

Thermodynamics Lesson 1: Particles, Temperature & Energy Flow

Mr Haynes

Gosford High School

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Outline

- 1 Introduction
- 2 Particle Model and Temperature
- 3 Heat Transfer Mechanisms
- 4 Thermal Equilibrium Intro
- 5 Summary

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 \implies Higher Average KE \implies Faster Particle Motion (vibration, translation, rotation).
- Lower Temperature \implies Lower Average KE \implies Slower Particle Motion.

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



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.

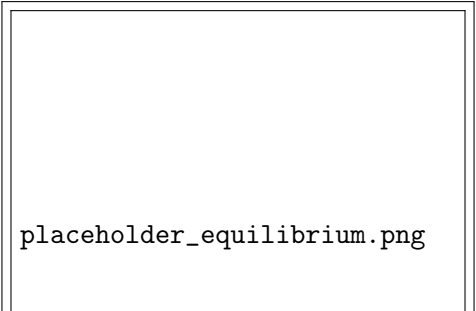
3. Radiation

- 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.



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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?