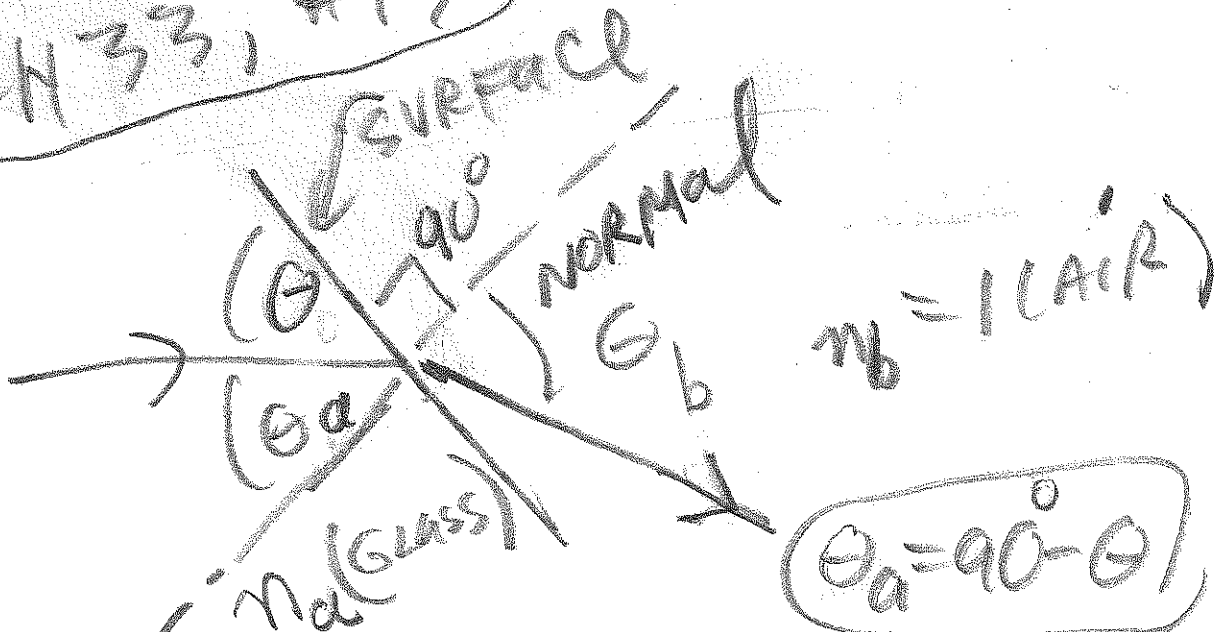


11-1-13

LAST TIME

CH 33, #17



$$n_a \sin \theta_a = n_b \sin \theta_b$$

$$n_a \sin(90^\circ - \theta) = n_b \sin \theta_b$$

$$n_a \cos \theta = n_b \sin \theta_b$$

better to use θ_a :

$$n_a \sin \theta_a = n_b \sin \theta_b$$

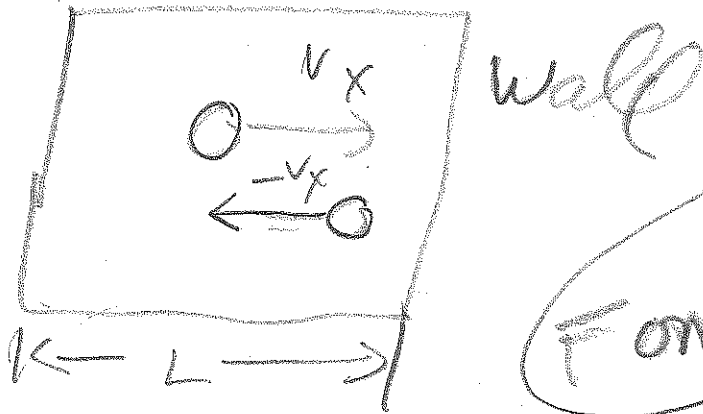
$$n_a \sin \theta_c = n_b \sin 90$$

$$\theta_c = \sin^{-1}\left(\frac{1}{n_a}\right)$$

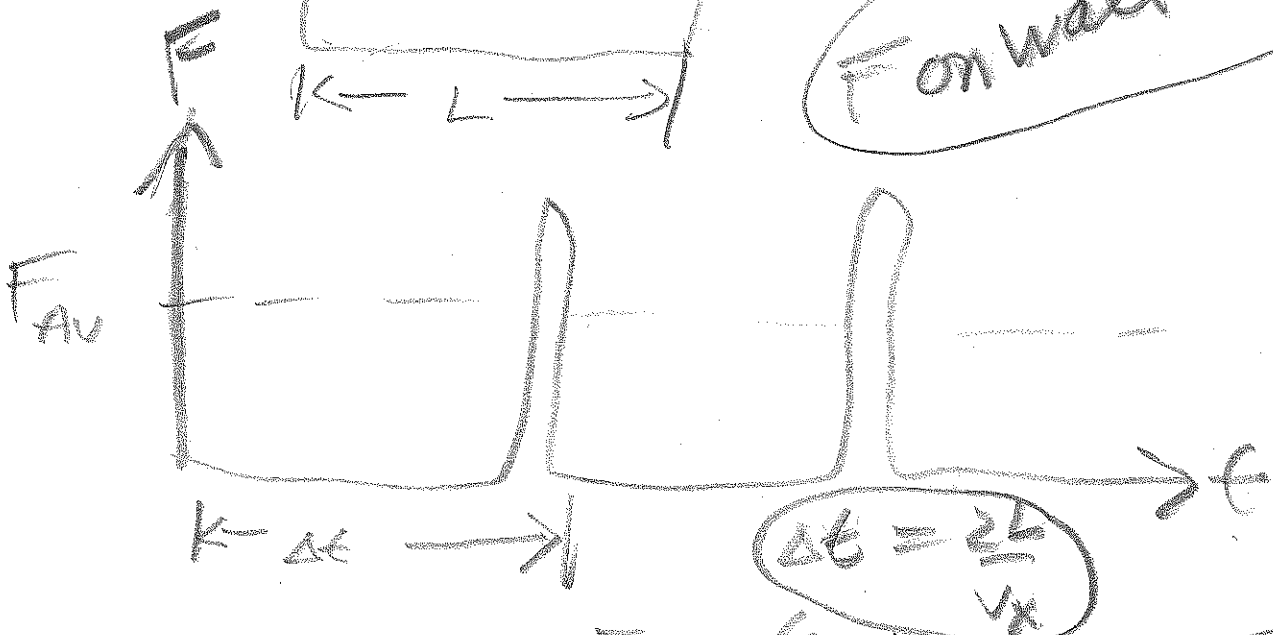
TODAY CH. 18

11-1-13

key point kinetic theory
sec 18.3



F on wall = F



$\Delta t = \frac{2L}{v_x}$

$\Delta p_x = F_{AU} \Delta t$

$F_{AU} = \frac{\Delta p_x}{\Delta t} = \frac{n \cdot 2m v_x}{n \Delta t}$

OVER n ROUND TRIPS

$F_{AU} = \frac{2m v_x}{\Delta t} = \frac{2m v_x}{2L/v_x}$

time between collisions = $\Delta t = \frac{2L}{v_x}$

$\frac{1}{2} m v_x^2 = \frac{m v_x^2}{2}$

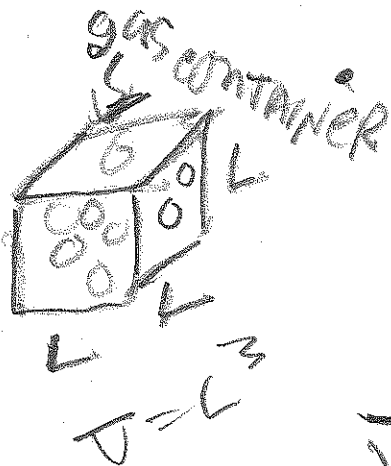
$$\frac{N \cdot m \overline{v_x^2}}{L} = F_{\text{total}}, \text{ N molecules.}$$

$$\text{PRESSURE} = P_{\text{TOTAL}} = \frac{N \cdot m \overline{v_x^2}}{L^3} = \frac{F_{\text{TOTAL}}}{L^2}$$

area $\frac{1}{3} = \frac{1}{3} \sqrt{v^2}$

$$P_{\text{TOTAL}} = \frac{N \cdot m \overline{v_x^2}}{V} \quad \text{EQN 18.13}$$

read derivation



$$P_{\text{TOTAL}} = \frac{1}{3} N \left[\frac{1}{2} m \overline{v^2} \right]$$

$\overline{v^2}$ = average of square of speed.

USE H.S. CHEMISTRY
 $PV = nRT$

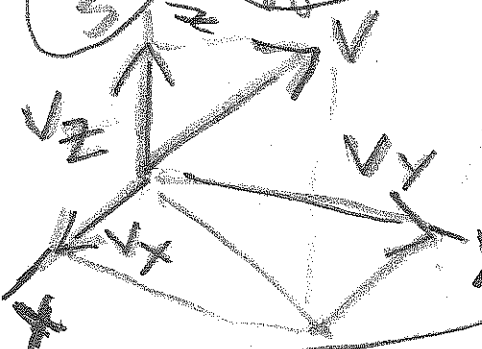
BUT $PV = nRT = \frac{2}{3} N \left[\frac{1}{2} m \overline{v^2} \right]$

$R = 8.31 \frac{J}{K \cdot \text{mole}}$

$T \propto$ average KE

3 degrees of freedom

$\frac{1}{2} m \overline{v^2} = \frac{3}{2} kT$



$N_A \frac{1}{2} m \overline{v^2} = \frac{3}{2} RT$

$k = 1.38 \times 10^{-23} \frac{J}{K}$

$N_A = 6.02 \times 10^{23} / \text{mole}$

NOTE: $\overline{v_x^2} + \overline{v_y^2} + \overline{v_z^2} = \overline{v^2} = 3 \overline{v_x^2}$

molecular speeds (CH 16)

$\sqrt{\overline{v^2}} \equiv v_{rms} = \sqrt{\frac{3RT}{M}}$

→ make sense:

$M = \text{molar mass}$

$n = \# \text{ of moles}$

$nRT = \frac{3}{2} N \left[\frac{1}{2} m \overline{v^2} \right] \Rightarrow \overline{v^2} \propto T$

18.4

REVIEW CH17

$$\Delta Q = m C_{cu} \Delta T$$

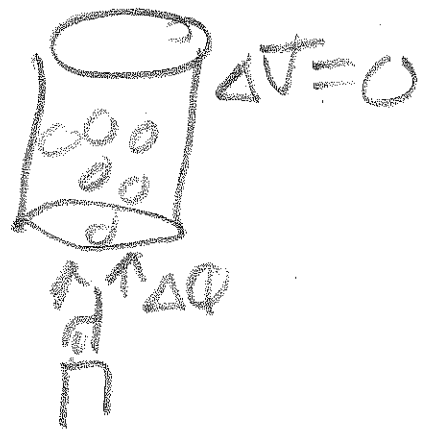
cu



CH 18:

$$dkE = \frac{3}{2} n R dT$$

CONSTANT VOLUME PROCESS

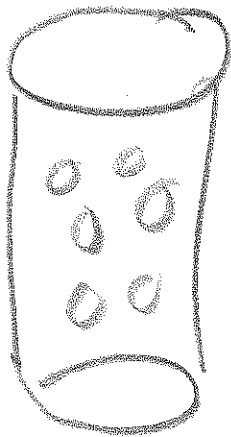


(proof) $dQ = n C_v dT$

$$n C_v dT = \frac{3}{2} n R dT$$

$C_v = \frac{3}{2} R$

ideal monatomic gas.



↑ WORK at
constant pressure

$$dQ = nC_p dt$$

↑ dQ
↑ dQ

$$C_p > C_v$$

SHOW THIS:

$$dQ = dU + pdV$$

$$dQ = \frac{3}{2}nRdT + nRdT$$

$$dQ = \frac{5}{2}nRdT$$

$$dQ = nC_p dT$$

$$pV = nRT$$
$$pdV = nRdT$$

($p = \text{constant}$)

$$C_p = \frac{5}{2}R > C_v = \frac{3}{2}R$$

CH 19

1st LAW THERMODYNAMICS

$F =$ FORCE
of GAS
on piston



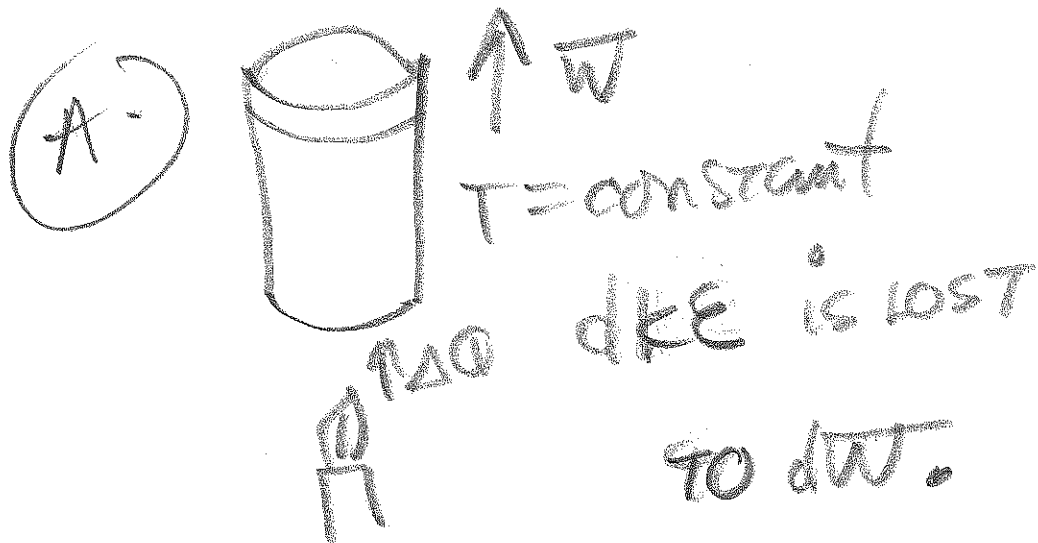
↑ WORK is done by gas on
piston.

$$\Delta Q = \Delta E_{\text{INT}} + W$$

$$dQ = dU + dW$$

different processes

- (A) Isothermal
- (B) Isovolume
- (C) Isobaric



$$dQ = dU + dW$$

$$U \propto T \text{ ideal gas}$$

$$E_{\text{INT}} = U = \frac{3}{2} nRT$$

THUS: $dU = 0$, since $dT = 0$

THUS: $dQ = dW$

$\Rightarrow dQ = PdV$

(A)

note: $p dV = dW$

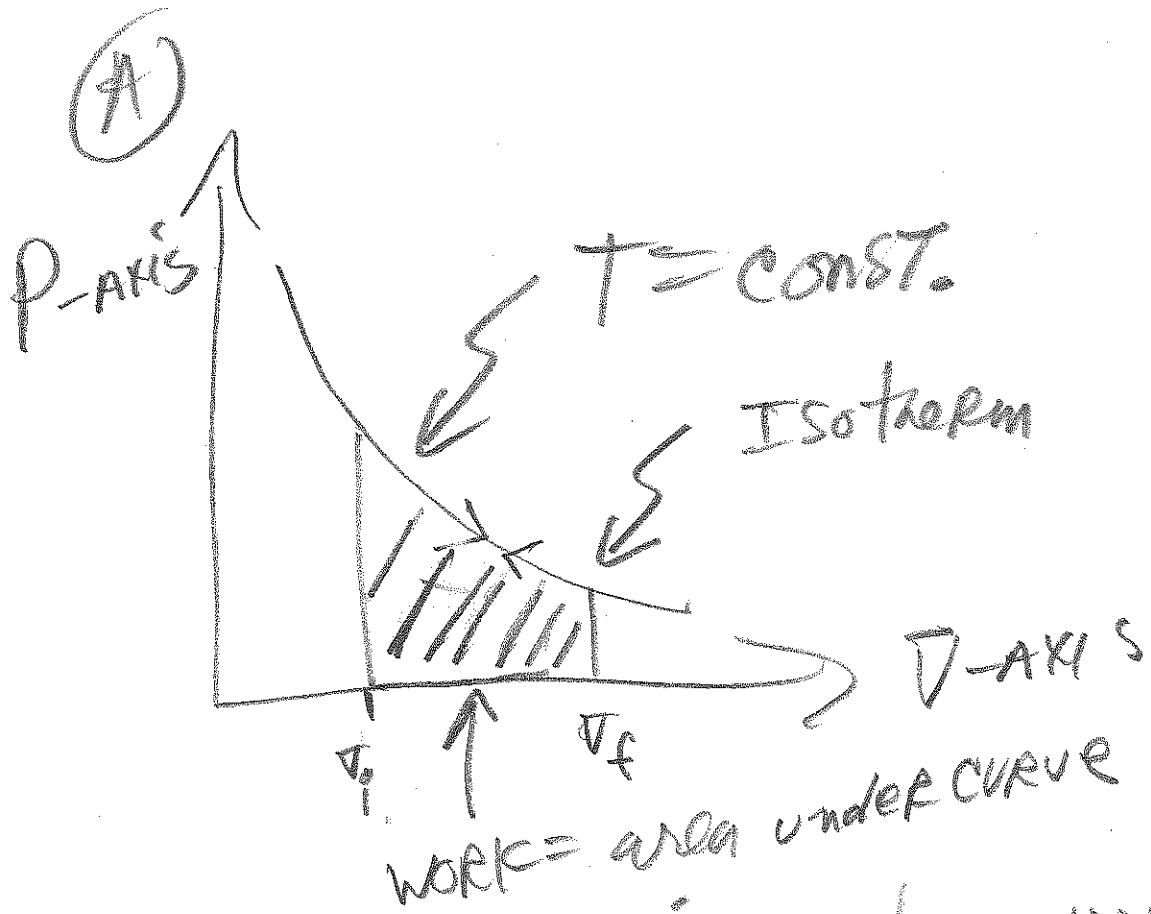
$$pV = nRT$$

$$p = \frac{nRT}{V}$$

Isothermal work

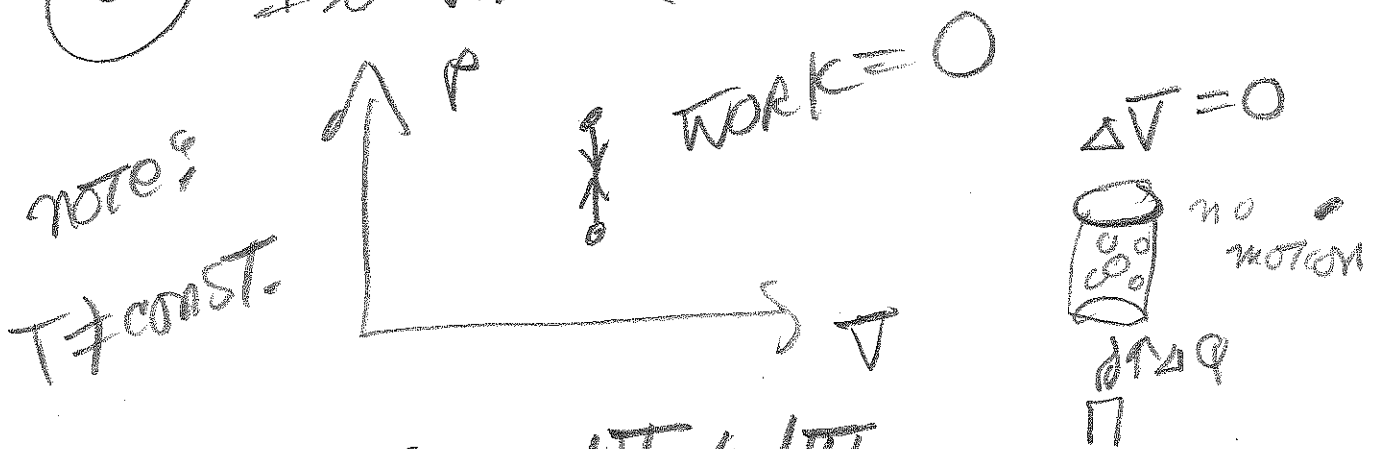
$$\int_{i}^{f} dW = \int_{i}^{f} \frac{nRT}{V} dV$$

$$W = nRT \ln \frac{V_f}{V_i}$$



SUMMARY: $dQ = dW$: input heat = work

(B) Iso volume



$$dQ = dU + dW$$

$$dQ = dU$$

$$dQ = \frac{3}{2} nRdT$$

(ideal monatomic gas)

NOTE:

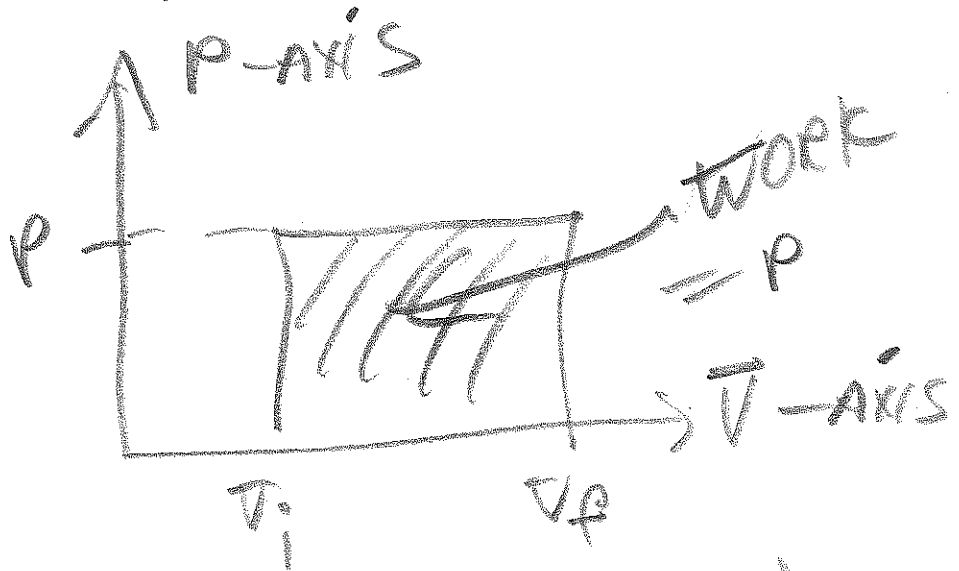
$$dQ = n C_V dT$$

$$n C_V dT = \frac{3}{2} n R dT$$

$$C_V = \frac{3}{2} R$$

(C)

ISO BARI C:

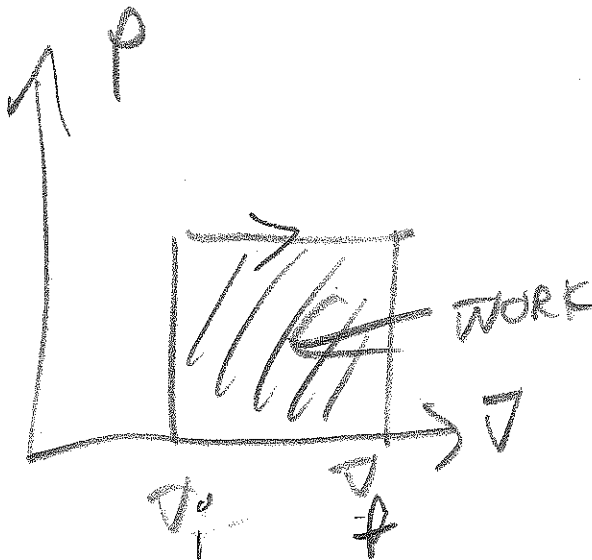


$$\text{WORK} = P \cdot (V_f - V_i)$$

NOTE: $dQ = dU + PdV$

$$(c) \quad dQ = \frac{3}{2} nRdT + nRdT$$

$$\text{SINCE } PV = nRT$$



$$d(PV) = nRdT$$

$$PdV = dW$$

(P = constant)

$$dW = nRdT$$

$$dQ = \frac{3}{2} nRdT + nRdT$$

$$nC_p dT = n \left(\frac{5}{2} R \right) dT$$

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

note: isobaric, T ≠ const.