examin change in E with time

$\frac{dE}{dt}$ $E = H$ in mech.

explicit time dep $\lambda(t)$ $\frac{dH}{dt} = \frac{\partial H}{\partial t}$

$$\frac{dE}{dt} = \frac{\partial E}{\partial t} = \frac{\partial E}{\partial \lambda}\frac{d\lambda}{dt}$$

assume $\dot{\lambda}$ is small; $\overline{E} \rightarrow$ thermo energy

$$\frac{dE(S)}{dt} = \frac{\partial E}{\partial \lambda}\frac{d\lambda}{dt}$$

λ: P, V, ... E(S)

slowly $dE = \left(\frac{\partial E}{\partial S}\right)_\lambda dS + \left(\frac{\partial E}{\partial \lambda}\right)_S d\lambda$

redefine temp as

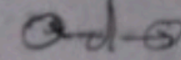
$$\left(\frac{\partial E}{\partial S}\right)_\lambda = \frac{1}{T}$$

Thermodynamic identity

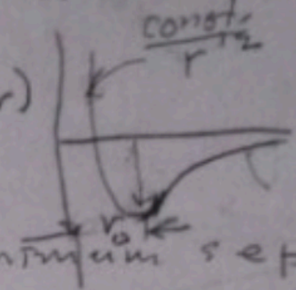
n = number density = $\frac{\#\text{ of part}}{\text{volume occupied}}$

$V \sim L^3$; $n^{-1/3}$ average part. seperation

$\Rightarrow$ different phases



V(r) interpart. pot.



vander waals $V(r) = -\frac{\text{const.}}{r^6}$

6-12 potential

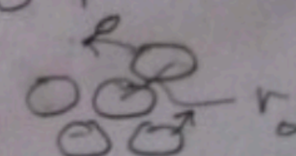
in addition have K.E.

KE/part $\sim k_B T$

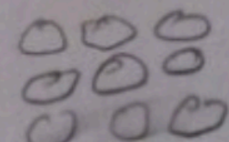
when cold atoms

$n^{-1/3} \sim r_0$

liquid



solid



gas K.E. dominant

three phases: gas, liquid, solid

now $r_0 \sim a$ atom diameter

liquid & solid have equilib volume