\; P_A$

(b) for a small displacement x

$\Delta P = -\frac{B\Delta v}{v} = -\gamma p\frac{\Delta v}{v}$

(for adiabale process $B = \gamma p$

$FA = -\frac{7}{5} \times (1.8 \times 10^5) \times \frac{\Delta l}{l}$

$F = -2.52 \times 10^5 \times \frac{Ay}{\gamma} = -2.52 \times 10^5 \times \frac{A^2 y}{l}$

$= 2.52 \times 10^5 \times \frac{10^{-8} \times y}{1.4 \times 10^{-4}}$, $F = -18\,y$

$T = 2\pi\sqrt{\frac{m}{k}} = 2\pi\sqrt{\frac{1}{18}} = \frac{2\pi}{3\sqrt{2}}$

(c) $kx = Mg$

$x = \frac{Mg}{k} = \frac{8}{16} = \frac{1}{2}$

Work, Energy, Theorem

$W = \Delta U + \Delta k = \Delta U$

$= \frac{1}{2}kx^2 + mgx = 75\text{ J}$

17. $P = \frac{RK}{A} = \frac{K(xA)}{A^2} = \frac{kV}{A^2}$

$P \times v = \frac{nRT}{v} \times v$; $= v \times T\;1/2$

$C = C_V + xR = C_V + \frac{R}{2} = \frac{3}{2}R + \frac{R}{2} = 2R$