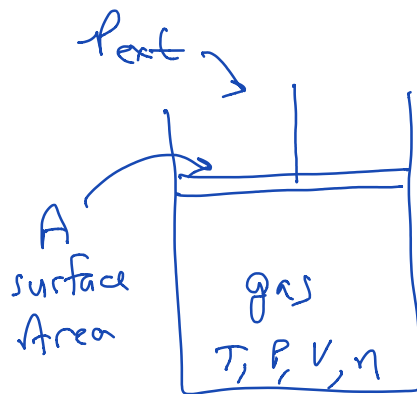
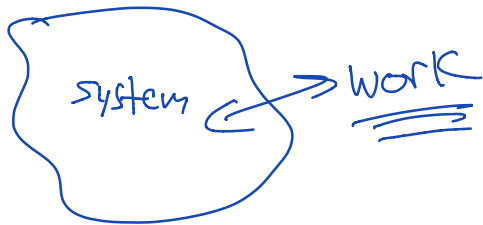


Work : pressure - volume work



$$dw = -P_{ext} dV$$

*
*
A

Sign convention

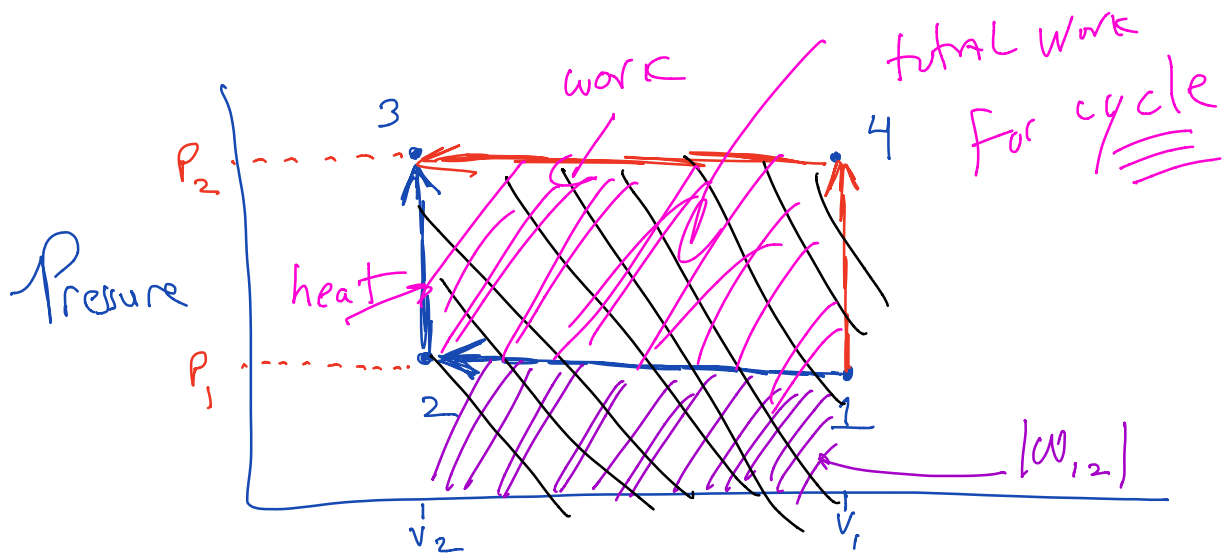
+ dw = environment does work on system

- dw = system does work on ENV.

Work is not a state function!!

$$\oint dw = 0$$

not necessarily



$$dW_{1 \rightarrow 2 \rightarrow 3} = -P_{\text{ext}} dV \quad \text{volume}$$

$$dW_{1 \rightarrow 2} = -P_{\text{ext}} dV$$

$$= -P_1 dV$$

$$W_{1 \rightarrow 2} = \int_1^2 dW_{1,2} = \int_{V_1}^{V_2} -P_1 dV = -P_1 \int_{V_1}^{V_2} dV$$

$$\rightarrow W_{1 \rightarrow 2} = -P_1 (V_2 - V_1) \quad \textcircled{A}$$

$$W_{2 \rightarrow 3} = \int_2^3 -P_{\text{ext}} dV$$

$$= 0$$

$$W_{4 \rightarrow 3} = \int_4^3 -P_{\text{ext}} dV = \int_{V_1}^{V_2} -P_2 dV = -P_2 (V_2 - V_1) \quad \textcircled{B}$$

$$\underline{W_{4 \rightarrow 3} = -P_2(V_2 - V_1)} \quad \underline{W_{1 \rightarrow 3} = -P_1(V_2 - V_1)}$$

∴ Work is path dependent

∴ not state function

Work can't be written as a function of state variable

$$P = \frac{NRT}{V} = P(V, T, n)$$

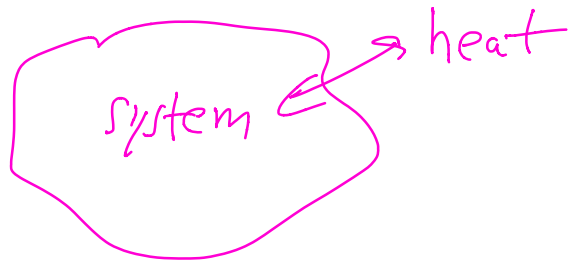
— $W \neq f(\text{state variables}) !!$

$$\oint dW \neq 0$$

— Work is -(area under curve) of P-V diagram

— there is no ΔW only $W !!!$
 $\int_1^2 dW = W_{1 \rightarrow 2}$

work



heat \rightarrow leads to Δ in temperature

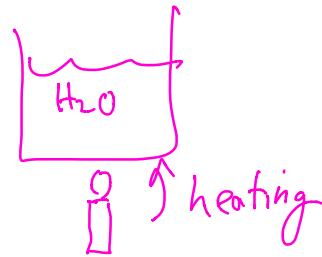
$$\Delta T = T_2 - T_1$$

$$\Delta T = \frac{q}{C}$$

heat capacity

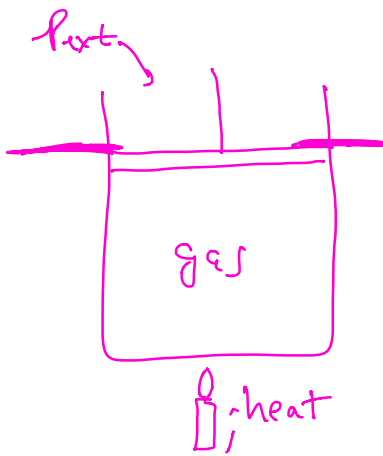
specific heat

heat, q



$$q = C \Delta T$$

$$dq = C dT$$



constant pressure expansion

$$dq_p = C_p dT$$

constant heat c

constant volume

$$dq_v = C_v dT$$

~~heat~~
heat interaction is path dependent

$$C_p > C_v$$

Turns out that C_p, C_v
are functions of Temperature.

$$\rightarrow C_p(T), C_v(T)$$

$$C_p(T) > C_v(T)$$

no Δq only q

$$\int_1^2 dq = q_{1 \rightarrow 2}$$

Work, w ✓

heat, q ✓

> not path-independent
not state functions

Relation between q, w
J. P. Joule

↳ showed equivalence of heat & work !!!

Heat & work are interconvertible

And he showed:

conservation: in theory

all heat \rightarrow all work

and all work \rightarrow all heat