SCIENCE NORTH SCIENCE NORD
SUDBURY, ONTARIO, CANADA

Heat Transfer Part 4 **Grade 7 – Heat in the Environment**

Lesson Plan

Assessment	Demo, 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.
- Heat has both positive and negative effects on the environment.

Learning Goals

- Understand what insulation is in the context of heat transfer
- Be able to explain how greenhouse gases insulate the earth, leading to heating
- Be able to independently build a device that minimizes heat transfer.

Specific Expectations:

1.2 assess the environmental and economic impacts of using conventional and alternative forms of energy
2.3 use technological problem-solving skills to identify ways to minimize heat loss
2.4 use scientific inquiry/experimentation skills to investigate heat transfer through conduction, convection, and radiation
2.5 use appropriate science and technology vocabulary
3.7 describe the role of radiation in heating and cooling the earth, and explain how greenhouse gases affect the transmission of radiated heat through the atmosphere
3.8 identify common sources of greenhouse gases

Description:

This is the **fourth** 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. In this lesson we look at insulation and one of the consequences of "insulation" in our atmosphere – the greenhouse effect.

Materials/Resources:

Heat Transfer Part 4 Visuals, Reference Images, Experiment Worksheet (for demo and activity)

Demo:
-Two pop bottles (smaller will work better)
-Dark food colour
-Two thermometers to measure water temperature
-Heat source (e.g. light bulbs)

Greenhouse activity:
-1 clear plastic bowl for each student or group
-Aluminum foil
-Fleece bits (to use as insulation)
-Dark rocks (e.g. dark aquarium pebbles)
-Glue, Scissors, Coloured paper

Safety Notes

Caution working with scissors

Introduction

So far students have learned a lot about heat transfer. What about preventing heat transfer though?

- Discussion questions
- **What do we call a material that prevents heat transfer?** (Insulation)
- **Can you think of a process that prevents heat transfer in our atmosphere?** (We have all this solar radiation coming in, it heats up the Earth, but today we are experiencing higher heating than in the past – greenhouse gases prevent heat from escaping).
- Greenhouse gases INSULATE our atmosphere (for transfer of infrared radiation)
- Visuals (See Link)
- **Slide 2:** How the greenhouse effect works
- **Slide 3:** How CO2 absorbs IR radiation and then re-emits it.
- **Slide 4:** One of the consequences of global warming is that the ice over the North Pole melts. So now the sun is hitting dark water instead of white ice!
    - Dark surfaces absorb more light than light surfaces. Heat up more. Etc.
    - This can also be used to great advantage – e.g. if you wish to heat something up with sunlight.
- Let's do an experiment to measure what happens when you heat a light versus dark liquid

Heating Clear and Dark Water (demo)

We can let this experiment run during class and observe the results at the end. It will reinforce the concept of climate change feedback loops. Optionally you can have students record the temperature of the water every few minutes and ask them to graph the data at the end of class. It will be very interesting to see how **the darker water reaches equilibrium between heating gain/loss, but at a higher temperature than the light water.**

- Fill two pop bottles with water. Add dark food colouring to one of the bottles
- Insert a thermometer into each bottle, if necessary tape it on so that the readout stays above the bottle opening
- Place each bottle under a lamp that gets hot (e.g. 100W incandescent light bulb in a table lamp)

Action

Build a Super Greenhouse

Students have to modify a basic transparent bowl to make it into the most effective greenhouse possible. They are given materials to use for construction. Greenhouses have to be heat up well – so they must have transparent surfaces, but they should also retain heat well. We will test the greenhouses next day for heat RETENTION.

- We are talking about reducing heat transfer with an insulating material, such as CO2 creating a blanket around the Earth that absorbs IR radiation. The greenhouse effect also acts on a small scale in actual greenhouses we use for gardening.
- Greenhouses have to heat up. How do they do that?
    - Sun light can enter through clear areas. Heat is trapped inside – i.e. greenhouse lets radiation in but prevents heat transfer out.

    - At night greenhouses cool off. Ideally we can keep them quite warm through **passive heating**.
        - Something inside the greenhouse was heated up during the day that retains heat well. Releases it at night.
        - Can you think of any examples? (E.g. dark rock, water in a dark barrel, etc.)
- You now have all these materials to build a greenhouse that heats up well and retains heat well. Use the worksheet to provide rationale for your design.
    - Think about how you can get the most sunlight in but ALSO prevent the most heat from escaping?
    - HINTS:
        - Think about what direction the Sun shines on the greenhouse from
        - Where would heat escape the easiest? To where will heat naturally flow?
        - Can you balance the need for radiation coming in AND insulating to prevent heat from escaping?
        - What are the best materials you could use to capture heat during the day that can be released at night?
        - Take the rest of class to build the greenhouse, everyone by themselves or in small groups.

The types of things students may want to incorporate include insulating the top (where heat rises to), including a reflective surface at the back ("North" side) of the greenhouse, insulation on surfaces that don't receive much light. Strategically placed dark objects inside the greenhouse (that heat up) etc.

Consolidation/Extension

Time permitting: Students present their greenhouse model to the class.

Extension: This unit includes an idea to test the greenhouses for heat retention on the last day. If you have the resources you can take an additional day and test how well the greenhouses heat up. You would place them each under a lamp or take them outside and place them in the Sun. Students can then measure and graph the temperature inside over the course of the class.

- If you do this it's important that you have thermometers for each greenhouse that can be placed inside and can be read without having to open it.