

5.1.2 Types of the System

Classifying thermodynamic systems by the movement of matter and energy across boundaries.

- **System:** The specific part of the universe under observation.
- **Surroundings:** The rest of the universe that can interact with the system.
- **Boundary:** The real or imaginary wall separating the two.

1. The Open System

Definition

An open system allows the exchange of both energy and matter with its surroundings.

$$\Delta \text{ Matter} \neq 0 \mid \Delta \text{ Energy} \neq 0$$

Matter Flow: **YES**

Energy Flow: **YES**



Example: The presence of reactants in an open beaker. Mass can evaporate or be added; heat can be absorbed or lost to the room.

2. The Closed System

Definition

A closed system allows the exchange of energy (heat and work) but prevents the exchange of matter with its surroundings.

$$\Delta \text{ Matter} = 0 \mid \Delta \text{ Energy} \neq 0$$

Matter Flow: **NO**

Energy Flow: **YES**



Example: The presence of reactants in a closed vessel made of copper or steel. The lid prevents mass from escaping, but the thermally conducting metal walls allow heat transfer.



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$$E=mc^2$$



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3. The Isolated System

Definition

An isolated system completely prevents the exchange of both energy and matter with its surroundings.

$$\Delta \text{ Matter} \neq 0 \mid \Delta \text{ Energy} \neq 0$$

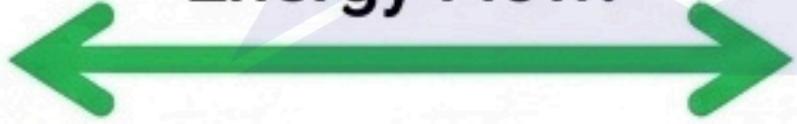
Matter Flow: **NO**

Energy Flow: **NO**



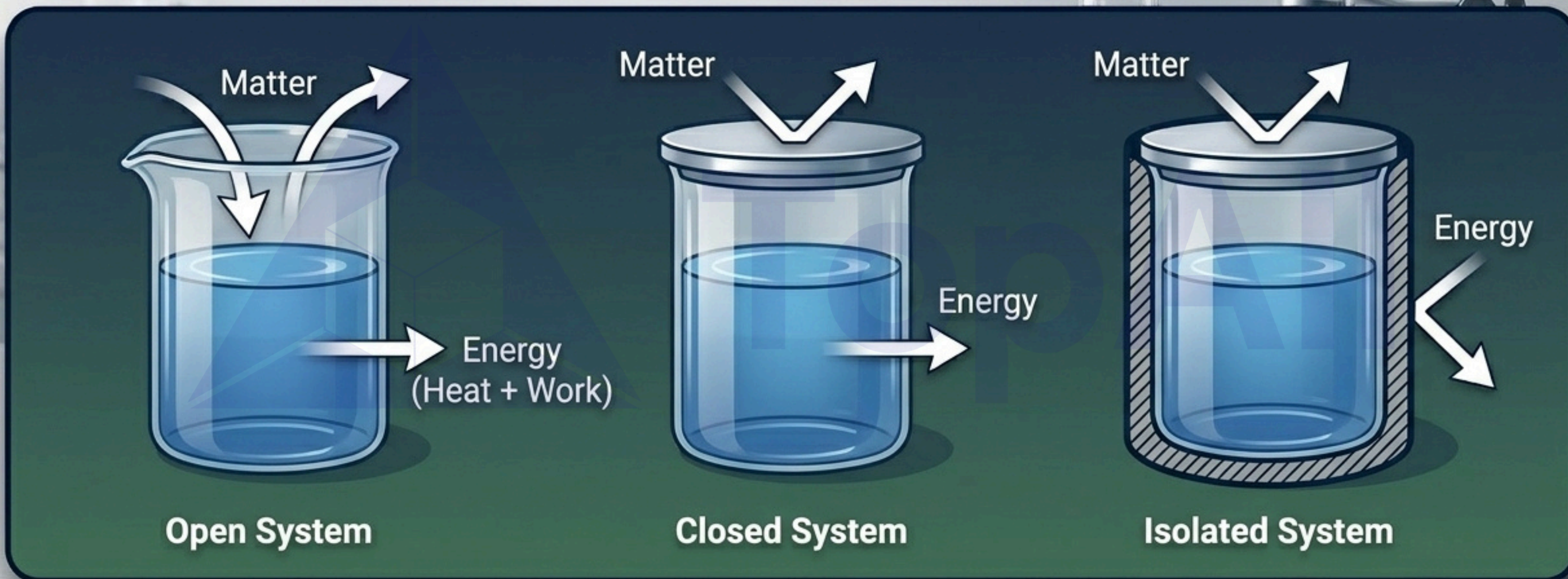
Example: The presence of reactants in a thermos flask. The sealed lid stops matter; the vacuum/insulation stops heat. The internal energy (U) remains constant.

Matter Flow vs. Energy Flow

Open System	Closed System	Isolated System
Matter Flow:  (Exchanges with surroundings) Energy Flow:  (Exchanges with surroundings)	Matter Flow:  (Trapped within system) Energy Flow:  (Exchanges with surroundings)	Matter Flow:  (Trapped within system) Energy Flow:  (Trapped within system)

Exam Tip: The state of an isolated system cannot be affected by its surroundings. Because there is no transfer of energy as heat or work, if $w = 0$ and $q = 0$, then the change in internal energy $\Delta U = 0$.

Open, Closed, and Isolated Systems Compared



Reference: NCERT Fig. 5.2

System = Blue Liquid

Surroundings = Green/Navy Background



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