

CHM 222

QUIZ I, 16 Jan 2018

KEY

1) $W = P_{\text{ex}} dV$

For reversible work, $P_{\text{in}} = P_{\text{ex}}$

$$W_{\text{rev}} = P_{\text{in}} dV \text{ \& } W_{\text{irrev}} = P_{\text{ex}} dV$$

for expansion, $P_{\text{in}} > P_{\text{ex}}$,

$$W_{\text{rev}} > W_{\text{irrev}} \quad (4 \times 1 = 4)$$

2) $C_V = (dQ/dT)_V$

$$dE = dQ - P_{\text{ex}} dV$$

at Constant volume

$$dE_V = dQ_V$$

$$\text{So, } C_V = (dQ/dT)_V = (dE/dT)_V \quad (4 \times 1 = 4)$$

3) (a) two bulbs A and B connected by a stop cock, immersed in water

(b) B is evacuated.

(c) stop cock opened to allow ideal gas to expand against zero pressure, $P_{\text{ex}} = 0$

(a-c= 2)

(d) No temp change, $dT=0$ and $dQ=0$

$$(e) dE = (dE/dT)_V dT + (dE/dT)_V dV$$

$$(f) dE = dQ - P_{\text{ex}} dV$$

$$\text{Or } (dE/dT)_V dT + (dE/dT)_V dV = dQ - P_{\text{ex}} dV$$

Since $dT=0$ and $dQ=0$ and $P_{\text{ex}} = 0$

$$(dE/dT)_V dV = 0$$

since dV is not zero, $(dE/dT)_V = 0$. (d-f = 4)

4) In Joule-Thompson Experiment $dQ=0$

$$\text{So } dE = P_{\text{ex}} dV$$

$$\text{Since irreversible, } W_{\text{irrev}} = P_{\text{ex}} dV = P_{\text{ex}} (V_{\text{final}} - V_{\text{initial}})$$

$$\text{For left piston } P_{\text{ex}} dV = P_1 (0 - V_1) = -P_1 V_1$$

$$\text{For right piston } P_{\text{ex}} dV = P_2 (V_2 - 0) = P_2 V_2$$

$$dE = E_2 - E_1 = -(-P_1 V_1 + P_2 V_2)$$

$$E_2 + P_2 V_2 = E_1 + P_1 V_1 \quad (6 \times 1 = 6)$$

5) H vs T curve for Carnot Cycle.

$$\text{For ideal Gas, } H = E + PV = E + RT$$

$$\text{Further for ideal gas, } dE = C_V dT$$

$$\text{So } dH = C_v dT + R dT = C_p dT$$

For isothermal process $dT = 0$ and hence, $dH = 0$.

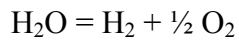
Thus two isothermals become a point.

$$\text{For adiabatic process } dH = C_p dT$$

$$\text{Integrating } H = C_p T + \text{constant}$$

Thus for adiabatic process H varies linearly with T i.e. a straight line. (6x 1)

6) work done for electrolysis of 36 gm water at 27 C. (use $R = 8 \text{ J M}^{-1}\text{K}^{-1}$)



$$1 \text{ mole or } 18 \text{ gm water} = 1 \text{ mole H}_2 + \frac{1}{2} \text{ mole O}_2 = \frac{3}{2} \text{ mole}$$

$$36 \text{ gm or } 2 \text{ moles water} = 3 \text{ mole}$$

$$W = P_{\text{ex}} (V_{\text{gas}} - V_{\text{water}}) = P_{\text{ex}} V_{\text{gas}} = P_{\text{ex}} \times (nRT/P_{\text{ex}}) = nRT = 3 \times 8 \times 300 \text{ J} = 7200 \text{ J}$$