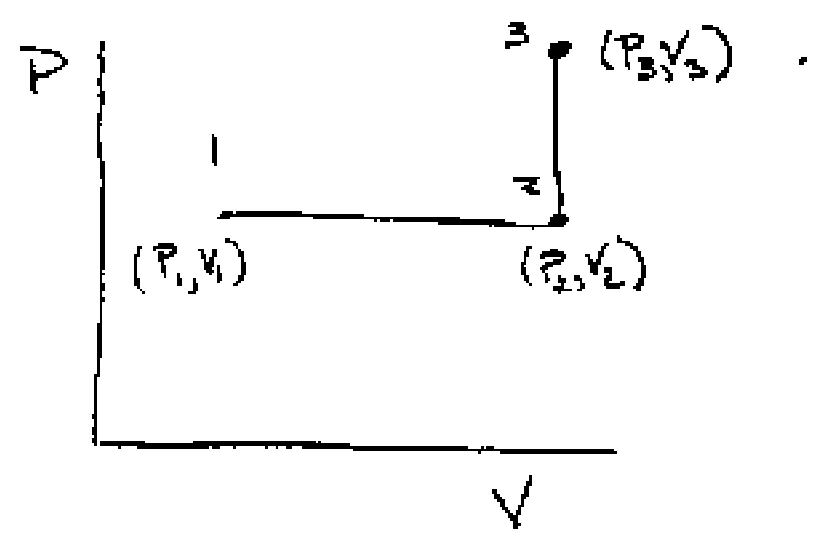
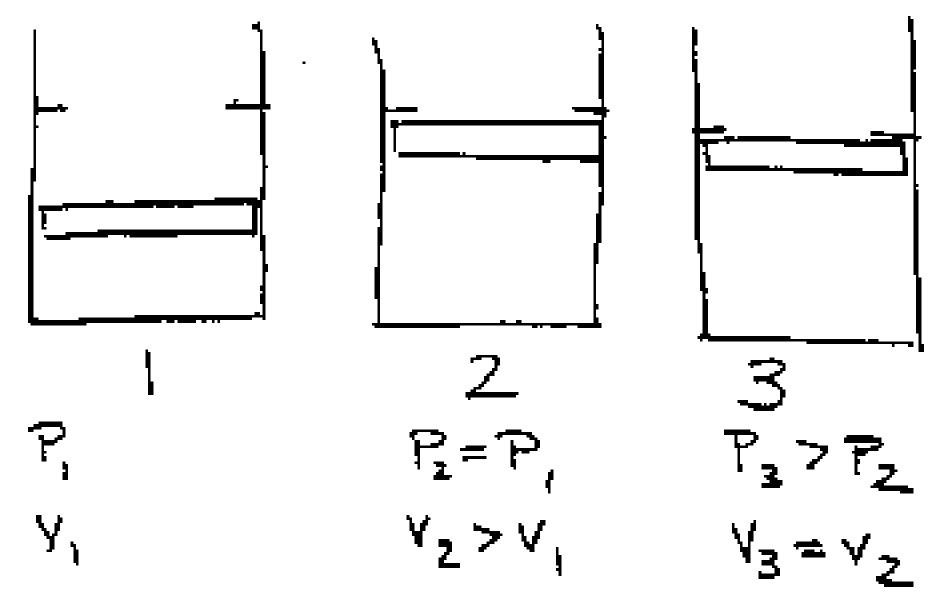
1st law of Thermo

WORK Review

Work is PATH DEPENDENT

∴ if I have gas expanding against a piston, and piston hits the stops.





work is area under PATH

$$ {}_1W_3 = {}_1W_2 + {}_2W_3 = \int_1^2 P\,dV + \int_2^3 P\,dV $$
$$ = P(V_2 - V_1) + 0 $$

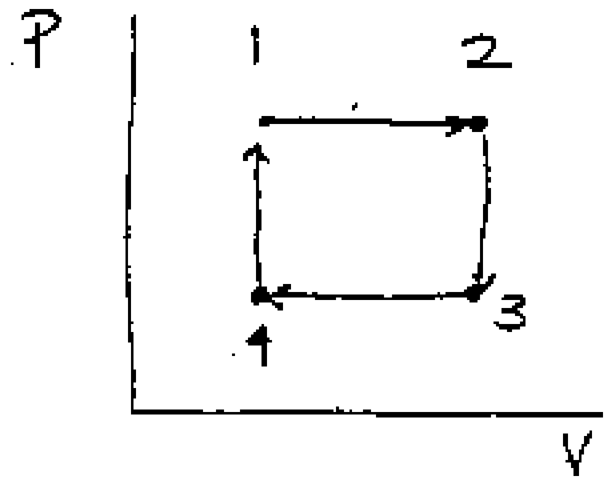
The state at a given point is

for an Ideal gas given by $PV = mRT$

for compressed liq
sat liq &/or sat vap
super heated vapors (not idea)
} by table values

HEAT is also path dependent

If we consider a cycle 12341



$$\oint \delta Q = \oint \delta W$$

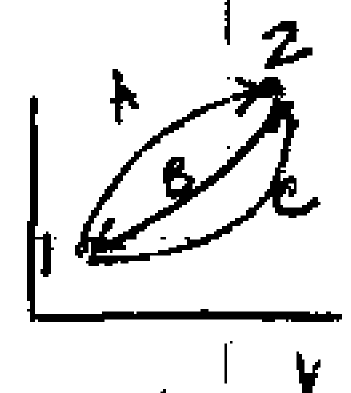
1^{st} law of Thermodynamics

or $J \oint \delta Q = \oint \delta W$

where J is a proportionality factor.

i.e. 1 Btu = 778.17 ft-lbf

When considering several paths from state 1 to state 2



See pg ~~4B of 6~~ 3 of 4 → $\delta Q - \delta W$ depends only on initial & final state

∴ point function → energy of that mass E

$$\int_1^2 \delta Q_A + \int_2^1 \delta Q_B = \oint \delta Q$$

$$dE = \delta Q - \delta W$$

W+ work done BY system
W− work done ON system
Q+ heat transferred TO system
Q− heat transferred FROM system

$$\delta Q = dE + \delta W$$
$${}_1Q_2 = E_2 - E_1 + {}_1W_2$$

E = internal energy + kinetic energy + Potential energy

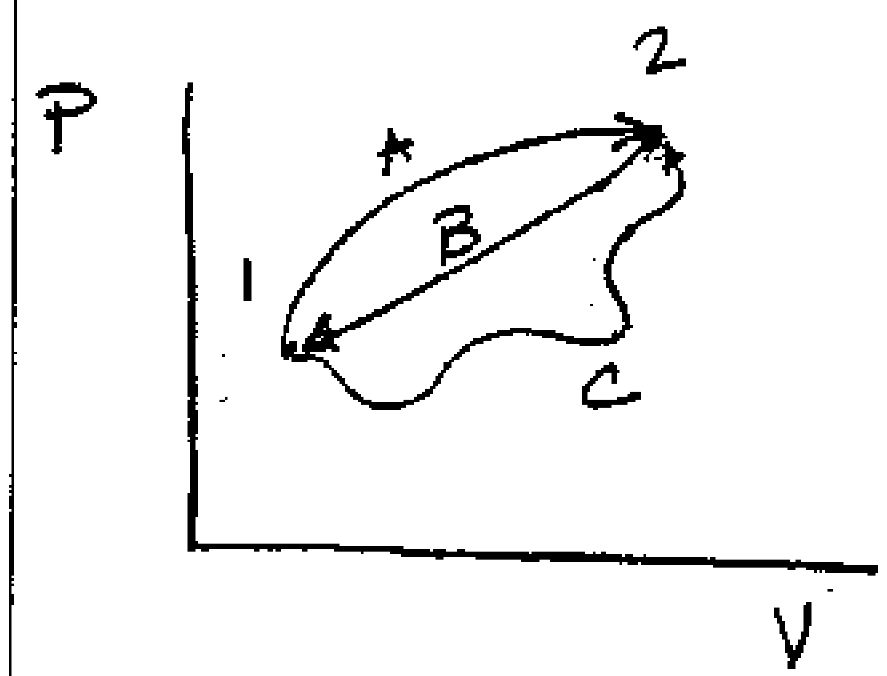
$$E = U + KE + PE$$

$$dE = dU + d(KE) + d(PE)$$

$KE = \frac{1}{2} m v^2$ $\quad v$ = velocity

$PE = mgh$ $\quad h = z$ = elevation

$${}_1Q_2 = U_2 - U_1 + \frac{m(v_2^2 - v_1^2)}{2} + mg(z_2 - z_1) + {}_1W_2$$



$$\oint \delta Q = \oint \delta W$$

look @ ⭮ A-B

$$\int_1^2 \delta Q_A + \int_2^1 \delta Q_B = \int_1^2 \delta W_A + \int_2^1 \delta W_B$$

$$\int_1^2 \delta Q_A - \int_1^2 \delta W_A = -\int_2^1 \delta Q_B + \int_2^1 \delta W_B$$

look@ ⭮ C-B

$$\int_1^2 \delta Q_C + \int_2^1 \delta Q_B = \int_1^2 \delta W_C + \int_2^1 \delta W_B$$

$$\int_1^2 \delta Q_C - \int_1^2 \delta W_C = -\int_2^1 \delta Q_B + \int_2^1 \delta W_B$$

$$\int_1^2 (\delta Q - \delta W)_A = \int_1^2 (\delta Q - \delta W)_C$$

$\int (\delta Q - \delta W)$ does not depend on path –
depends only on initial & final states
∴ called point function

$$dE = \delta Q - \delta W$$

INTERNAL ENERGY — $\underline{\underline{U}}$

if we have a system where ΔPE & $\Delta KE = 0$
no elevation or velocity changes

$$\delta Q = dU + \delta W$$

for saturated mixtures

$$U = U_{liq} + U_{vap}$$

define $u = \frac{U}{m}$

$$mu = m_f u_f + m_g u_g$$

$$u = u_f + x u_{fg}$$

P-u diagram

Problem analysis

1. sketch system / process
2. write initial values known
3. write final values known
4. write info about process; ie what remains constant
5. sketch info on Pv diagram
6. what is the thermodynamic behavior
   Ideal gas, steam tables?