09/08/15

Chapter 19 Lecture

Ch.19 Review

$\Delta E_{int} = \underset{\downarrow}{Q} - W$ ← done by the system

heat added to system

$\Delta E_{int} = \underset{\downarrow}{Q} + W$ ← done on the system

heat added to system

extended form: $\Delta E_{int} + \underbrace{\Delta V + \Delta E_{kin}}_{\text{we usually find this to be negligible}} = Q - W$

* monoatomic!

$E_{int} = \frac{3}{2} N K_B T = \frac{3}{2} nRT$

$\Delta E_{int} \rightarrow \Delta T$ (ideal gas)

* diatomic

$E_{int} = \frac{5}{2} N K_B T$

high temp

$E = \frac{7}{2} K_B T N$

2 extra d.o.f.:
[illegible]
$E_{kin}$ spring
V spring

* any

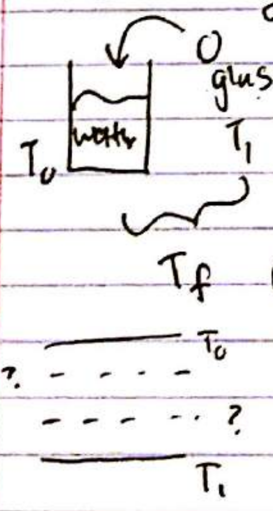
$E_{int} = N \cdot E_{int\,per\,d.o.f} \cdot \#\,of\,d.o.f.$

$Q = \Delta T \cdot m \cdot c$ ← specific heat, assume constant

$c_{water} = \frac{1\,cal}{g \cdot {}^\circ C}$

$c = \frac{Q}{m \Delta T}$

use intuition on size comparison



① $\sum Q = 0$ (isolated system)

② $Q_{out} = Q_{in}$

③ $\overbrace{m_W c_W (T_f - T_0)}^{<0} = \overbrace{m_g c_g (T_f - T_1)}^{>0}$

④ $c_g = \frac{m_w c_w (T_0 - T_f)}{m_g (T_f - T_1)}$ * because $T_0 > T_f$

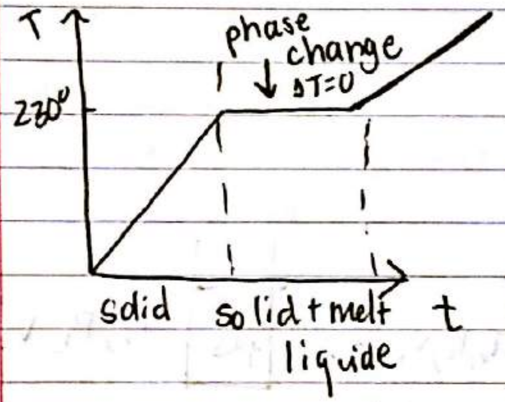
-make sure $\Delta T = T_f - T_i$

-pay attention to signs!

rate of temp change:

$$\frac{\Delta Q}{\Delta t} = \frac{\Delta T}{\Delta t}$$ linear change according to demo

at 230°C, tin melts.



$Q = mc\Delta T$ is not perfect!

phase change:

$\Delta T = 0$ → $Q \cancel{=} 0$

$Q = m\boxed{L}$ — latent heat (hidden)

or $\ell$

$\ell_F$ → fusion $(s \to \ell)$

$\ell_v$ → vaporization $(\ell \to g)$

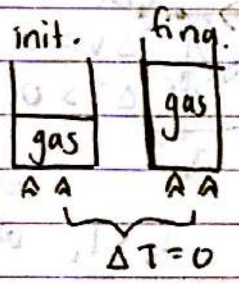
$$\boxed{\underset{\Delta T}{\Delta E_{int}} = \underset{\substack{mc\Delta T \\ m\ell \\ \text{include!}}}{Q} - W}$$

Calculating work

ISOTHERMAL → heat reservoir

-gas does work when expanding

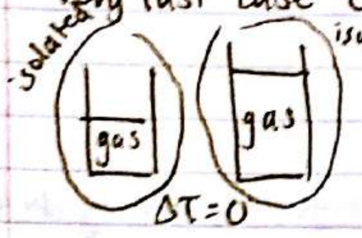
$\Delta E_{int} = 0$, $W = Q$



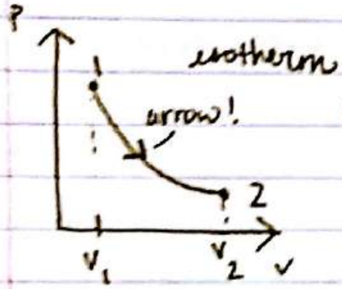
slow process

∴ in equilibrium

-imagine sand, removing one grain at a time very fast case cannot be treated same way

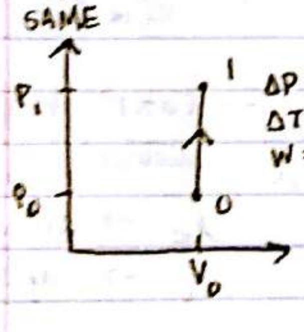


$W = 0$
"free expansion"

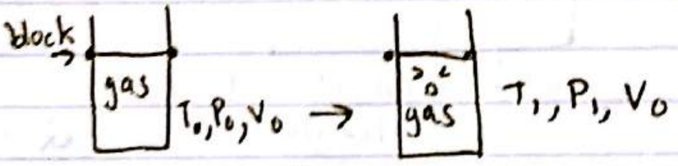


$PV = nRT =$ constant
$P \sim \frac{1}{V}$

ISOVOLUMETRIC

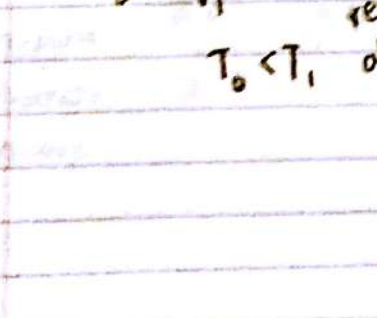


$\Delta P > 0$
$\Delta T > 0$
$W = 0$



$\Delta V = 0$

ISOBARIC

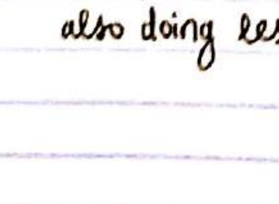


$\Delta P = 0$
$\Delta V > 0$
$\Delta T > 0$

$T_0 < T_1$ read the all-telling graph

ADIABATIC, $Q=0$ $\Delta E_{int} = W$

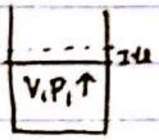
no heat can flow in or out of system



(it's not on isotherm.)
faster b/c W → ΔEint. → ΔT
also doing less work.

work (isotherm)

slow process: $dW$



$dW = F \cdot d\ell$

$W = \int_{\text{state 1}}^{\text{state 2}} F \cdot d\ell$

$F = P \cdot A$

$dW = P \cdot A d\ell$

$dW = P dV$

$$\boxed{W = \int_{V_1}^{V_2} P dV}$$ area under the curve

state variable depends only on initial & final state

e.g. potential energy

$E_{int}$ ($\Delta T$)

work is not a
state variable
(because $d\ell$)
dependent on path
taken
heat is not either.