Thermodynamics Lesson 1: Particles, Temperature & Energy Flow

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Outline

Introduction: Why Study Thermodynamics?

Focus Inquiry Question 1: How are temperature, thermal energy, and particle motion related?

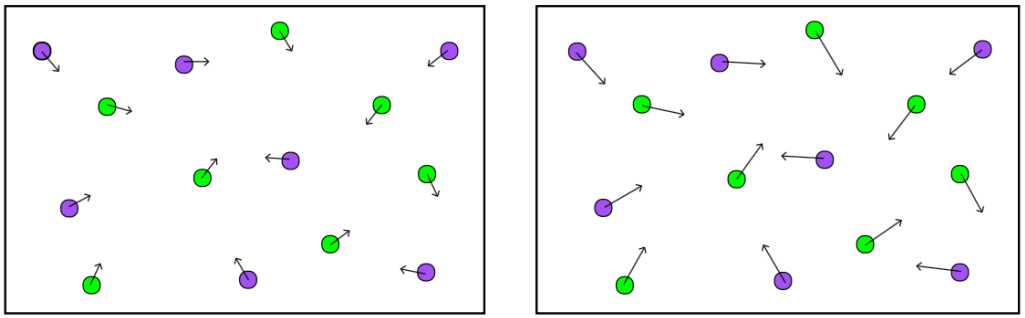
- **Definition:** The study of energy, its transfer (heat, work), and transformations.
- **Think/Pair/Share:** Why does a metal chair feel colder than a wooden one at the same room temperature?

- **Relevance:**
  - *Historical:* Driven by the need to understand and improve Steam Engines (Industrial Revolution).
  - *Future:* Crucial for Climate Science (energy efficiency), Sustainable Technologies, Computing (heat limits).
- **Key Terms (Worksheet 1):**
  - Temperature (Measure of *average* particle Kinetic Energy - KE) [N1]
  - Thermal Energy (Total internal energy - KE + Potential Energy) [N1]
  - Heat (Transfer of thermal energy due to temperature difference)

Temperature and Particle Kinetic Energy

- Matter is made of particles (atoms/molecules) constantly in motion.
- Temperature is directly related to the *average* kinetic energy of these particles.
- Higher Temperature $\Longrightarrow$ Higher Average KE $\Longrightarrow$ Faster Particle Motion (vibration, translation, rotation).
- Lower Temperature $\Longrightarrow$ Lower Average KE $\Longrightarrow$ Slower Particle Motion.

Visualisation: PhET Simulation "Energy Forms and Changes" shows this link.



Lower temperature

Higher temperature

Observe particle speed increasing as heat is added

Mechanisms of Heat Transfer

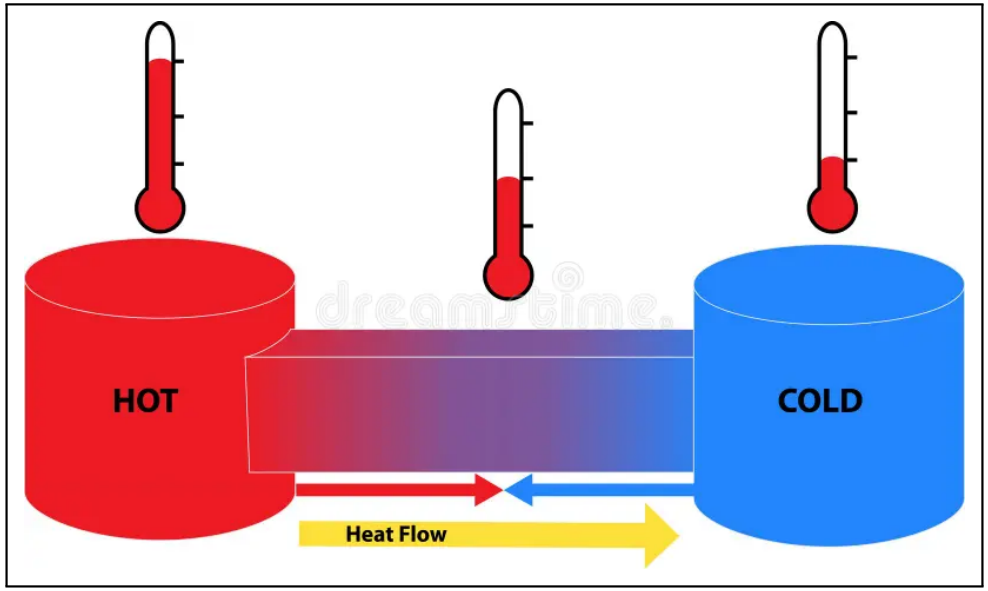
Heat (thermal energy) transfers via three main mechanisms:

1. **Conduction**
   - Transfer through direct particle collisions.
   - Dominant in solids.
   - Faster in materials with closely packed particles / free electrons (e.g., metals).
   - *Example:* Hot spoon handle.
2. **Convection**
   - Transfer by the movement of fluids (liquids/gases).
   - Hotter fluid is less dense and rises; cooler fluid sinks. Creates currents.
   - *Example:* Boiling water, sea breeze.
3. **Radiation**
   - Transfer via electromagnetic waves (infrared).
   - Requires NO medium.
   - All objects above absolute zero radiate.
   - *Example:* Heat from sun, warmth from a fire.

Activity 1 provides demonstrations/simulations for these.

Thermal Equilibrium

- **Direction of Flow (Inquiry Q3 link):** Heat naturally flows from a hotter object to a colder object when they are in thermal contact.
- **Equilibrium Definition:** The state reached when there is **no net flow** of heat between objects in thermal contact.
- **Condition:** This occurs when the objects reach the **same temperature**.
- *Example:* A cold drink eventually warms up to room temperature. The drink and the room air reach thermal equilibrium.



Lesson 1 Summary

- Thermodynamics studies energy transfer and transformation.
- Temperature reflects average particle kinetic energy [N1].
- Heat is energy transferred due to temperature differences.
- Heat transfers via Conduction, Convection, Radiation [N4].
- Thermal Equilibrium is reached when temperatures are equal (no net heat flow) [N2].

Next Steps:

- Complete Worksheet 1 (Definitions, Explanations).
- Complete #MarkSense Quiz 1 (Check understanding).
- Preview Lesson 2: Quantifying heat transfer (Calculations!).

Thank you!

Questions?