SCIENCE NORTH SCIENCE NORD
SUDBURY, ONTARIO, CANADA

Heat Transfer Part 1 **Grade 7 – Heat in the Environment**

Lesson Plan

Assessment	AFL, experiment, worksheet
Cross-curricular	

Big Ideas

- Heat is a form of energy that can be transformed and transferred. These processes can be explained using the particle theory of matter.
- There are many sources of heat.

Learning Goals

- Gain an understanding for what is heat.
- Make connections between heat and the particle theory of matter.
- Learn how Sun heats up the Earth's atmosphere through radiation

Specific Expectations:

2.5 use appropriate science and technology vocabulary
3.2 identify ways in which heat is produced
3.6 explain how heat is transmitted through radiation, and describe the effects of radiation from the sun on different kinds of surfaces
3.7 describe the role of radiation in heating and cooling the earth

Description:

This is the **first** lesson in a five-lesson unit on heat. The framework for the unit is to look at the heat transfer from solar energy on Earth. This lesson focuses on what heat is.

Materials/Resources:

Heat Transfer Part 1 Visuals and Experiment Worksheet
Heat source – space heater (**without** fan), bright halogen light, or toaster.
Food colouring
Transparent cups (plastic or glass), Tupperware
Hot and cold water, to fill half the cups with each
Candle
Match

Safety Notes

Caution working with heat source and open flames

Introduction

Defining Heat

- For the next five lessons students will study heat. Students will study what heat is and what its effects are on materials. Students will do many interesting experiments.
- Heat is actually a tricky word. Let's start with a related term that we maybe understand better: **temperature**.

Discussion questions:

  - **What does temperature mean?** (Something feels hotter or colder)
  - **What gives something its temperature?** (It's a form of energy - we can create heat in various ways – but it always involves adding energy – e.g. electricity, by burning something etc.)

- Hold up a **mug of hot water** (optional: get a volunteer to actually do this and describe what they feel)
  - **What happens?** (Your hand HEATS up).
  - We say that heat is transferred from the mug to your hand. So to distinguish it from temperature: We don't say that temperature is transferred – BUT at the end your hand has a higher temperature
  - **So temperature is a measure of how much heat was transferred.**
- Something that has more heat always gives it to something that has less heat (like your hand getting warm from the mug).
- There is a TRANSFER of energy. Once the temperature of two objects is the same, heat stops flowing.
- Heat is defined as the transfer of energy.
  - It can happen in **three** ways – Students will look at these over the next few days.

Action

****SAFETY NOTE:** The following experiments involve hot objects and materials. Students are reminded to NOT touch the heat sources or hot water. Students are to be careful not to spill any hot water on them or anyone else.

Heat Transfer By Radiation and the Earth's energy

Throughout this unit students will think about how heat is transferred on Earth.

Big picture discussion questions: (Heat Transfer Part 1 Visuals)

- Where does the energy on Earth come from?
  - Some is internal – radioactivity mostly.
  - **Virtually ALL other energy we receive is from the Sun!** (Solar energy was needed to make things such as coal and oil. It is needed to grow plants today, to **heat** the atmosphere, etc.)
- **Slide:** The Sun is very hot and it heats up the Earth (as discussed above – hot things transfer heat to cooler things)
- **Slide:** How is the heat transferred to the Earth?
  - Through radiation. The Sun radiates light. When it hits our atmosphere it heats it up.

- Radiation can travel through a perfect vacuum (Otherwise we would be very cold on Earth!)

- **How this works?**
  - Teacher turns on a **device that gets quite hot** – e.g. toaster, space heater, or a bright halogen work light is perfect to really get the image across.
  - Have students come and FEEL the heat. Move hands closer and further away. What do they observe?
    - Further away it feels cooler – but the energy spreads over a larger area, so the total energy is actually preserved. If you could collect energy from a larger area at a distance and then concentrate it you could focus the heat and make a spot very hot (think solar cooker or lighting a fire with a magnifying glass)
  - So you can feel the heat from the source here. It travels to you by radiation.

Heat as Particle Motion

Students complete an experiment (or observe a demo) and experiment worksheet. (See Link)

- Students are in groups of 2 or up to 6.
- Each group receives two cups and a bottle of food colour (**food colouring stains)
- Have students fill one cup with cold water.
- Teacher fills the other cup with hot water (ideally very hot, e.g. boiled in a kettle, but hot water from the tap will work too)
- Have students put a drop of food colour in each cup. Students observe what happens.
- Students write observations on worksheet. Then, complete a discussion and then write up a conclusion.
- Discussion questions: What happens?
  - We can see the motion of the water.
  - Colour disperses much faster in the hot water.
  - There must be more motion in the hot water.
  - More motion means more energy. So we can actually see that the hot water has more heat energy than the cold water.
  - Motion of what? PARTICLES.
  - **Slides: Heat therefore is a measure of the motion of particles in the water.** We can see that something hot has more internal motion.
- So if we go back to the previous experiment, it also means that when your hand feels hot it's because the molecules in it have more motion. Your hand doesn't "melt" away though, so in this case the molecules just vibrate, as they don't get to freely move around as in a liquid (well, at least the molecules that make up the solid structure of your hand). We are mostly made of water of course, so it will do just what we saw here).

Consolidation/Extension

Particle Theory of Matter

- The motion in the liquid is actually due to individual particles moving around.
- What are these particles?
- They are molecules (H2O), which are made up of atoms, as we now know.

If you want to extend this there are two nice videos by the Canadian Museum of Nature showing models of how water molecules interact with each other:

- First video: https://www.youtube.com/watch?v=sBZfPmIcS-E
- Second video: https://www.youtube.com/watch?v=moITG5Q7zzI

Jumping Flame Demonstration

- Light a candle, after a few seconds blow it out. Discuss what you see (smoke).
- What is smoke? (Take some guesses, it's actually evaporating wax particles (and some water vapour too, but we don't need to get into that). They have not burnt yet.
- Light the candle again. Also light a match and hold beside the candle.
- Blow out the flame and then rapidly move the burning match into the smoke trail several cm above the candlewick.
- What happens? (The candle relights!)
- Show a few more times for fun!
    - The wax particles are actually highly flammable. We can relight them with a match!
    - This is another demonstration that gives us a sense that matter is made of particles.

Prep for next day: If you are doing the convection box for the next lesson, ask each student group to bring in a cardboard box and two pop bottles (or food cans with both ends removed)