Year 11 Physics - Activity Sheet 1
Demonstrating Heat Transfer Mechanisms

Thermodynamics

Module 3 - Lesson 1

Aim

To observe and explain the three primary mechanisms of heat transfer: conduction, convection, and radiation, and relate these to particle motion and temperature changes.

Knowledge Nodes Targeted

- N1: Temp/KE Relation (Observing effect of heating)
- N4: Transfer Mechanisms (Identifying and explaining each mode)
- N2: Thermal Equilibrium (Conceptual introduction via heat flow direction)

Part A: Demonstrations (Teacher Led or Video/Simulation)

Demo 1: Conduction

- **Materials:** Metal rod (e.g., copper or aluminium), heat source (Bunsen burner or torch), heat-resistant mat, (optional: thermal camera, wax dots along rod).
- **Procedure:**
  1. Place the metal rod on the heat-resistant mat.
  2. Carefully heat ONE end of the rod with the heat source.
  3. Observe how the heat travels along the rod (e.g., using touch carefully away from heat, thermal camera, or melting wax dots).
- **Safety:** Wear safety glasses. Handle hot rod with tongs. Be aware of hot surfaces.
- **Observation Prompt (for Worksheet 1):** Describe how the energy transferred from the hot end to the cold end. Explain using the particle model (vibrations, collisions). [N4]

Demo 2: Convection

- **Materials:** Large beaker or flask of water, heat source, (optional: potassium permanganate crystal or food colouring, small paper pieces).
- **Procedure (Option 1 - Visualisation):**
  1. Fill beaker with cold water. Carefully drop a small crystal of KMnO4 or a drop of food colouring to the bottom near one side.
  2. Gently heat the water directly below the colourant.
  3. Observe the movement of the coloured water.

- **Procedure (Option 2 - Simulation):** Use PhET "States of Matter" or search for "convection current simulation/video". Observe fluid movement patterns when heated from below.
- **Observation Prompt:** Describe the pattern of movement observed. Explain why the fluid moves in this way, relating it to temperature, density, and particle movement. [N4]

Demo 3: Radiation

- **Materials:** Heat lamp or incandescent bulb, hand or thermometer, (optional: infrared thermometer/camera).
- **Procedure:**
  1. Turn on the heat lamp/bulb.
  2. Carefully place a hand near (but not touching) the lamp. Feel the warmth.
  3. (Optional) Measure temperature near the lamp with IR thermometer or observe with IR camera.
- **Observation Prompt:** How did the heat reach your hand without direct contact or air movement being the main factor? What type of energy transfer is this? Does it require a medium? [N4]

Part B: PhET Simulation Exploration

Simulation: Energy Forms and Changes

- **Link:** https://phet.colorado.edu/en/simulations/energy-forms-and-changes
- **Procedure:**
  1. Open the simulation and select the "Intro" screen.
  2. Place a thermometer on the brick and the water.
  3. Place the brick and water on the stands.
  4. Check the "Energy Symbols" box.
  5. Use the slider to add heat to both the brick and the water.
  6. Observe:
     - The movement/vibration of the particles (atoms/molecules) within the brick and water.
     - The change in the temperature reading on the thermometers.
     - The flow of 'E' energy symbols representing heat transfer.
- **Observation Prompts (for Worksheet 1):**
  - How did particle motion change when heat was added? [N1]
  - How did temperature change? Relate particle motion to temperature. [N1]