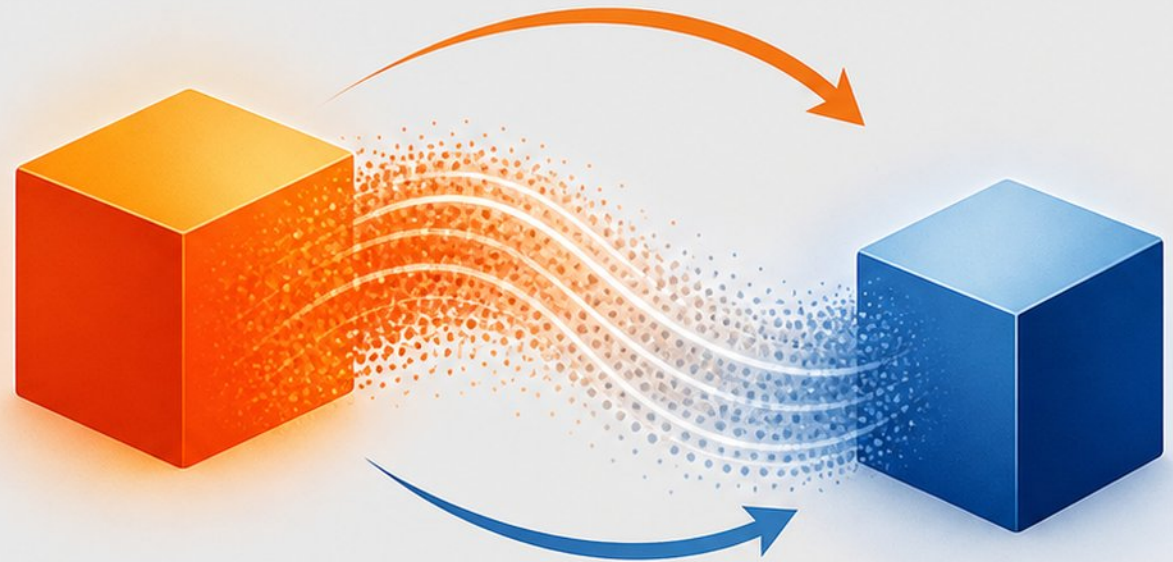


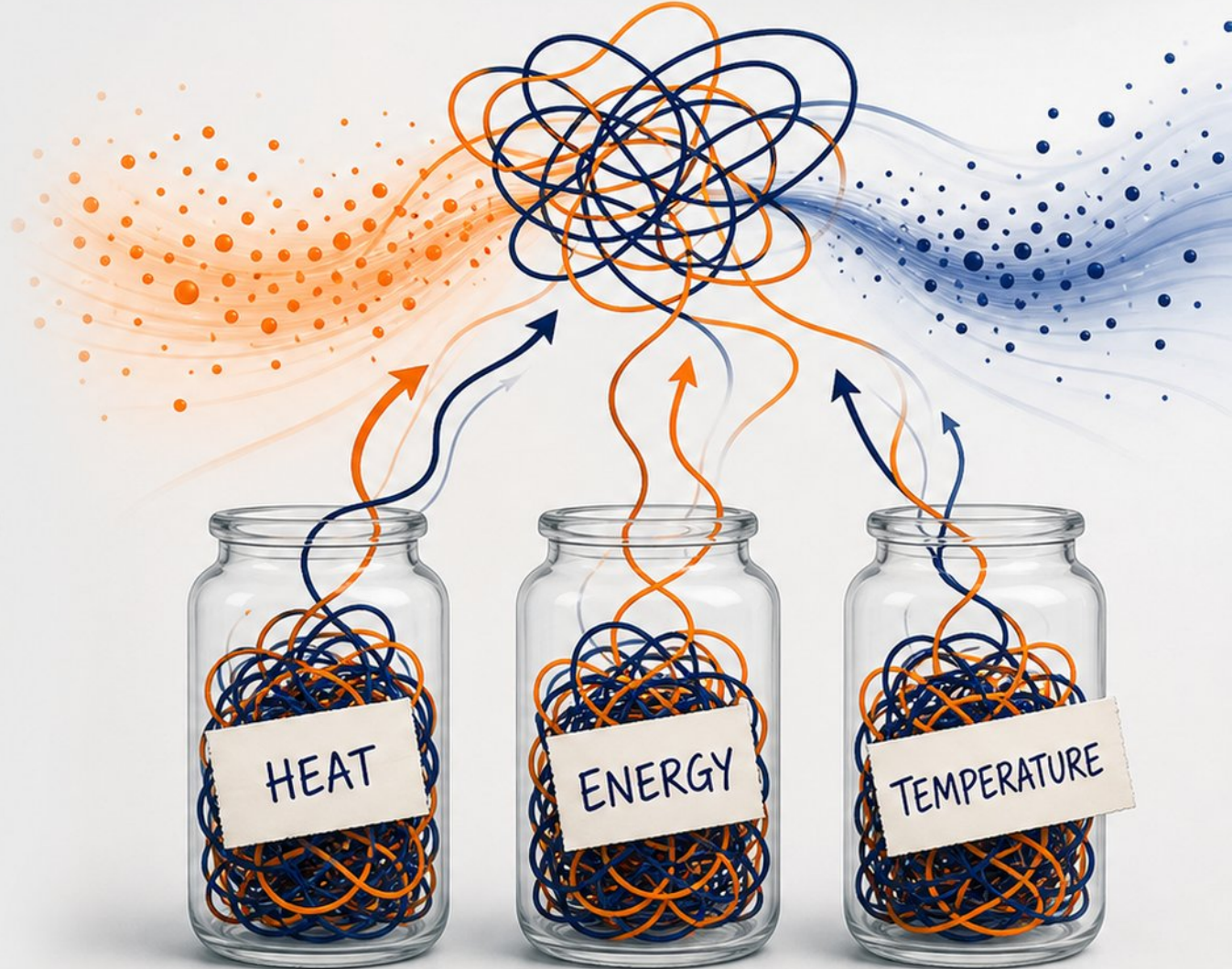
Heat and Temperature: How Thermal Energy Moves

- Distinguish heat, temperature, and thermal energy transfer
- Preview: "heat and temperature are the same" and other common myths
- After this session: differentiate and apply concepts correctly
- Core rule: heat is a process of energy transfer, not a substance objects "contain"



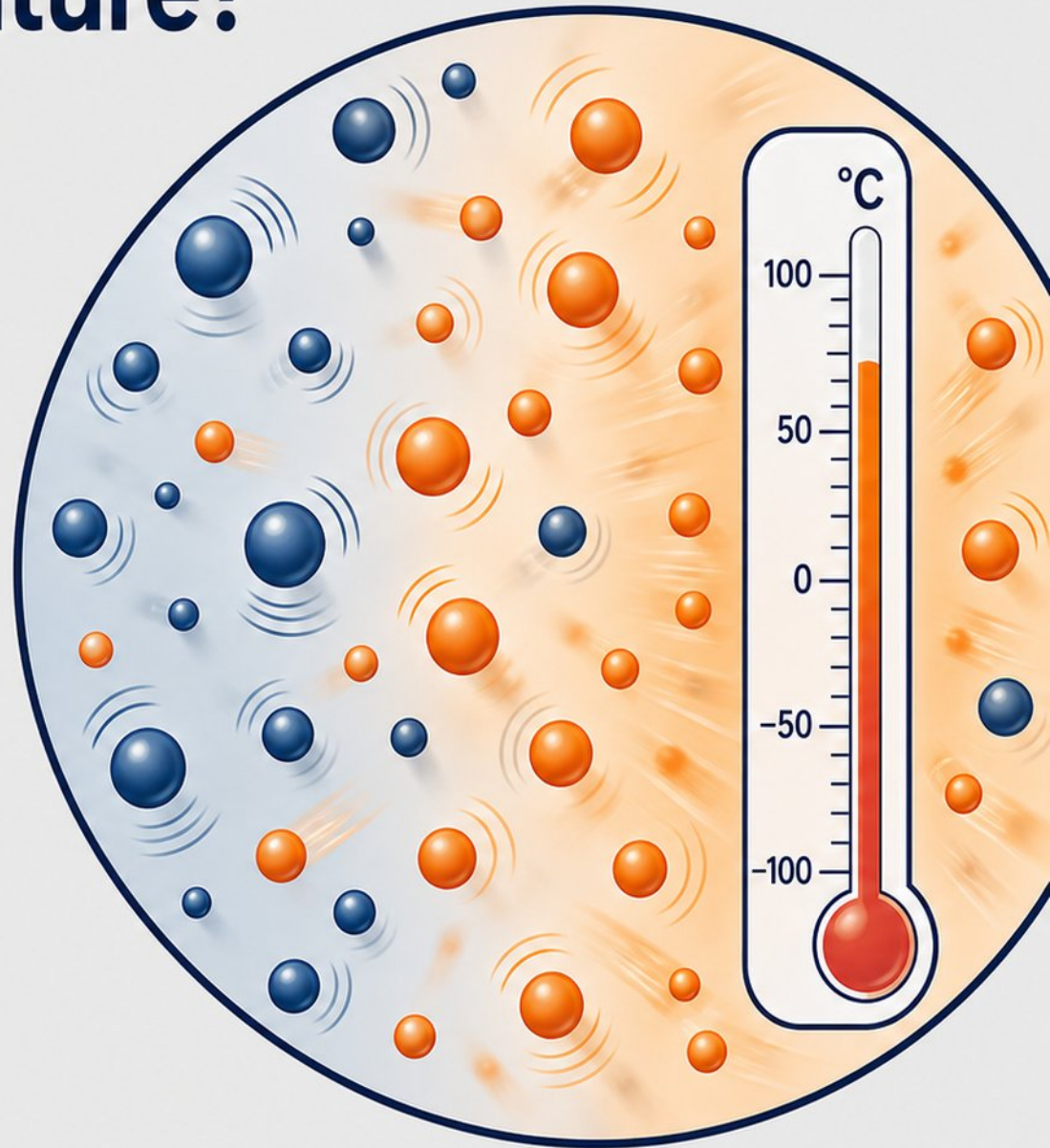
Why This Matters: The Cost of Common Confusions

- Confusing heat, energy, and temperature as interchangeable
- Mistaking rate of transfer for total amount transferred
- Misunderstanding modes: conduction, convection, radiation
- These errors persist from school through professional practice
- Goal: Build a mental model that survives real-world use



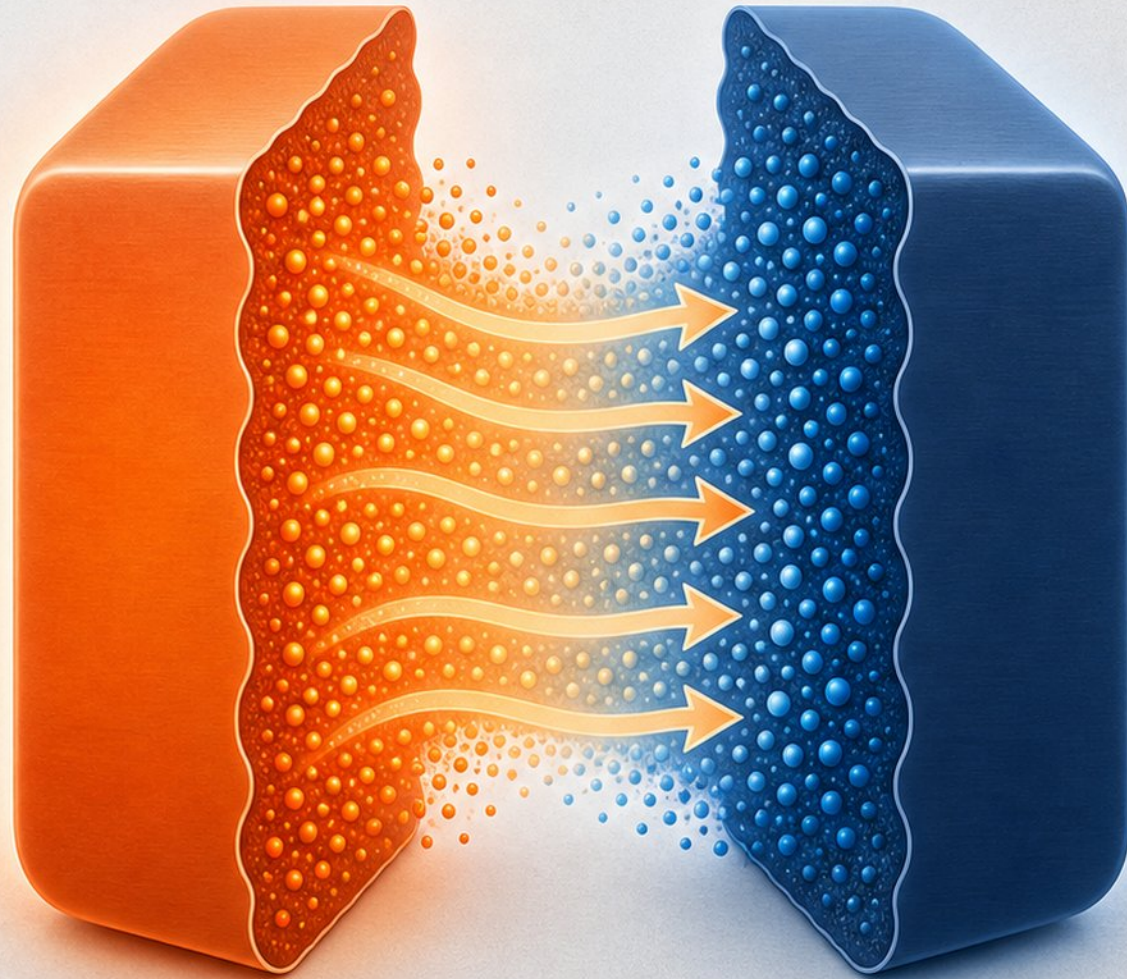
What Is Temperature?

- Measures average kinetic energy of particles in a substance
- Scales: Celsius, Fahrenheit, Kelvin – each with fixed reference points
- Thermometers sense expansion or electronic changes
- Intensive property: does not depend on mass or volume



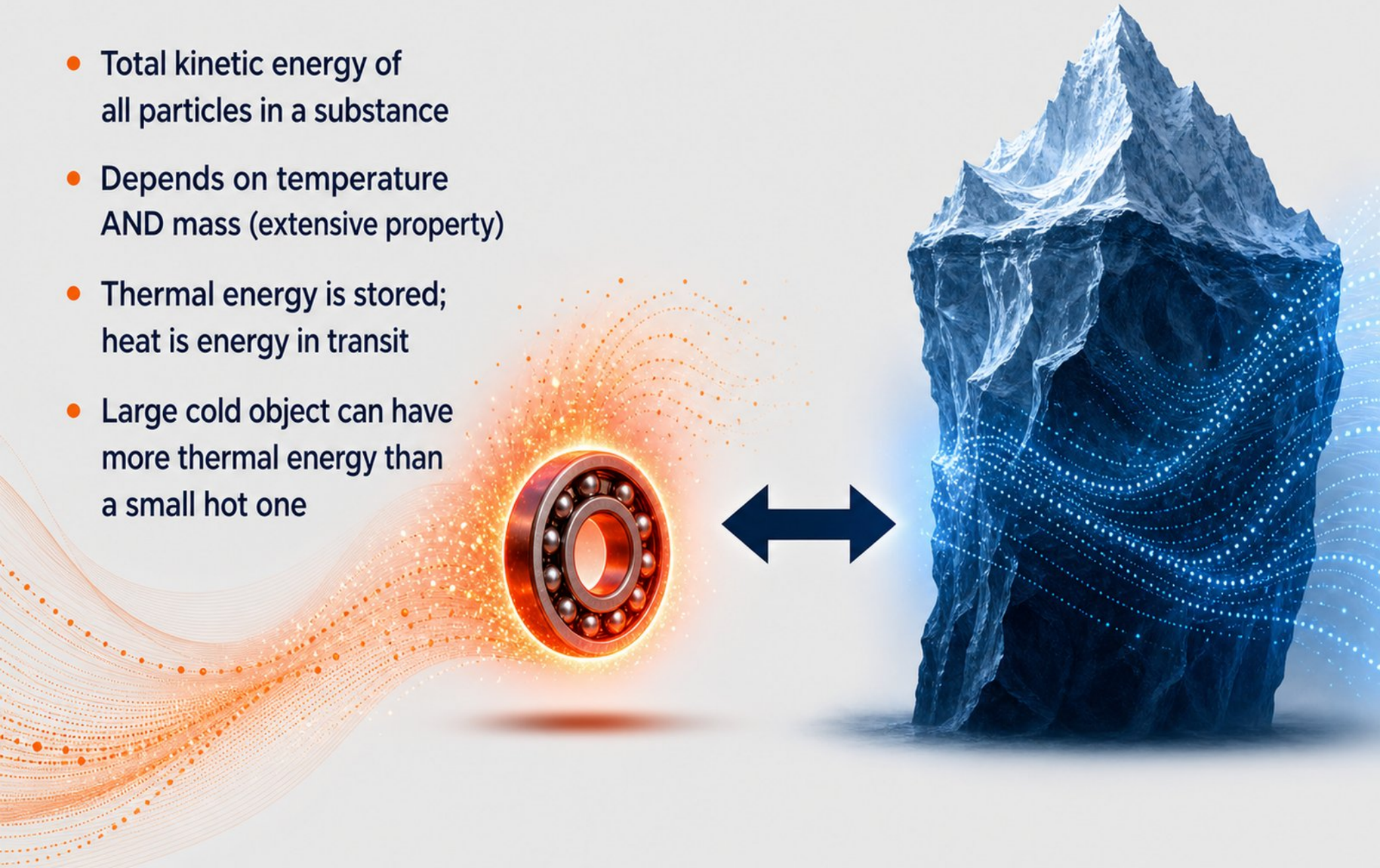
What Is Heat?

- Heat is energy transferred due to a temperature difference
- Heat flows spontaneously from hotter to colder—never reverse
- Units of heat: joules (J) and calories (cal)
- Heat is a transient process, not a property an object 'contains'



Thermal Energy: The Total Internal Energy of a Substance

- Total kinetic energy of all particles in a substance
- Depends on temperature AND mass (extensive property)
- Thermal energy is stored; heat is energy in transit
- Large cold object can have more thermal energy than a small hot one



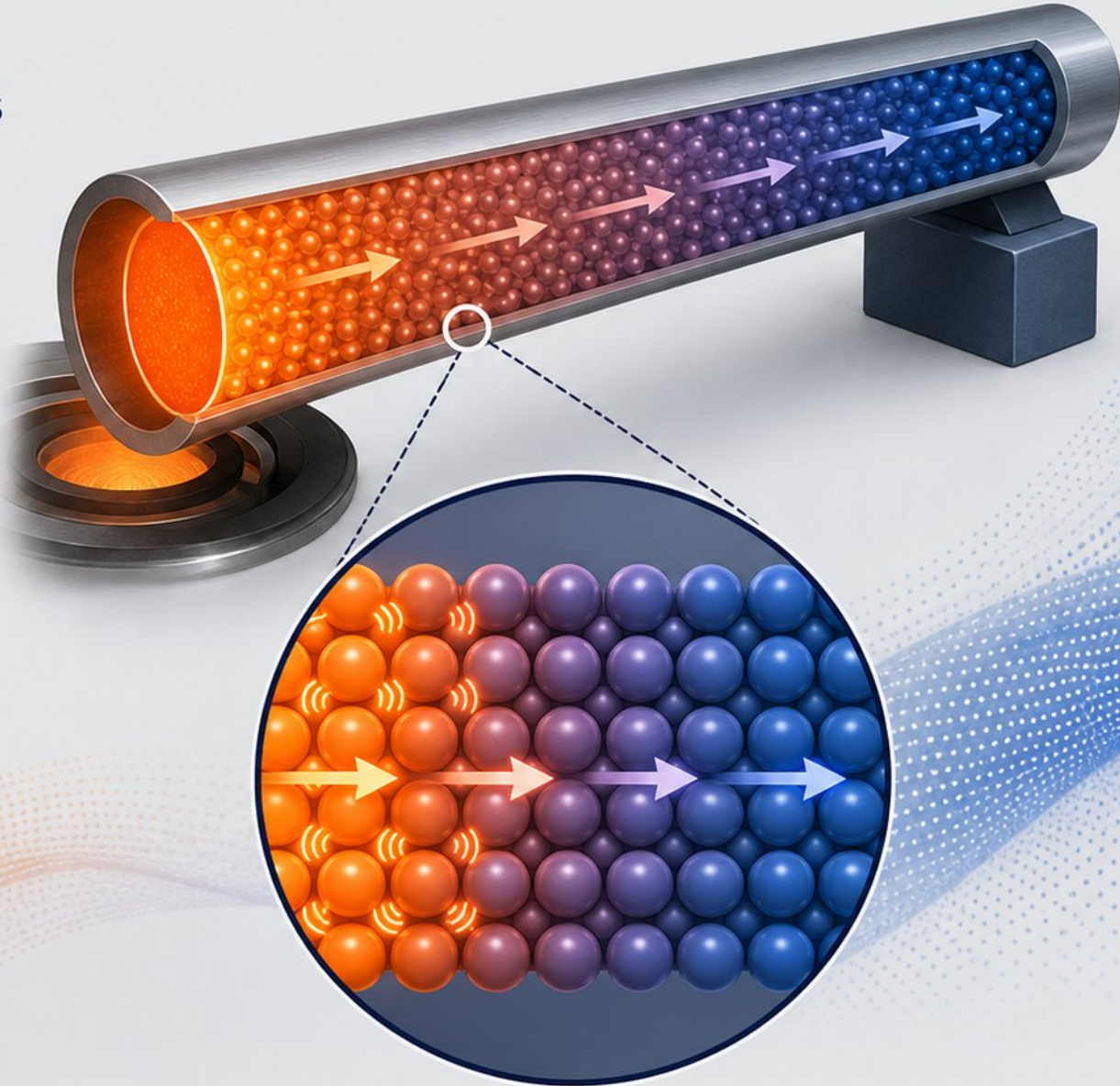
The Iceberg vs. the Hot Cup of Coffee



- - Compare: 1,000 kg iceberg at 0°C vs 1 kg coffee at 90°C
- - Iceberg has far greater total thermal energy due to its immense mass
- - Heat flows from hot coffee to cold iceberg, not the reverse
- - Direction is set by temperature, not total stored energy

How Thermal Energy Moves: Conduction

- Heat transfer through direct contact and particle collisions
- Predominantly in solids where particles are tightly packed
- Good conductors (metals) vs. insulators (wood, plastic, air)
- Everyday examples: a pan on a stove, a metal spoon in hot soup



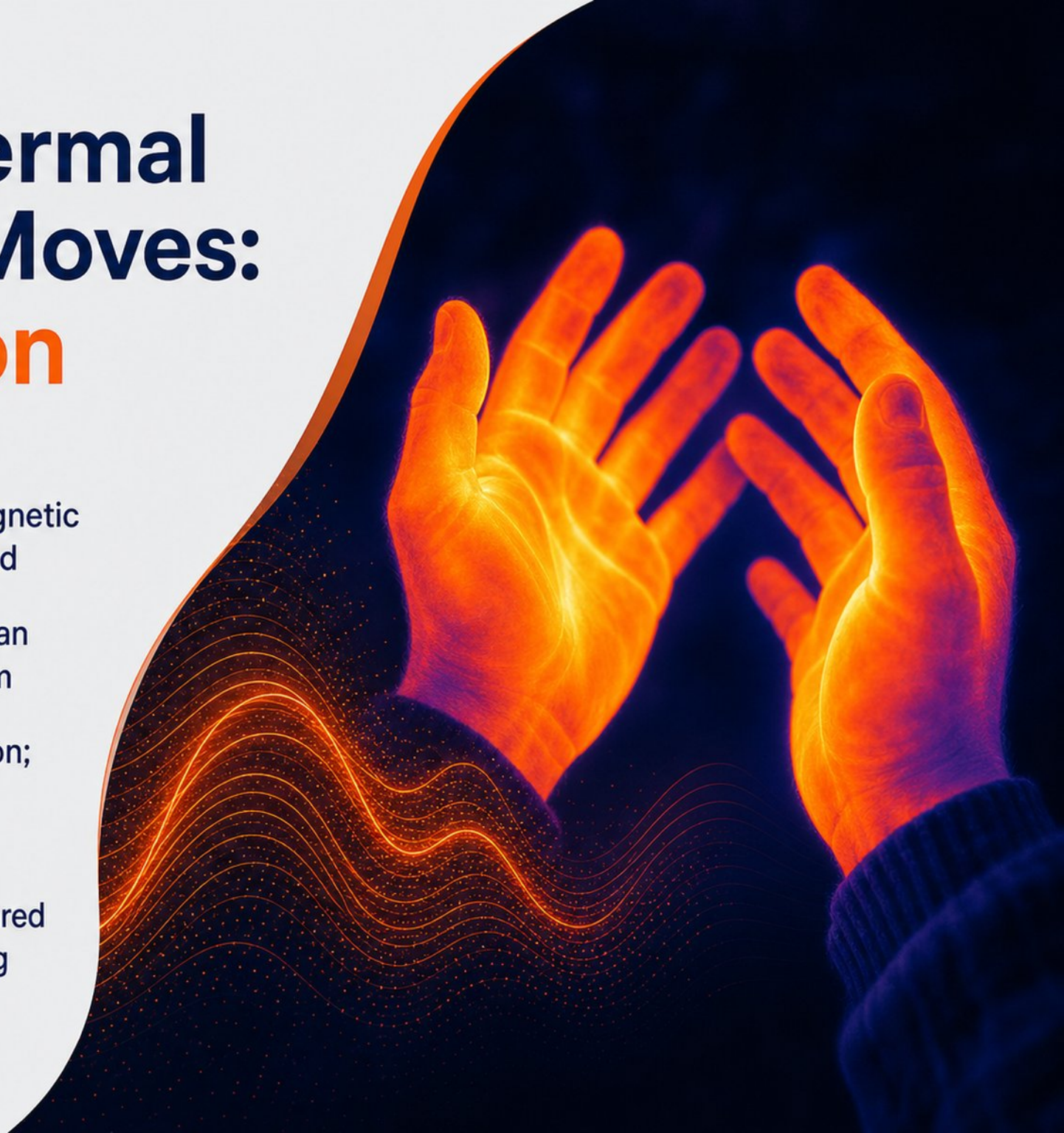
How Thermal Energy Moves: Convection

- Convection: bulk movement of fluids (liquids/gases) driven by density differences
- Warmer fluid rises, cooler fluid sinks, creating a convection current
- Everyday examples: boiling water, room heaters, sea breezes, weather patterns
- Convection requires a medium; it cannot occur in a vacuum

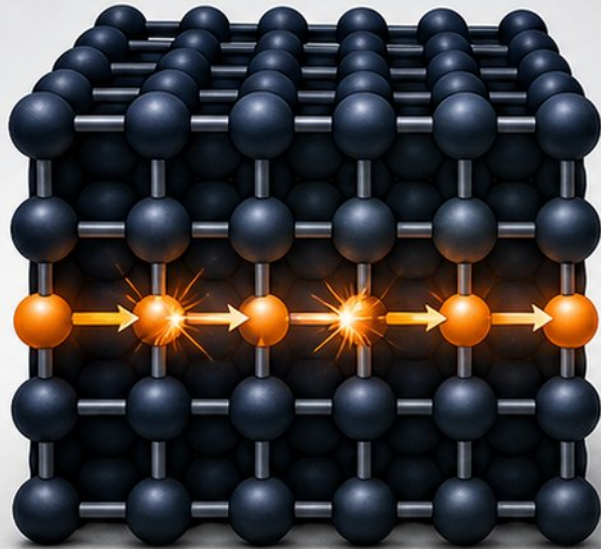


How Thermal Energy Moves: Radiation

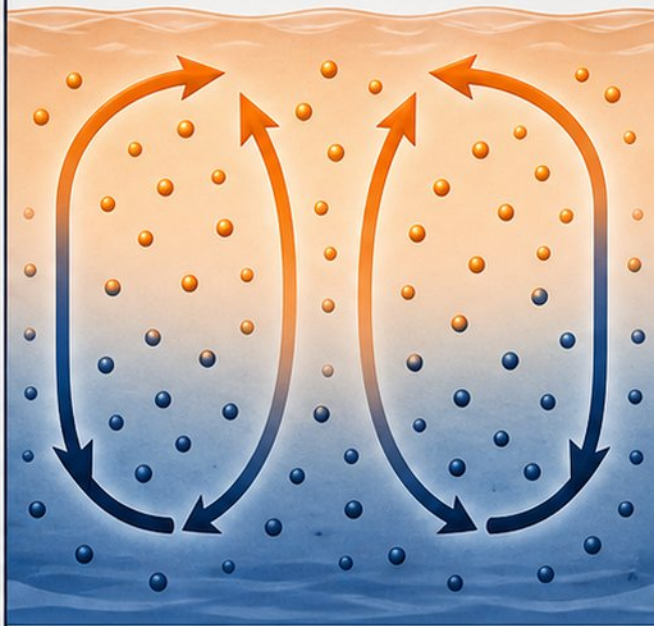
- Transfer via electromagnetic waves, primarily infrared
- No medium required; can travel through a vacuum
- All objects emit radiation; rate rises sharply with temperature
- Examples: sunlight, infrared heaters, thermal imaging cameras



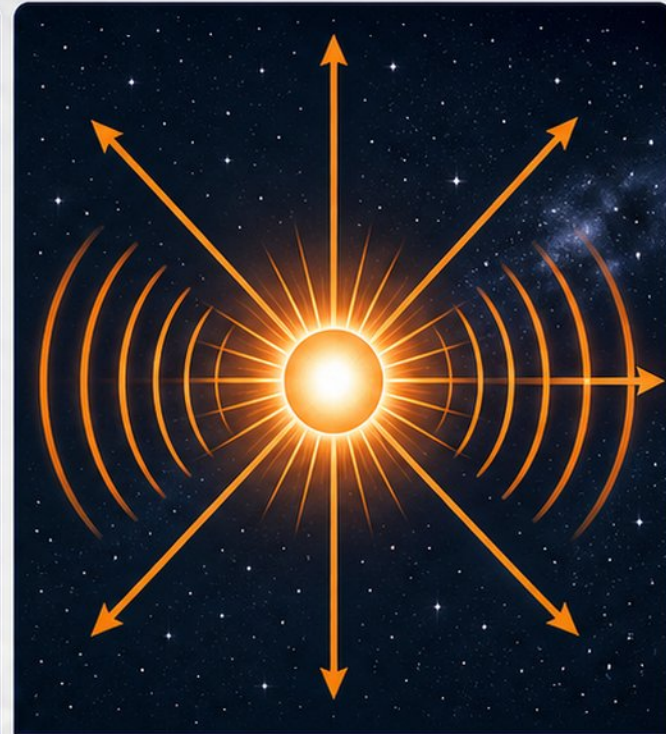
Modes of Transfer: Side-by-Side Comparison



Conduction: direct contact, particle collisions, fastest in solids



Convection: fluid movement, density-driven currents, requires a medium

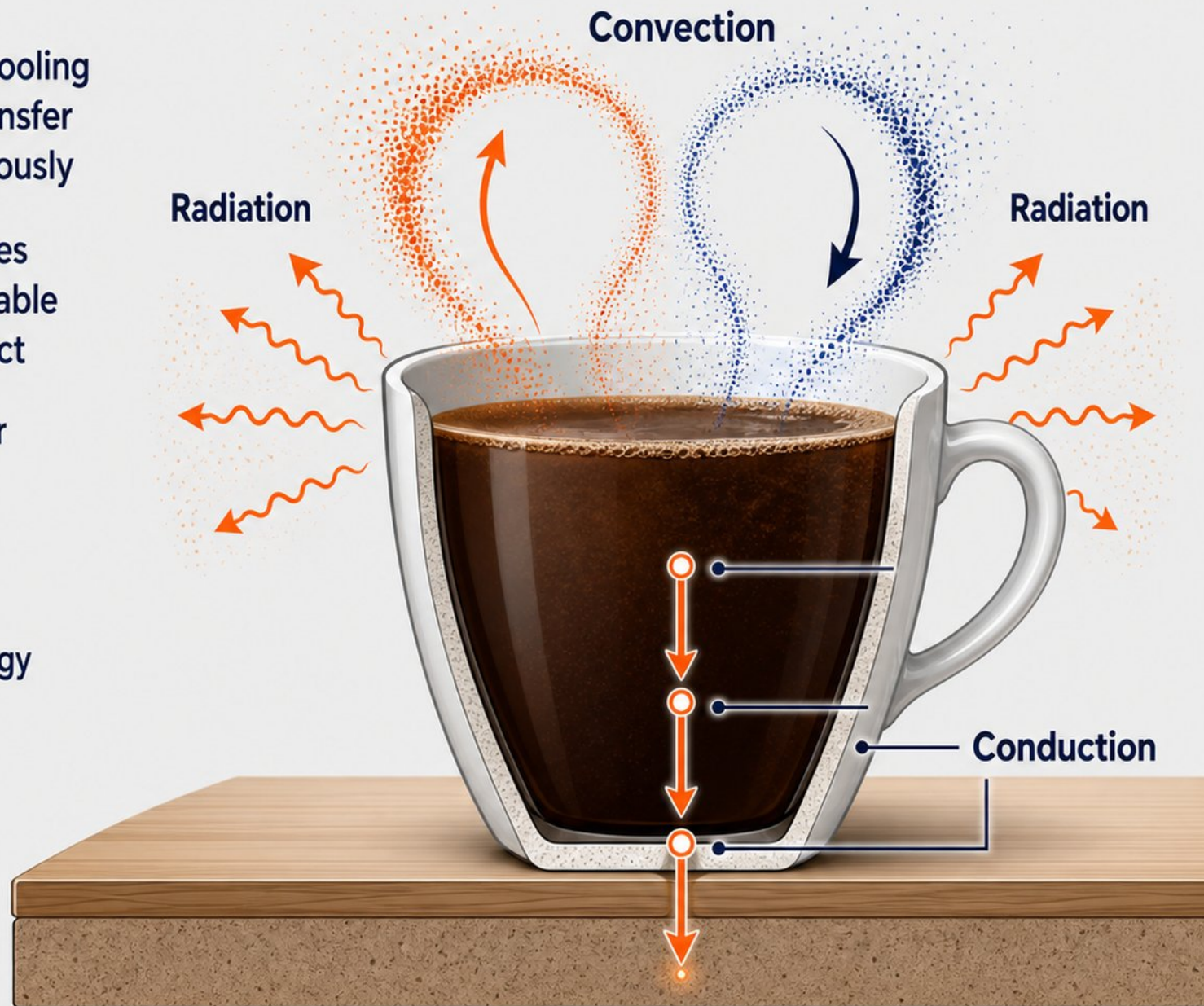


Radiation: electromagnetic waves, no medium needed, travels through vacuum

Real-world situations almost always involve all three modes simultaneously

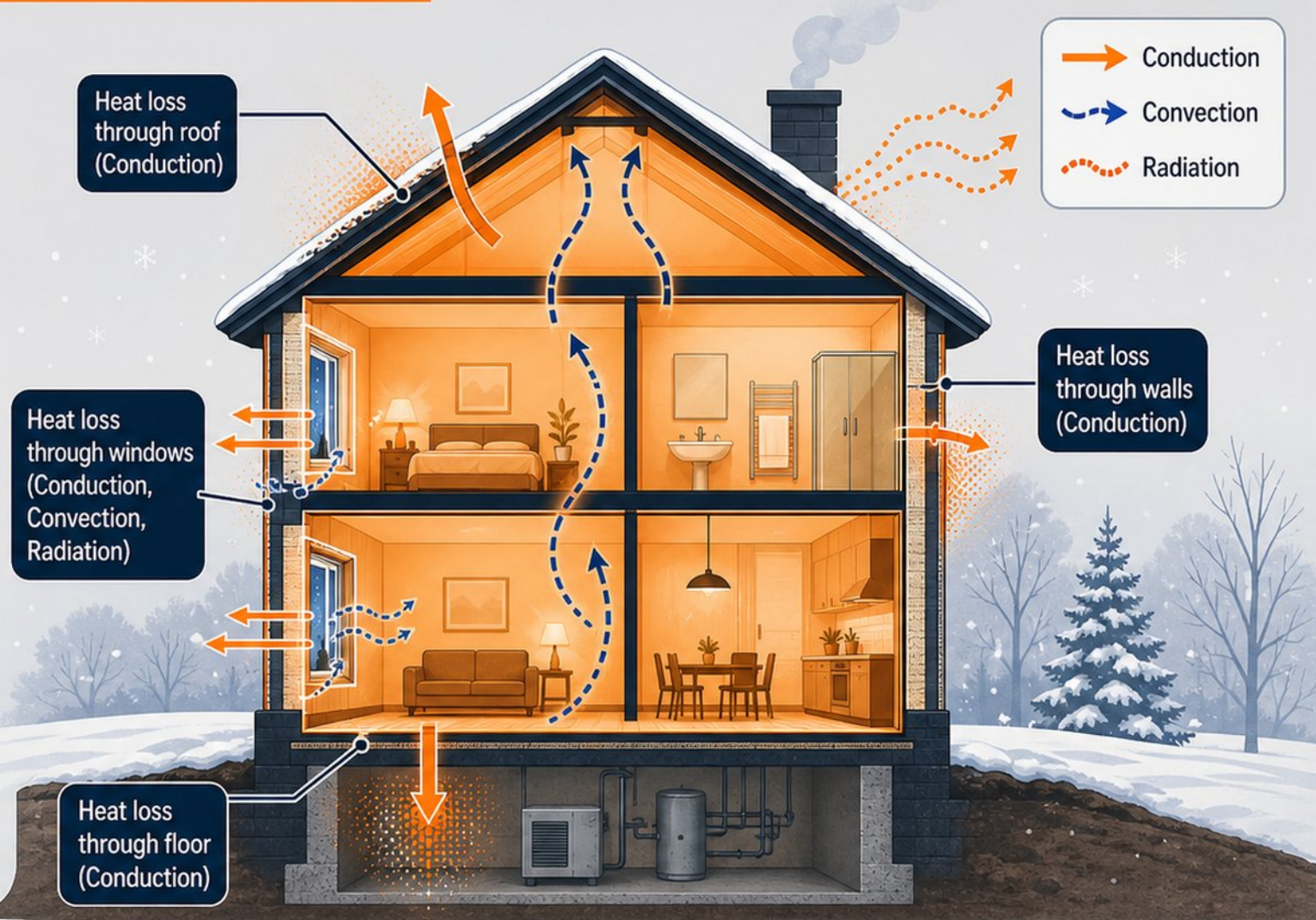
Energy Transfer in Action: A Cup of Coffee Cooling

- - Analyze a hot coffee cooling on a desk—all three transfer modes occur simultaneously
- - Conduction: heat moves from coffee → cup → table surface via direct contact
- - Convection: warmed air above the coffee rises, replaced by cooler sinking air
- - Radiation: infrared energy radiates from the coffee surface to cooler surroundings
- - Identify which mode dominates at each stage of the cooling process



Energy Transfer in Action: A House Losing Heat in Winter

- **Conduction:** heat escapes through walls, windows, roof, and floor
- **Convection:** warm air rises and leaks through gaps; drafts form near windows
- **Radiation:** infrared energy radiates from warm interior surfaces to cold exteriors
- **Insulation, double-glazing, and draft-proofing** block all three modes



INSULATION

Reduces heat flow through walls, roof, and floor by slowing conduction.



DOUBLE-GLAZING

Adds an insulating air layer that reduces conduction, convection, and radiation through windows.



DRAFT-PROOFING

Seals gaps around doors, windows, and penetrations to stop air leaks and drafts (convection).

Mythbusting: Top Misconceptions and How to Fix Them



“Cold moves into a warm room.”

Truth: heat moves out; cold is just less heat, not a substance.



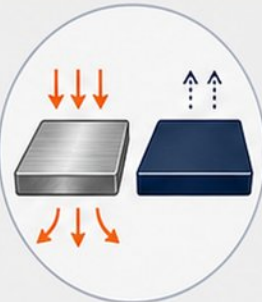
“Temperature tells you an object's heat content.”

Truth: heat is transfer; thermal energy depends on mass and temperature.



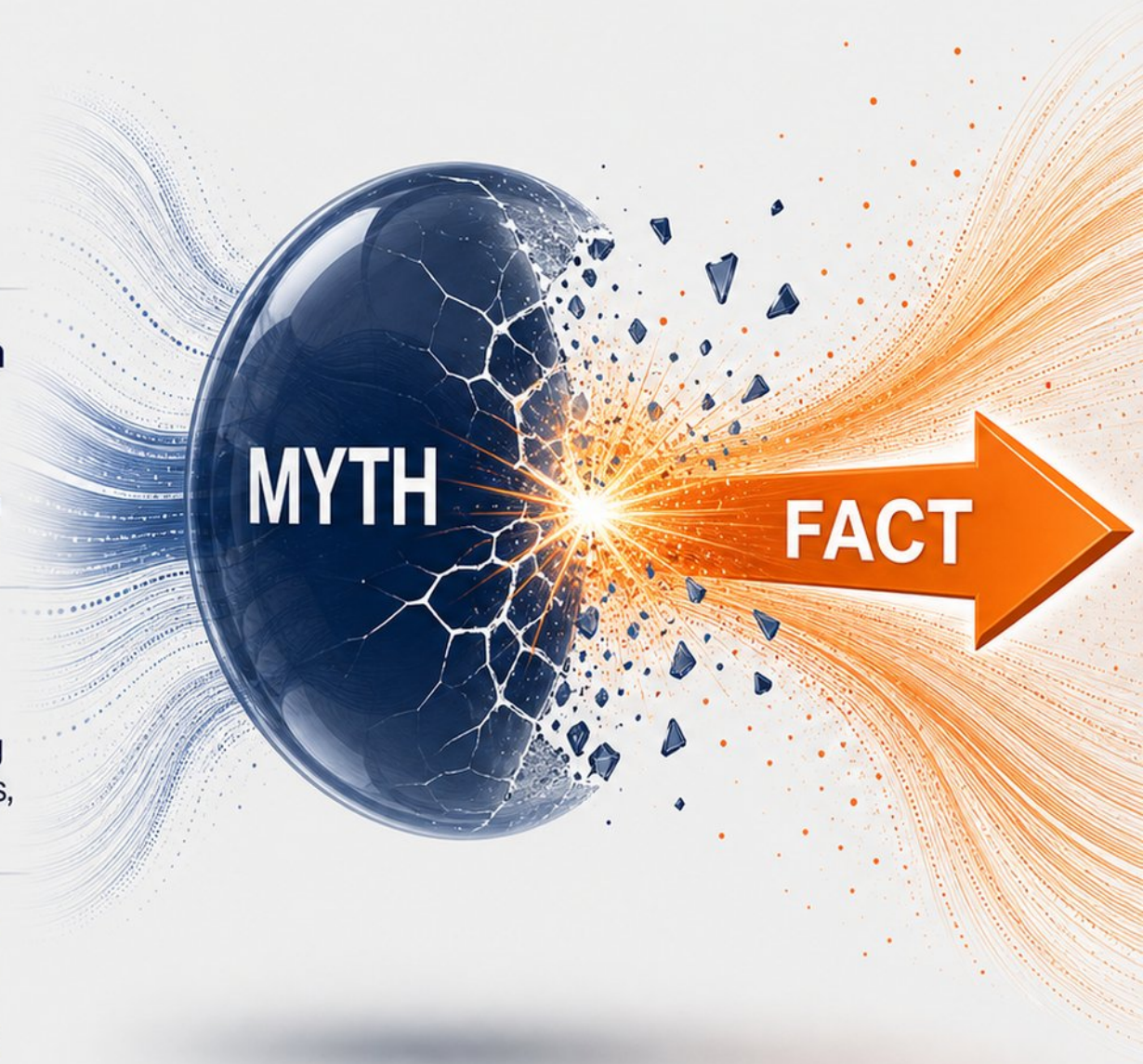
“Sweaters and blankets create heat.”

Truth: they trap air, slowing heat loss; they are insulators, not sources.



“Metal is naturally colder than plastic.”

Truth: same temperature; metal feels colder by conducting heat away faster.



Cognitive Strategies to Reframe Your Thinking

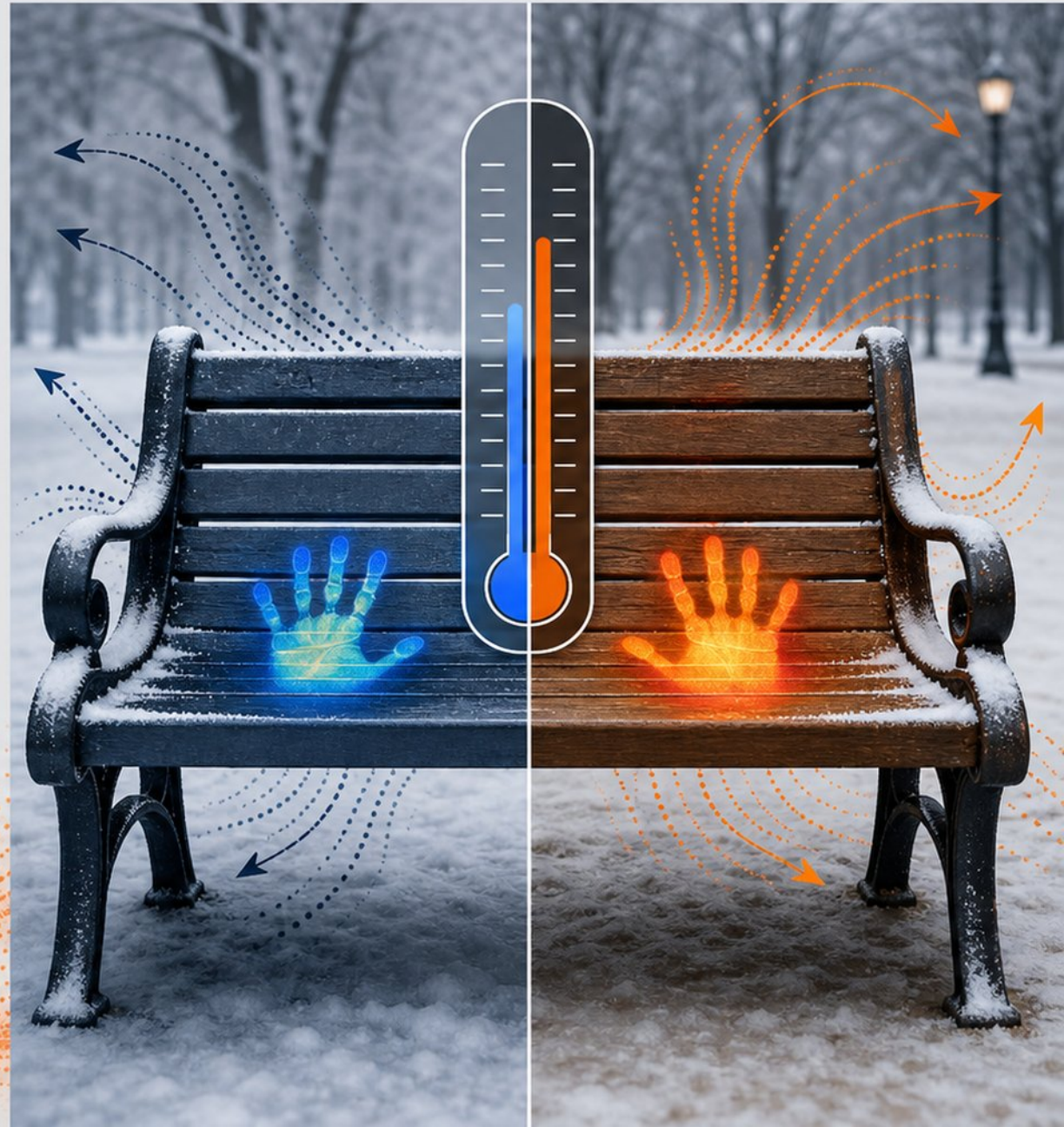


- Identify energy transfer direction: always from hotter to colder
- Replace "heat content" with "thermal energy" for stored energy
- Analyze: what warms, what cools, and by which mode?
- Use cognitive conflict: test predictions against experiments



Check Your Understanding: Self-Assessment

- - Heat flows spontaneously from hotter to colder objects
- - Heat transfer is measured in joules (J) or calories (cal)
- - Direction depends on temperature, not total thermal energy
- - Holding ice: conduction from hand; convection/radiation also occur
- - Metal feels colder than wood because it conducts heat away faster



Recap and Key Takeaways



- **Temperature:** average kinetic energy of particles (intensive property)



- **Heat:** energy transferred due to a temperature difference (process, not a property)



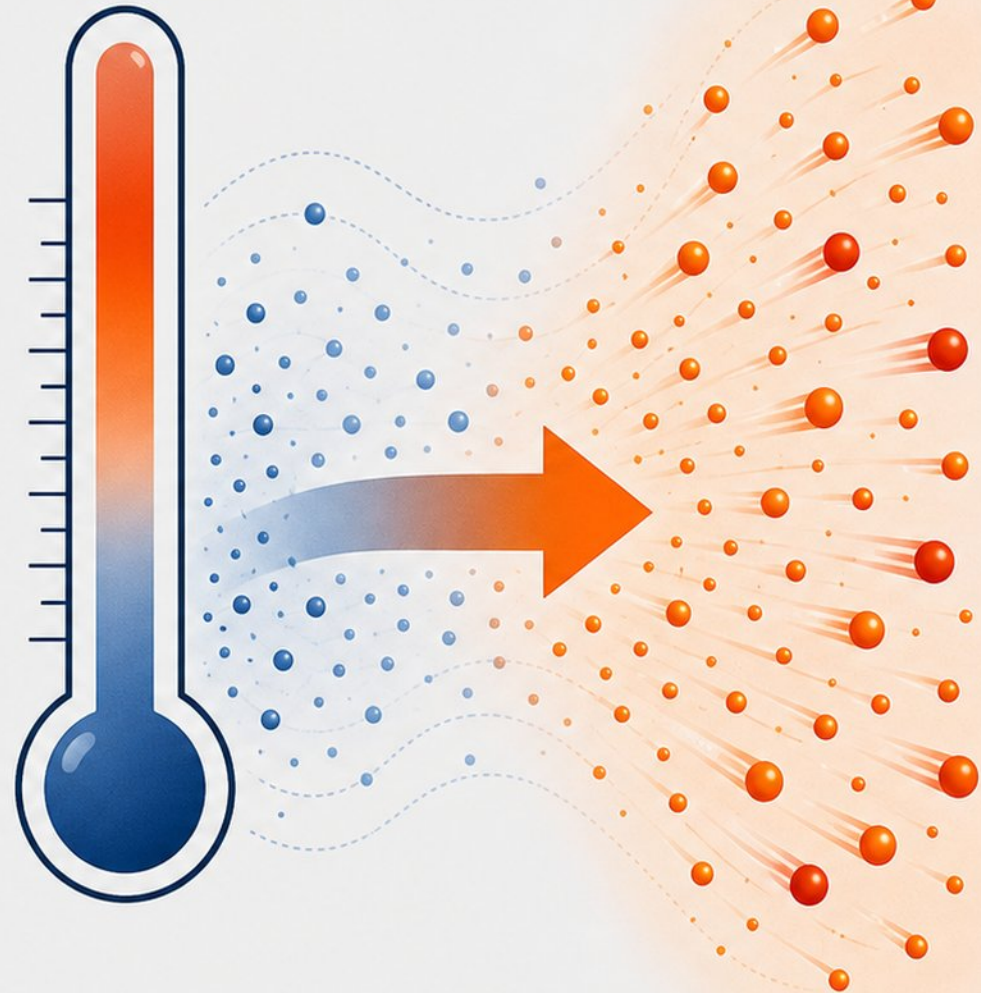
- **Thermal energy:** total kinetic energy of all particles (extensive property)



- **Three transfer modes:** conduction, convection, and radiation



- **Mastery:** identify the dominant mode and never confuse these three concepts



PersonWise.

PersonWise • AI digital-human course platform



Scan the code or click anywhere to watch this course live, with voice Q&A

personwise.ai/t/d4516e71/public