Energy

Internal energy - all ways energy can be stored, noted as U

$$U_{Total} = U_{KE} + U_{vibration} + U_{PE} + U_{CE} + \ldots$$

ΔU is more relevant for seeing how much is gained or lost

↳ units of Energy?. $1 J = 1 \frac{kg \cdot m^2}{s^2}$

1st Law of Thermodynamics

$$\Delta U_{universe} = \Delta U_{system\,(sys)} + \Delta U_{surroundings\,(surr)} = \underline{\underline{0}}$$

energy cannot be created or destroyed! only transferred

↓

what are some types of systems?

- isolated = no E, no mass exchange
- closed = E exchange, no mass exchange
- open = E, mass exchange

→ so what? work and heat

$$\Delta U = q + w$$

- q ↑ heat = random particle motion
- w ↑ work = non-random particle motion

ΔU: stored

$q + w$: transferred

Equilibrium

def: variables remain constant with respect to time and are <u>uniform</u> throughout system

examples: thermal, mechanical

State variables

only depend on the state of the system!
examples = T, P, N, U, H, S, etc.

↓

what is state? independent of the history of the system (path-independent)

what is path-<u>dependent</u>? heat (q)
work (w)

↓ use these to form . . .

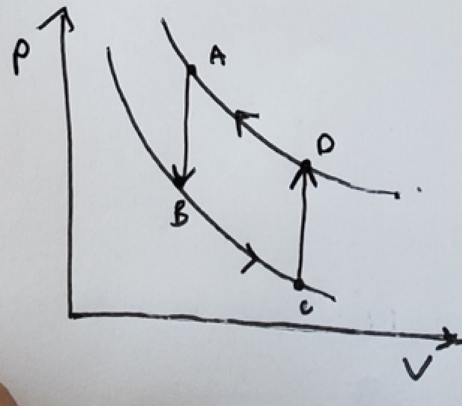
equations of state: examples

volume [V] = $f_1(n, P, T)$
pressure [P] = $f_2(n, V, T)$ } → $PV = nRT$

↓ can combine these via . . .

process: involves a change in the state functions defining a system

example:



★ <u>how</u> a transition occurs matters

Reversible vs. Irreversible Transitions ③

reversible:
- process can be "reversed" through infiressimal changes to sysrem
- no loss, or dissipation of energy
  - ↳ does not exist in the real world

irreversible:
- process that is non-reversible
- can never reach the original state from its final state
- system passes through a series of non-equilibrium states
- describes real-world processes

Kinetic theory of gases

- translational kinetic energy = energy due to motion from one location to another

$E = \frac{3}{2} k_b T$

T = temperature
k_B = Boltzmann's constant

↓

Ideal Gas Law → $PV = nRT$

1) do not attract or repel each other
2) molecules do not take up volume
↳ 3) volume of the individual gas particles is negligible compared to volume of the gas
4) collisions between particles & container walls & between particles themselves are elastic