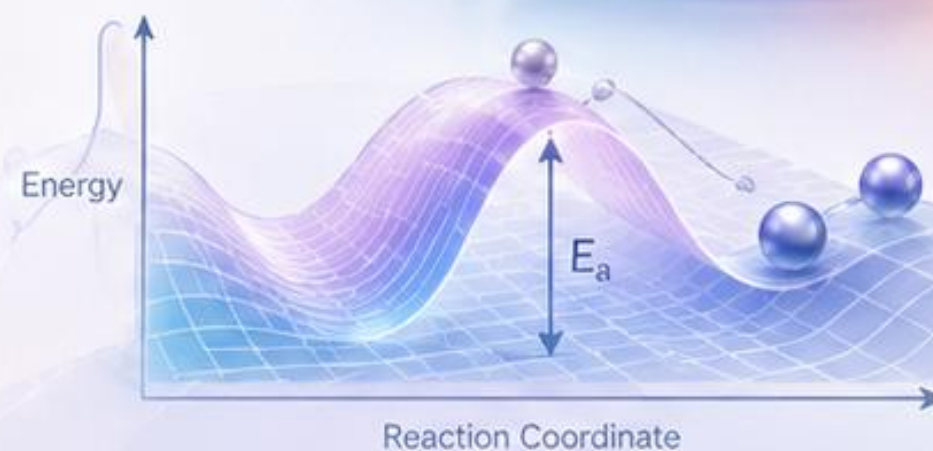
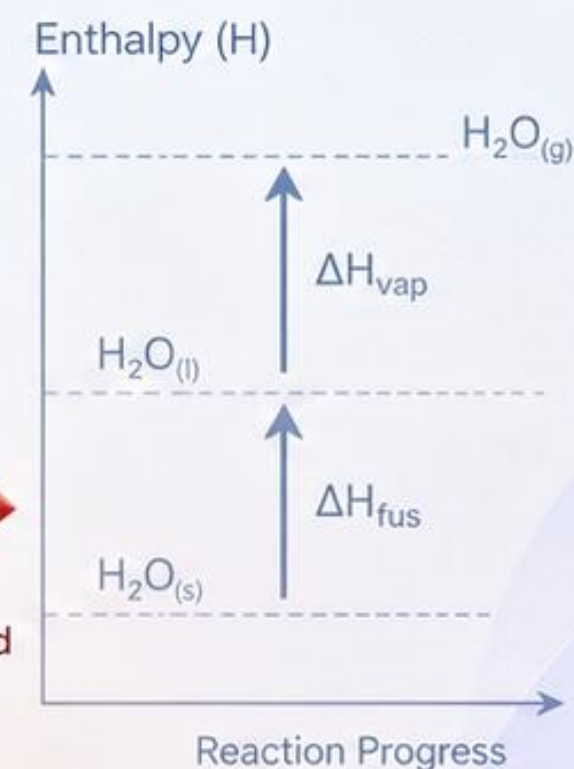


Heat Absorbed

$q = mc\Delta T$

Heat Released

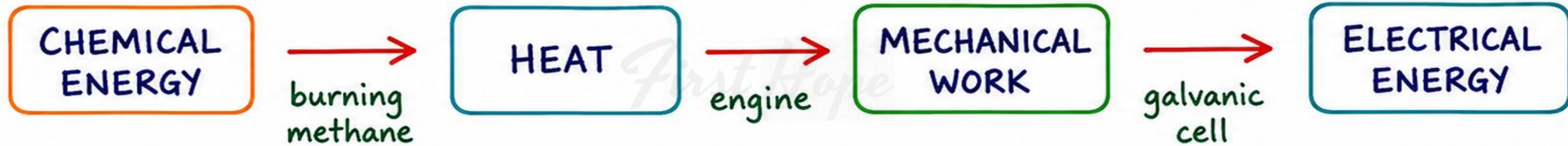


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THERMODYNAMICS — ENERGY AND CHANGE

- Thermodynamics studies energy changes during physical and chemical processes.
- It deals with macroscopic systems containing a very large number of particles.
- It uses the initial and final equilibrium states; it does not describe the detailed path or rate.



MAIN QUESTIONS

1. How much energy changes?
2. Will the process occur?
3. What drives it?
4. How far will it proceed?

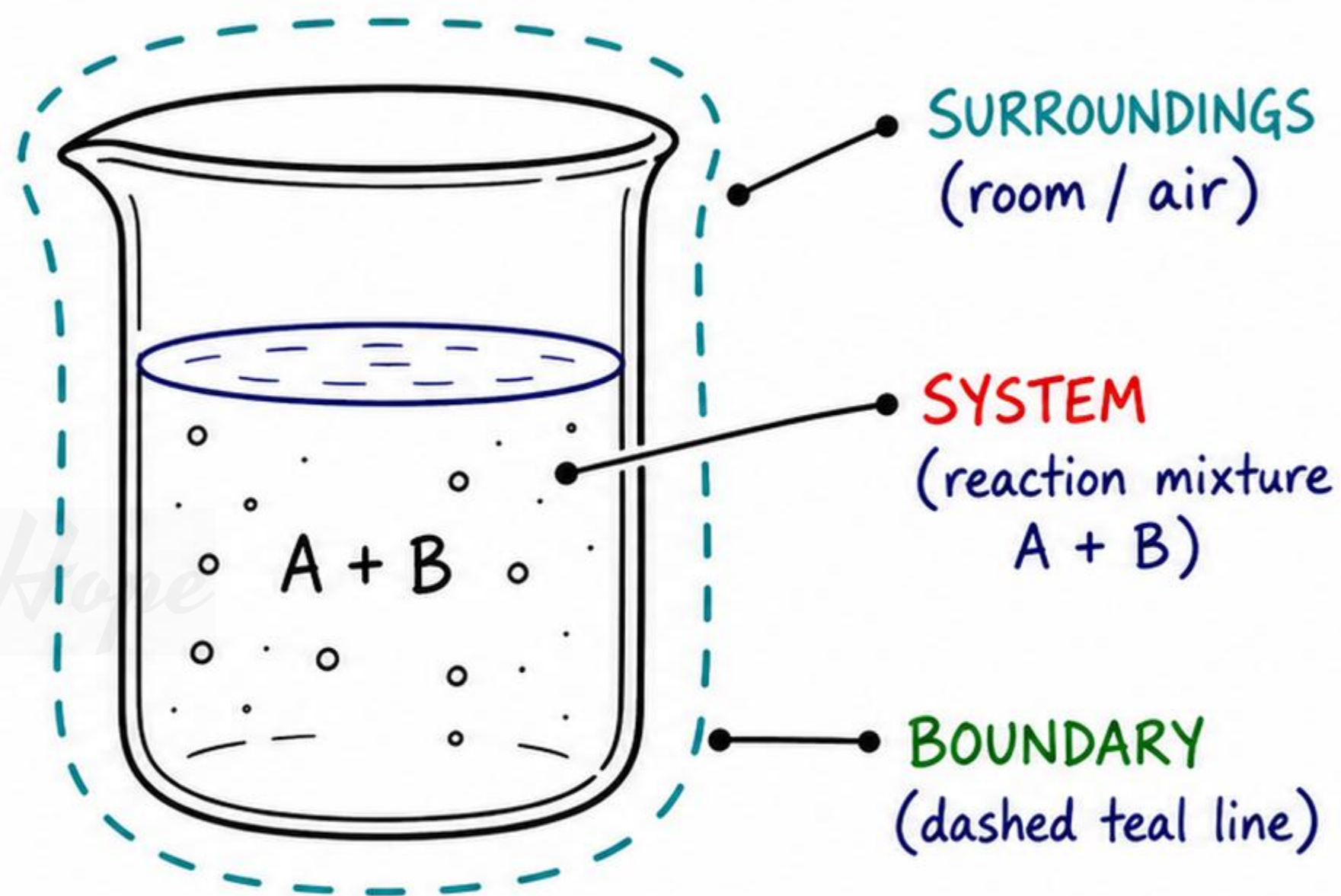
☆ At equilibrium, macroscopic properties such as pressure and temperature do not change with time.

SYSTEM, SURROUNDINGS AND BOUNDARY

- **System**: the part of the universe selected for observation.
- **Surroundings**: everything outside the system that can interact with it.
- **Boundary**: the real or imaginary surface separating system and surroundings.

UNIVERSE = SYSTEM + SURROUNDINGS

- ① A boundary may be physical (beaker wall) or imaginary (chosen region in space).
- ② Matter and/or energy may cross the boundary, depending on the system type.

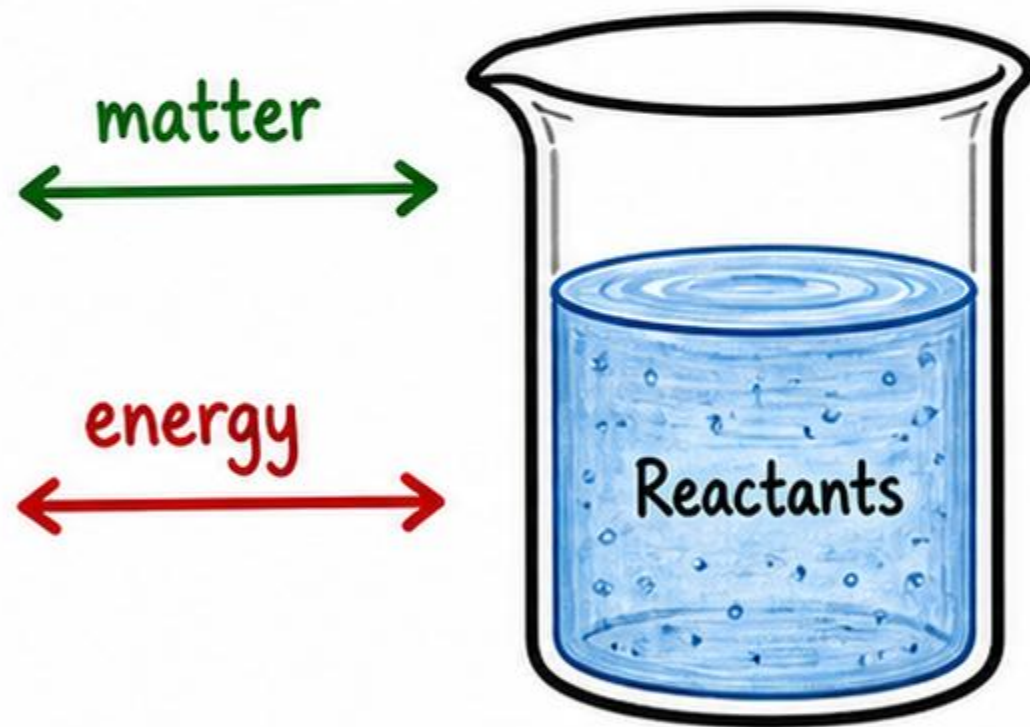


Define the system clearly before tracking energy or matter.

OPEN, CLOSED AND ISOLATED SYSTEMS

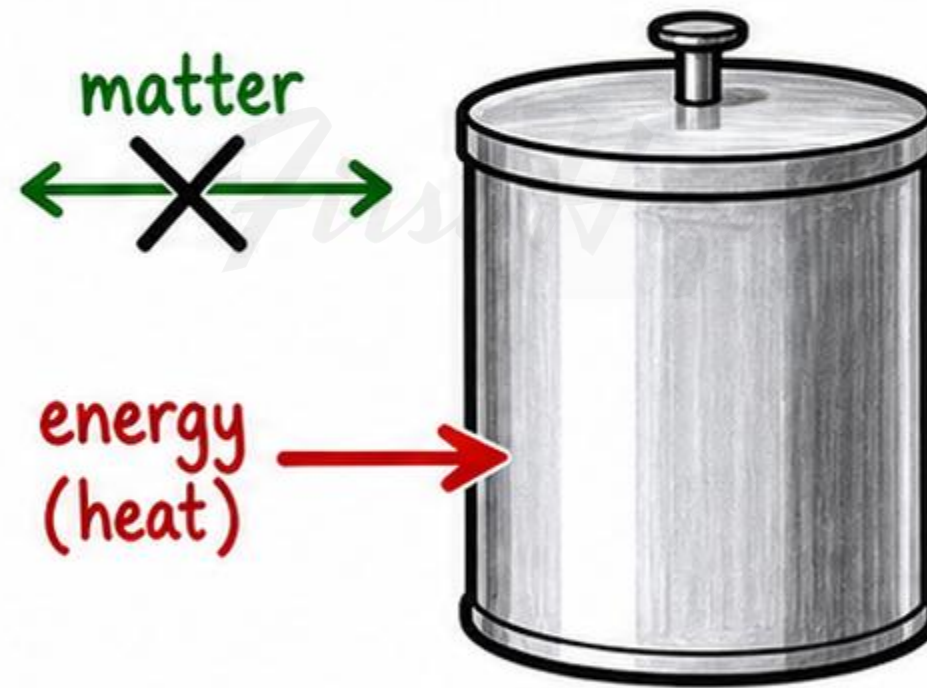
OPEN SYSTEM:

- Exchanges matter AND energy.
- Example: reactants in an open beaker.



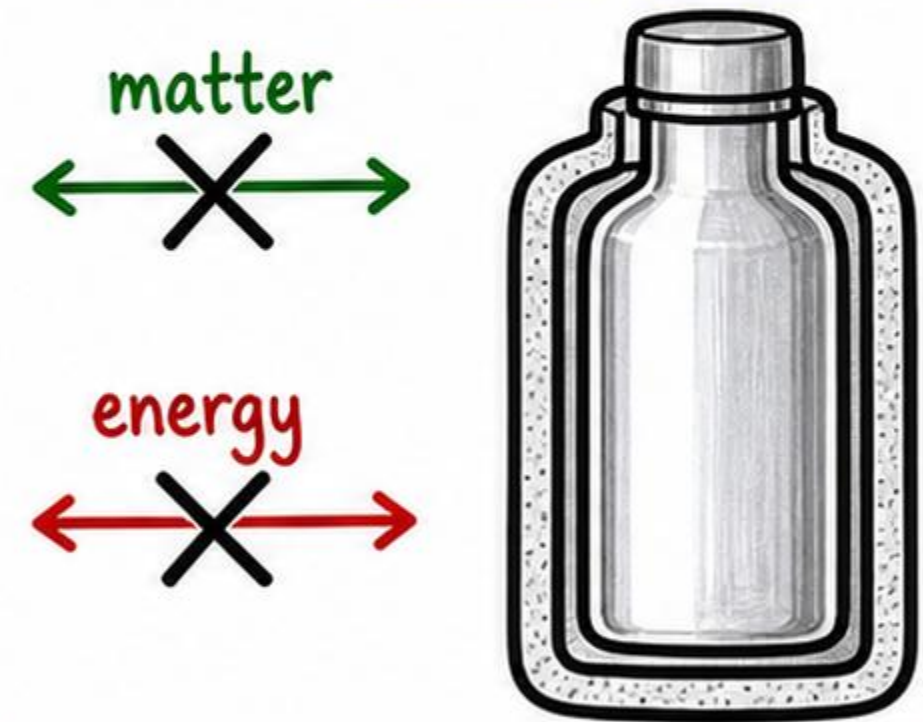
CLOSED SYSTEM:

- Exchanges energy, but NOT matter.
- Example: sealed conducting vessel.



ISOLATED SYSTEM:

- Exchanges neither matter nor energy.
- Example: ideal thermos / closed insulated vessel.

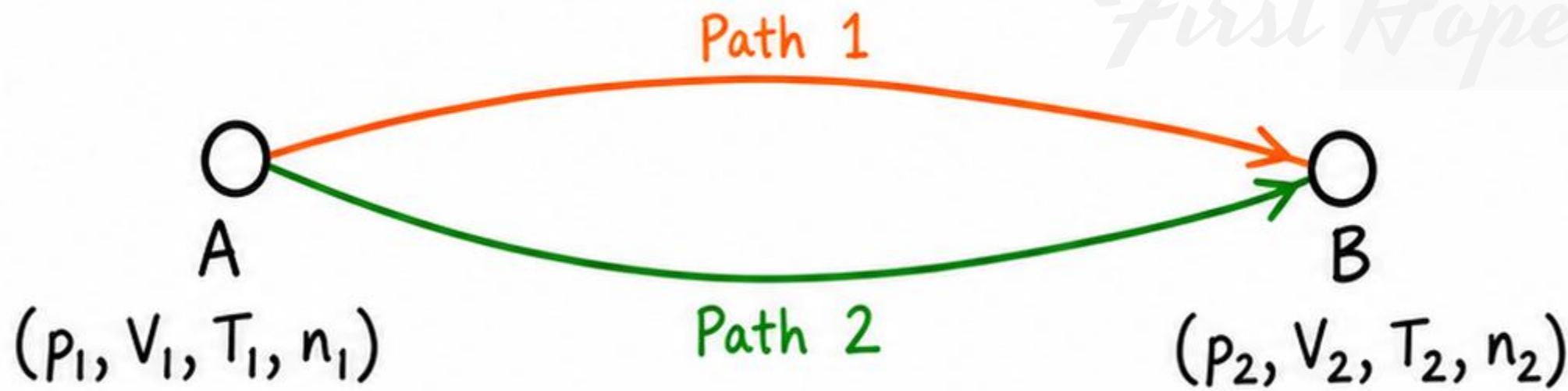


	OPEN SYSTEM	CLOSED SYSTEM	ISOLATED SYSTEM
matter	✓	✗	✗
energy	✓	✓	✗

STATE OF A SYSTEM AND STATE VARIABLES

- The state of a system is described by measurable macroscopic properties.
- Common state variables: pressure p , volume V , temperature T , amount n and composition.
- A state function depends only on the present state—not on how that state was reached.

STATE A: p_1, V_1, T_1, n_1 $\longrightarrow$ STATE B: p_2, V_2, T_2, n_2



same change in a state function.

EQUILIBRIUM

- Macroscopic properties do not change with time.
- Only a minimum number of independent properties is needed; the others then have definite values.

Examples of state functions: U , H , p , V and T .



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