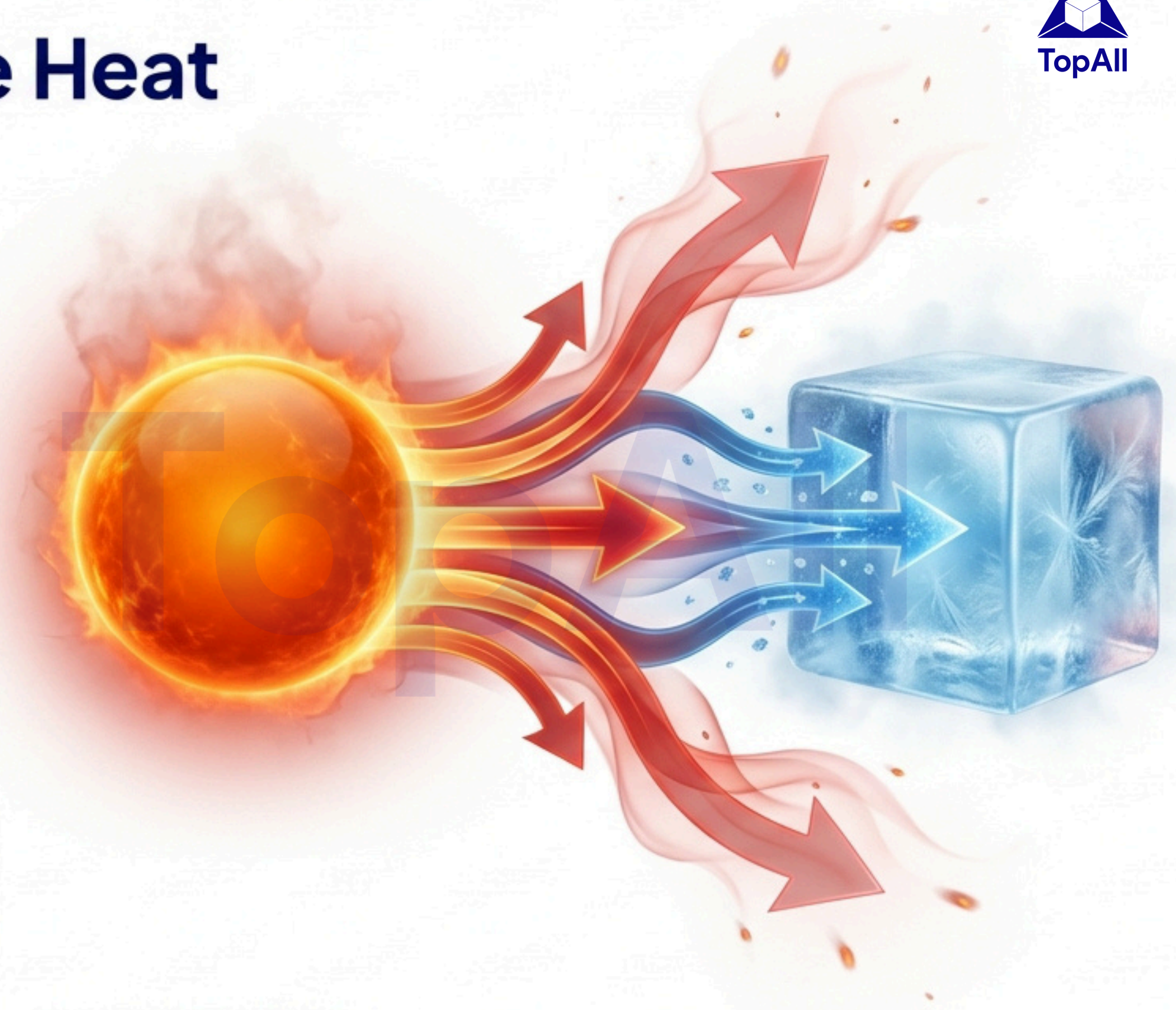


How Do We Measure Heat That We Can't See?

Heat is an invisible transfer of energy. To measure it, we have to trap it.

When a hot body meets a cold body, heat flows. But without the right environment, this heat escapes into the surrounding air, making accurate measurement impossible.

The Solution: We need a strictly controlled environment where zero energy escapes.



H1. The Foundation: Isolated Systems

1. Definition:

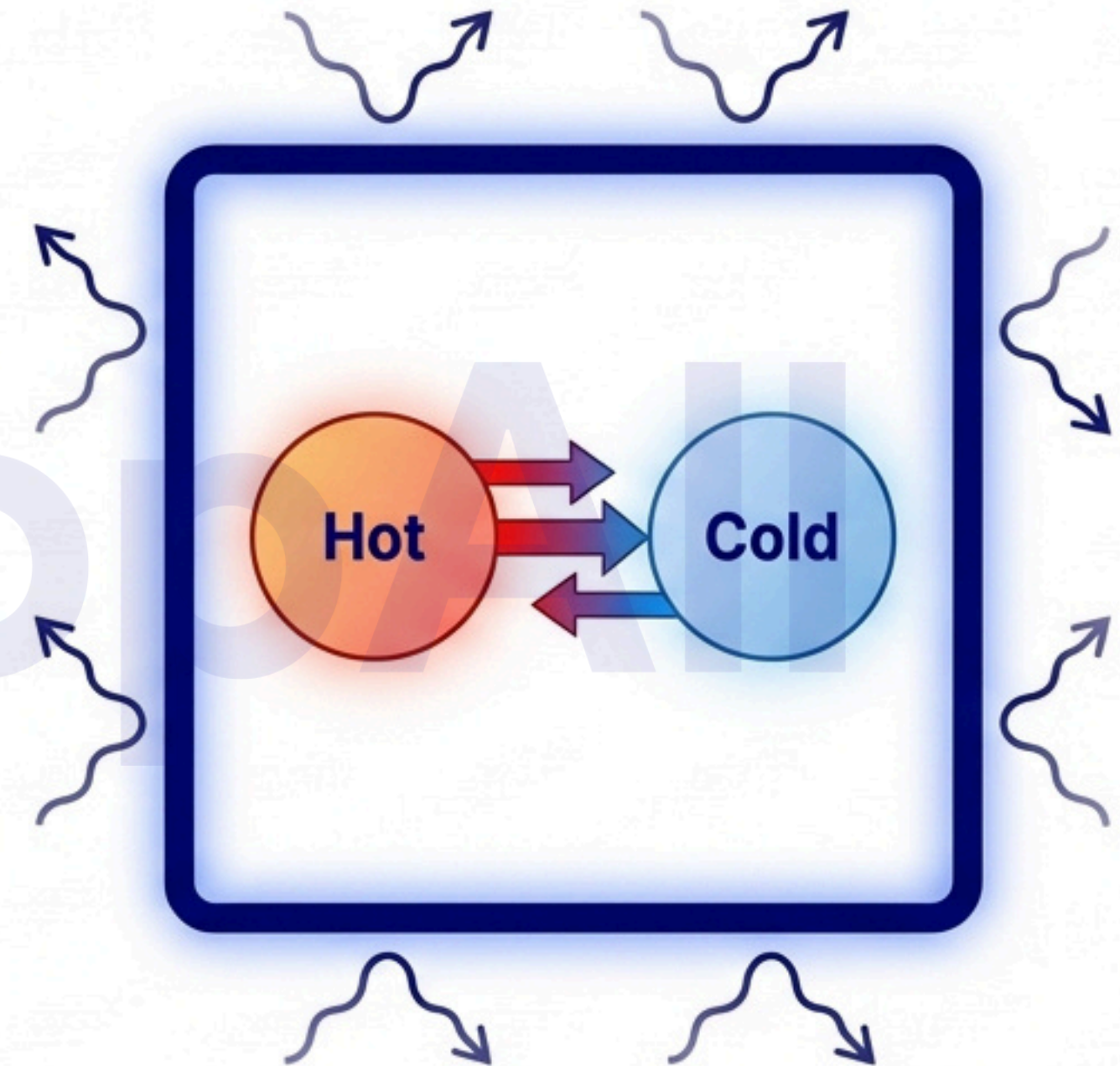
An **Isolated System** is an environment where **NO** exchange or transfer of heat occurs between the system and its surroundings.

2. The Rule of Equilibrium:

When different parts of an isolated system are at different temperatures, heat transfers only from the higher temperature part to the lower temperature part.

3. The Result:

The entire system eventually reaches a single, uniform steady state temperature.



Inside the Calorimeter (Fig. 10.20 Reference)



Core Components:

Metallic vessel and stirrer (usually highly conductive copper or aluminum).



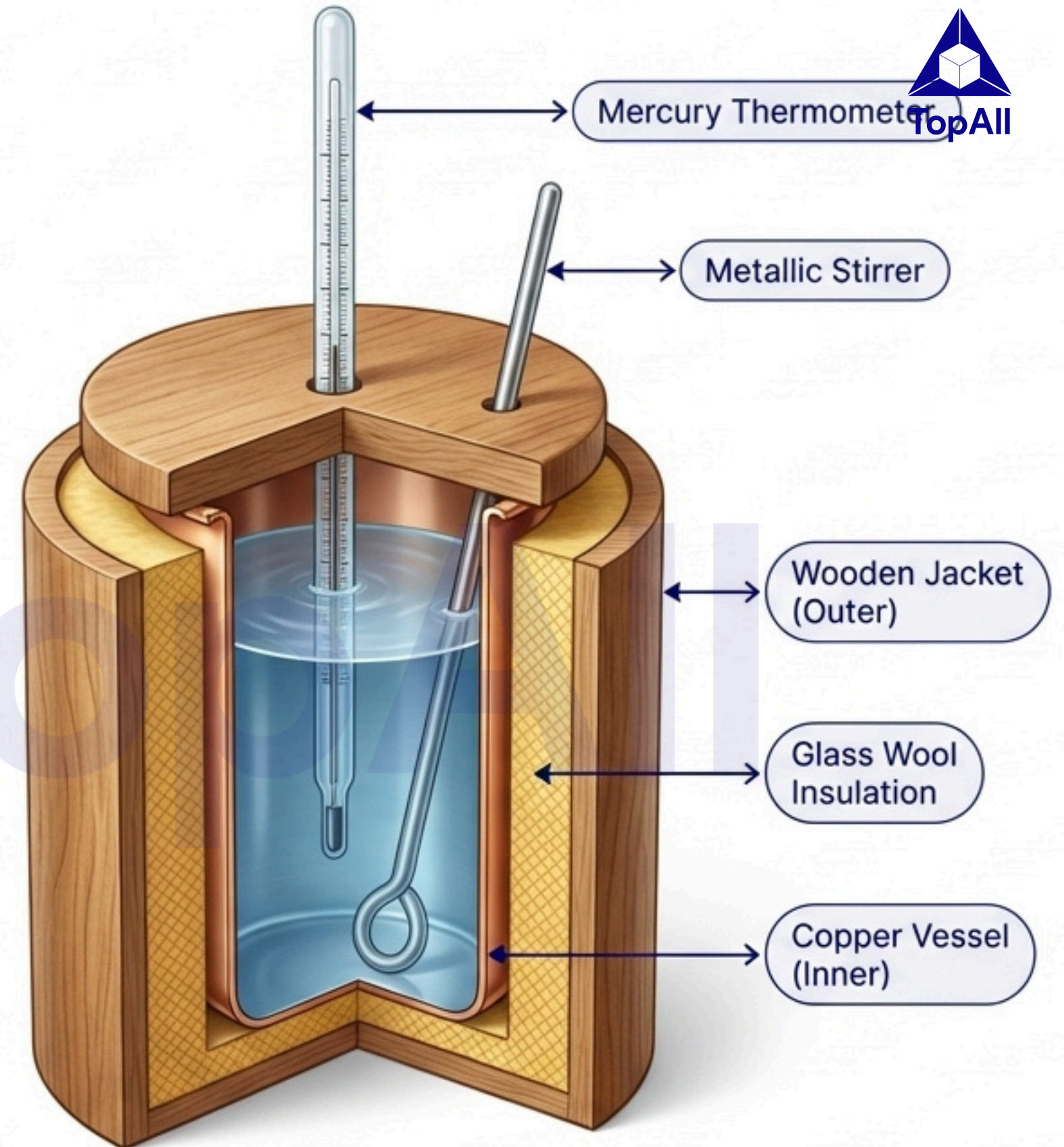
The Heat Shield:

Wooden jacket containing heat insulating material (e.g., glass wool) to reduce heat loss.

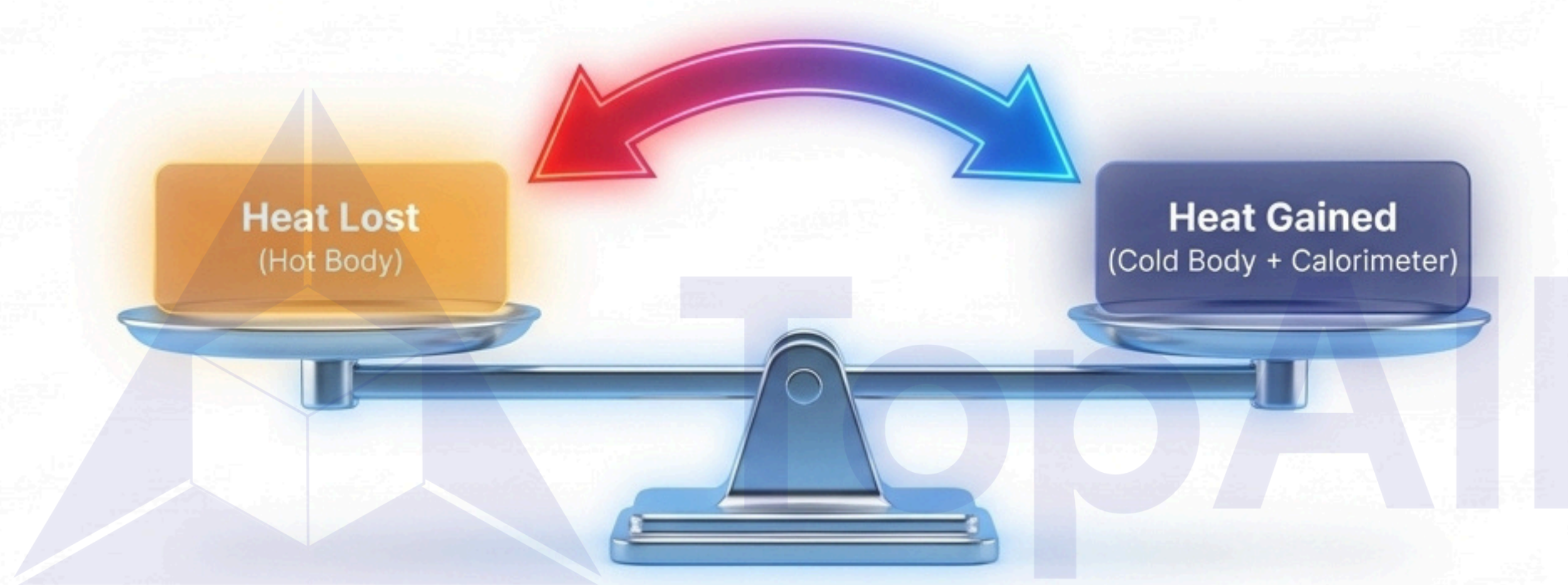


The Sensor:

An opening in the outer jacket for a mercury thermometer to track the steady state.



The Principle of Calorimetry



$$m_{\text{hot}} \cdot s_{\text{hot}} \cdot \Delta T_{\text{hot}} = m_{\text{cold}} \cdot s_{\text{cold}} \cdot \Delta T_{\text{cold}}$$



Note: If a calorimeter is involved, the vessel itself also gains heat alongside the cold liquid inside it.

Application: Example 10.3

The Setup: 0.047 kg Al sphere (100°C) dropped into a 0.14 kg Copper calorimeter containing 0.25 kg water (20°C). Steady state = 23°C.



Step 1: Heat Lost
(Aluminum)

$$0.047 \times s_{Al} \times (100 - 23)$$



Step 2: Heat Gained
(Water + Copper)

$$(0.25 \times 4186 + 0.14 \times 386) \times (23 - 20)$$



Step 3:
Equate & Solve

$$s_{Al} = 0.911 \text{ kJ kg}^{-1} \text{ K}^{-1}$$

Practice more, score more

Module Summary

- ✓ **Isolated Systems:** Calorimetry requires a strictly controlled environment where no heat enters or leaves the system.
- ✓ **Calorimeter Design:** Utilizes a highly conductive metallic inner vessel, a stirrer, and heavy outer insulation (wood and glass wool) to trap energy and measure heat transfer accurately.
- ✓ **Conservation of Energy:** The foundational equation for all thermal accounting is always:
Heat Lost = Heat Gained by the hot body = Heat Gained by the cold body.