Thermodynamics TA work AS1300

1 (a) melting Ice cube

Volume of ice changes as it melts, But mass doesnot. Thus its a control mass

(b) Air filled into tyre

Both mass and volume changes. Neither control mass nor a control volume

(c) LPG filled into LPG Cylinder

Volume remains the same. ⇒ Control volume

(d) Sand in Sand clock.

Control mass.

(e) Spring in a machine.

control mass.

(f) AC

control volume. Since air is free to move in or out, mass varies

(g) Domestic Refridgerator

Control mass.

(h) water heated by immersion heater.

control mass.

(i) Water flowing through tap

control volume.

(j) cloth drying in still air

control volume

(K) Water drying in a cup

Not CV

~~Not~~ control mass.

(L) Growing apple

Neither

(M) Air in Air pillow

Control Mass (Volume can change with temperature)

(N) Tube light

Control mass.

(O) Gas stove burner

Control volume.

(P) Water jet hitting a ⊥ plate

Control volume

(Q) Spherical lump of Burning coal.

Neither

(R) Compression in Piston

Control mass.

(S) Compression in Continuous flow compressor

Control volume

(T) heating in closed chamber

Control Mass.

2) Extensive Properties

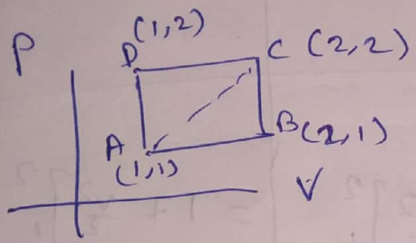
Depend on the amount of Substance.

$V, E+PV, \frac{PT}{V}, \frac{PV}{T}, \frac{PV}{T^2}$

Intensive

$P, T, \frac{P}{T}$

3)



$\int_A^D p\,dv = 0$

$\int_D^C p\,dv = 2$

$\int_A^C p\,dv = \int_1^2 v\,dv = \frac{v^2}{2}\Big]_1^2 = \frac{4-1}{2} = 1.5$

$\int_A^B p\,dv = 1$

$\int_B^C p\,dv = 0$

$\int_A^D v\,dp = 1$

$\int^C v\,dp = 0$

$\int_A^C v\,dp = 1.5$

$\int_A^B v\,dp = 0$

$\int_B^C v\,dp = 2$

Path ADC	Path AC	Path ABC
(a) $\int_A^C P\,dv = \int_A^D P\,dv + \int_D^C P\,dv$ $= 0+2=2$ Path-dependent (Property).	" $= 1.5$	" $= 1$
(b) $\int_{AC} v\,dp$ $= 1+0 = 1$ Path dependent	$= 1.5$	$= 0+2=2$
(c) $\int (P+v)\,dv$ $\int_A^C P\,dv + \int v\,dv$ $= 2 + \left.\frac{v^2}{2}\right]_1^1 + \left.\frac{v^2}{2}\right]_1^2$ $= 2 + 1.5 = 3.5$ Path dependent	$= 1.5 + \left.\frac{v^2}{2}\right]_1^2$ $= 3$	$= 1 + \left.\frac{v^2}{2}\right]_1^2$ $= 2.5$
(e) $\int P\,dv + v\,dp$ $= 2+1 = 3$ Path independent	$= 1.5+1.5$ $= 3$	$= 1+2$ $= 3$
(d) $\int P\,dv - v\,dp$ $= 2-1 = 1$ Path dependent	$= 0$	$= -1$

1.234567×10

4 (I)

(a) <u>90 cm Hg gauge</u>

$76\,cm\,Hg = 1\,atm = 1.01325 \times 10^5\,Pa$ #

$90\,cm\,Hg \Rightarrow \frac{1.01325 \times 10^2}{76} \times 90 = 119.99\,kPa$ gauge.

Gauge Pressure = Absolute − Atmospheric pressure

$\Rightarrow$ Absolute Pressure = 221.32 kPa

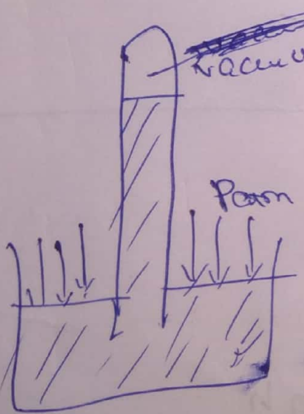
(b) <u>40 cm Hg vacuum</u>

$= \frac{101.325}{76} \times 40 = 53.33\,kPa$ vacuum.

Vacuum Pressure = Atmospheric Pressure − Absolute Pressure

Absolute Pressure $= 101.325 - 53.33$
$= 47.99\,kPa$ Absolute.

(c) <u>1m H_2O gauge.</u>



$P_{atm} - \rho g h = 0$

$h = \frac{101.325 \times 10^3}{1000 \times 9.81} = 10.33\,m\,H_2O$.

$1\,atm = 10.33\,m\,H_2O$

$1\,m\,H_2O \Rightarrow \frac{101.325}{10.33} = 9.8\,kPa$ gauge.

$= 111.13\,kPa$ absolute.

$= 0.5 \times 101.325$

$= 50.66$ kPa

(ii) 0.5 bar absolute

(a) $= -1.01325 + 0.5 = -0.71325$ bar gauge

$= -534.98$ mm Hg gauge

(b) 5 bar absolute

$$= \frac{(5 - 1.01325) \times 10^5}{1.01325 \times 10^5} \times 760$$

$= 2990.368$ mm Hg gauge.

(c) 20 cm Hg absolute.

$(76 - 20) = 56$ cm $= 560$ mm Hg vacuum

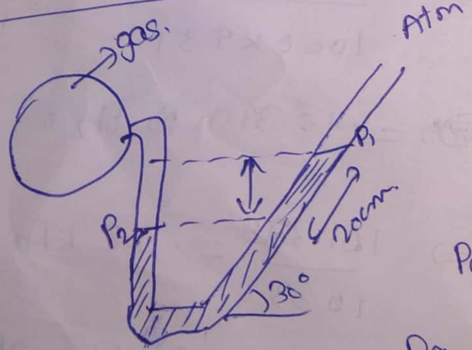
(or)

-560 mm Hg gauge

(d) 800 mm Hg absolute

$(800 - 760) = 40$ mm Hg gauge.

5



$P_1 = P_{atm}$

$P_2 = P_{gas}$

$P_{gas} - P_{atm} = \rho g h$

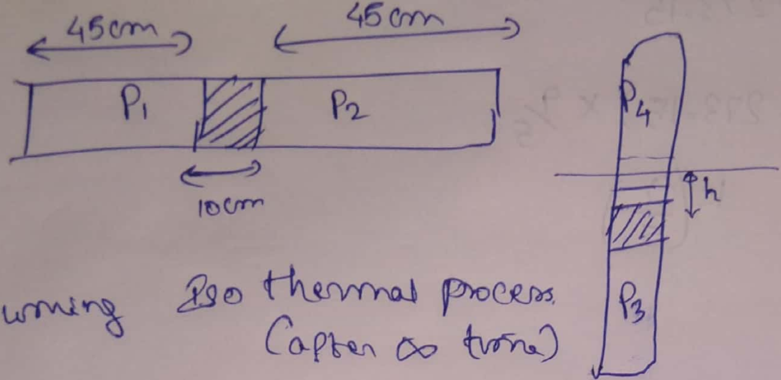
$P_{gauge} = P_{gas} - P_{atm} = 1000 \times 9.8 \times 0.2 \times \sin 30°$

$= 980$ Pa gauge.

$P_{gas} = 101325 + 980 = 102305$ Pa absolute

Absolute Pressure should be used for finding density

6



Assuming Iso thermal process (after ∞ time)

$$P_1V_1 = P_2V_2 = P_3V_3 = P_4V_4$$

$$V = A(\text{length})$$

$$45 \times P_1 = (45-h)P_3 = (45+h)P_4 \quad -①$$

$P_1 = P_{atm}$

Force equilibrium $\quad P_4 \cancel{A} + A\rho_{mercury}(10)g = P_3\cancel{A}$

$$P_4 + 0.1\rho g = P_3$$

$$\frac{0.45P_1}{0.45+h} + 0.1\rho g = \frac{0.45P_1}{(0.45-h)}$$

$$\Rightarrow 0.045P_1\left(\frac{2h}{(0.45)^2-h^2}\right) = 0.1\rho g$$

$$\frac{0.45}{0.1}\frac{P_{atm}}{\rho g}(2h) = (0.45)^2 - h^2$$

$$h^2 + \frac{0.76 \times 0.45}{0.1} \times 2h - 0.45^2 = 0.$$

$$h^2 + 6.84h - 0.2025 = 0.$$

$$h = 0.0295 \text{ m}$$

$$\boxed{h = 2.95 \text{ cm.}}$$

(8)

$F = C\left(\frac{9}{5}\right) + 32$

$C = (F-32)5/9$

$K = C + 273.15$

$R = (C + 273.15) \times 9/5$

$R = K\left(\frac{9}{5}\right)$

(a) $C = F$

$9C = 5F - 160$

$4F = -160$

$\boxed{F = -40}$

(b) $K = F$

$F = (F - 273.15)\frac{9}{5} + 32$

$5F = 9F - 2458.35 + 160$

$\boxed{F = 574.5875}$

(c) $R = C$

$5R = (R + 273.15)\,9$

$-273.15 \times 9 = 4R$

$R = -614.5875 \Rightarrow$ Not possible

$\Rightarrow K < 0$

(d) $R = K$ at $K = 0$

(e) $R = \left[(R-32)5/9 + 273.15\right]\frac{9}{5}$

$R = R - 32 + 273.15 \times \frac{9}{5}$

$\boxed{\text{Not possible}}$

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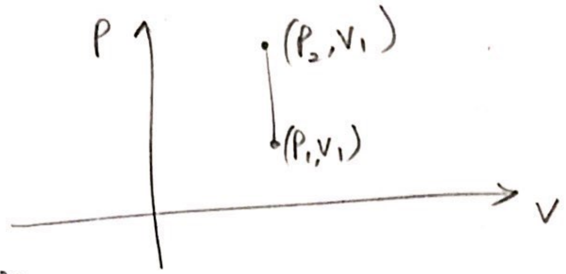
7. Derive the work done during the processes.

(a) constant volume (Isochoric process)

$\Delta V = 0$



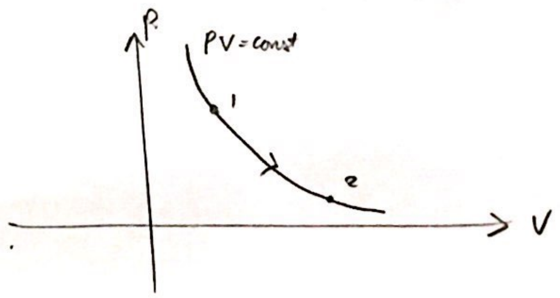
Work done: $W = \int_1^2 P\,dV = 0$

(b) Isothermal process

$PV = nRT$

$PV = \text{constant}$

$$W = \int_1^2 P\,dV = \int_1^2 \frac{nRT}{V}\,dV = nRT \ln\left(\frac{V_2}{V_1}\right)$$



(c) Polytropic process $PV^n = \text{const.} = C$

$$W = \int_1^2 P\,dV = C\int_1^2 V^{-n}\,dV = \frac{P_1V_1 - P_2V_2}{n-1}$$

(d) Isobaric process

$P =$ constant.

$$W = \int_1^2 P dV = P \Delta V$$

(e) Adiabatic process

$PV^{\gamma} =$ const. (C)

$$W = \frac{P_1 V_1 - P_2 V_2}{\gamma - 1}$$