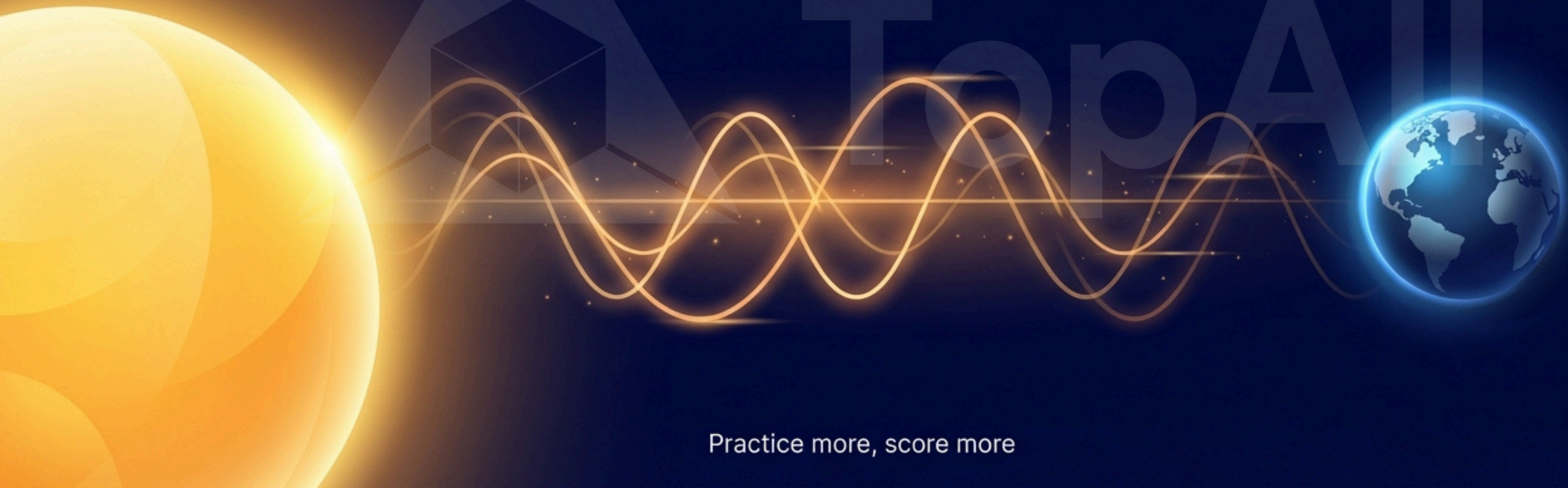


How Heat Travels Even Through Empty Space

Section 10.9.3: Radiation

Unlike conduction and convection, the Earth receives massive amounts of heat from the Sun across millions of miles of absolute vacuum.



Practice more, score more

Radiation: No Medium Required

Definition: The transfer of heat energy by electromagnetic waves. It requires no material medium to travel.

Speed: Travels at the speed of light. This explains why heat transfer by radiation is incredibly fast.

$$v = 3 \times 10^8 \text{ m/s}$$



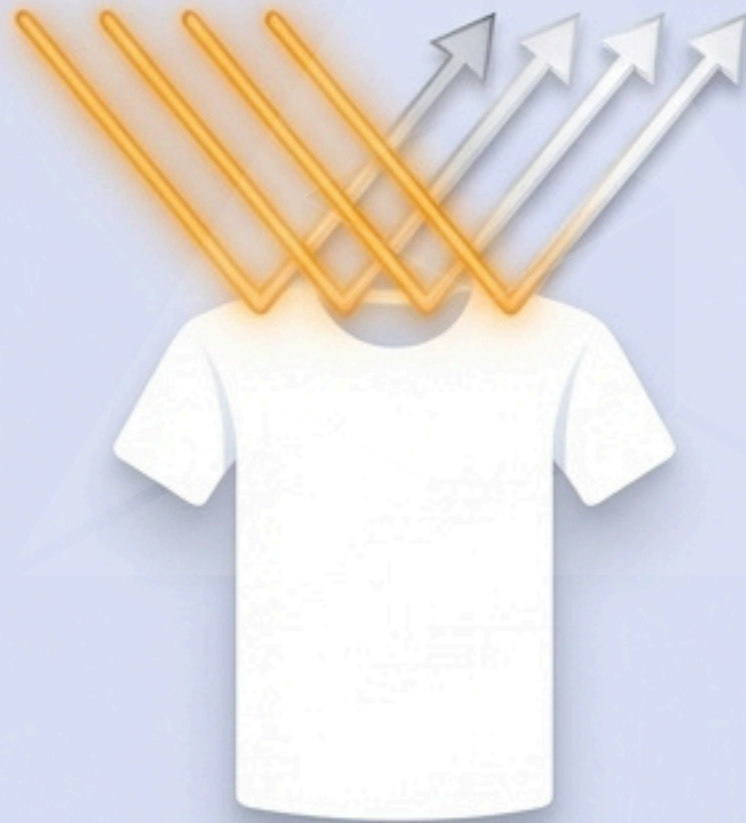
Universal Emission: All bodies emit radiant energy (thermal radiation) by virtue of their **temperature**, whether **solid, liquid, or gas**.

Absorption & Reflection: The Color Factor

When thermal radiation falls on a body, it is partly reflected and partly absorbed.
The amount absorbed depends heavily on color.

Summer (White/Light)

Reflects incoming heat.
Absorbs the least heat from the Sun.



Winter (Black/Dark)

Black bodies are excellent absorbers and emitters.
Absorbs heat from the sun to keep the body warm.



Why Cooking Pans Have Blackened Bottoms

The Design:

The bottoms of utensils for cooking food are intentionally blackened.

The Physics:

Blackened surfaces are superior absorbers of radiant energy.



The Result:

They absorb maximum heat from the fire and transfer it efficiently to the food.

The Dewar Flask (Thermos Bottle)

A device designed to minimize heat transfer, keeping hot contents hot and cold contents cold.

Silver Coating (Radiation)

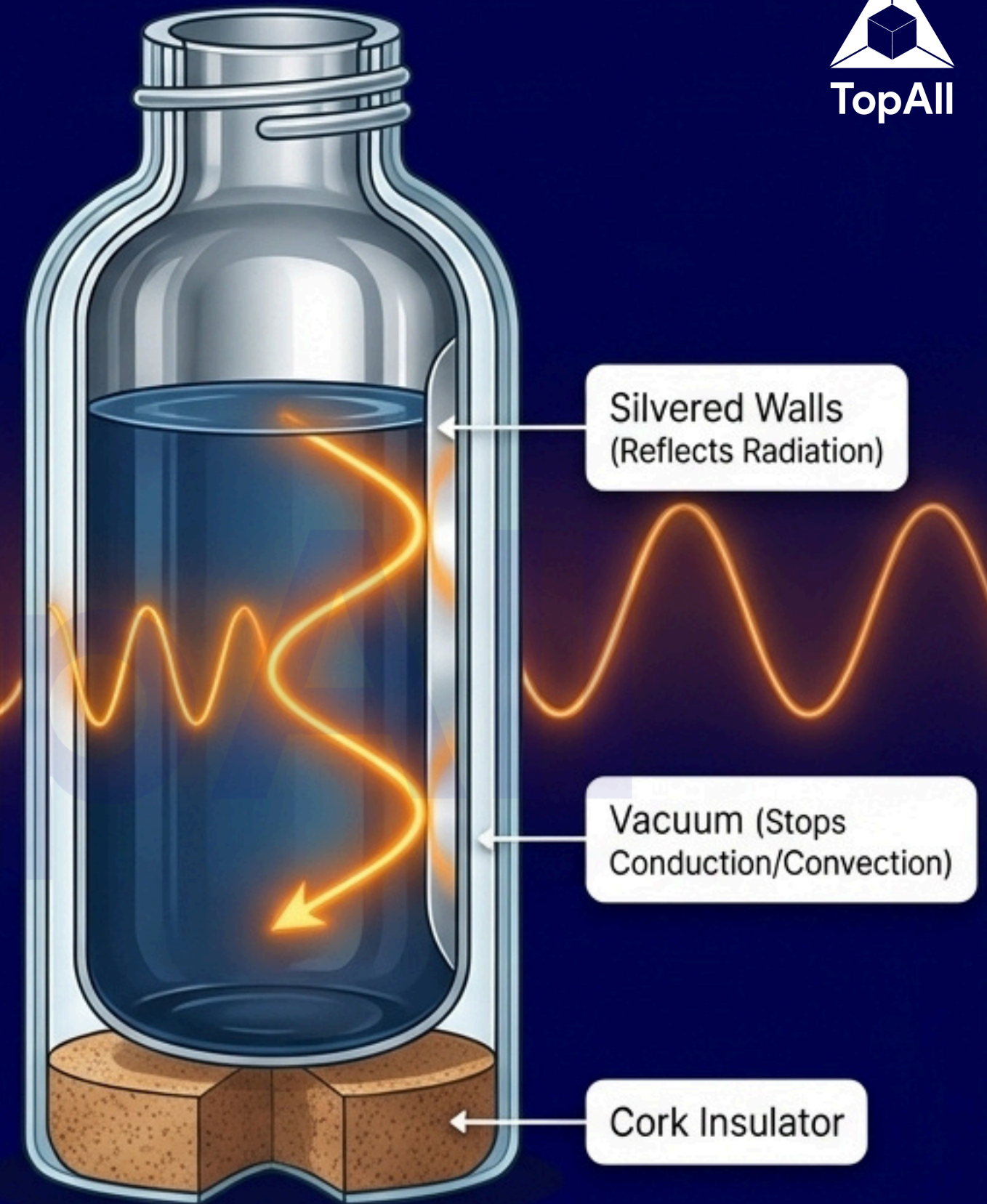
Inner and outer walls are coated with silver to reflect radiation back.

Evacuated Space (Conduction/Convection)

The vacuum between double glass walls prevents heat loss by conduction and convection.

Insulator Support

Supported on cork to prevent conductive heat loss to the base.



Key Takeaways

- ✓ **Speed & Medium:** Radiation transfers heat via electromagnetic waves at 3×10^8 m/s in a vacuum.
- ✓ **Universal Emission:** All bodies emit thermal radiation based on their temperature.
- ✓ **Color Dependency:** Dark/black bodies are the best absorbers and emitters; white/silver surfaces are the best reflectors.
- ✓ **Everyday Design:** We leverage these rules in summer/winter clothing, blackened cooking utensils, and the silvered walls of a Dewar flask.