SCIENCE NORTH SCIENCE NORD
SUDBURY, ONTARIO, CANADA

**Heat Transfer Part 5** **Grade 7 – Heat in the Environment**

# Lesson Plan

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|---|---|
| Assessment | experiment, worksheet, rubric |
| 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

- 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:

**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
**3.4** explain how heat is transmitted through conduction

## Description:

This is the **fifth** 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 focus on heat conduction and also test the greenhouses the students built in lesson 4.

## Materials/Resources:

Heat Transfer Part 5 Experiment Worksheet
Styrofoam cups for everyone
A hot beverage for everyone (e.g. hot chocolate)
Candles
Metal spoons
Balloons, water
Thin metal rod (e.g. coat hanger or wire)
Marshmallows
Retort stand or vice grips
Bunsen burner

## Safety Notes

Caution working with open flames

## Introduction

**Re-cap**

We have built a greenhouse that should work as best as possible to trap heat – i.e. heats up well AND retains heat well.
We have looked at how heat is transferred via radiation and convection.
Today we will test how well your greenhouses can trap heat and we'll do some experiments on the third way that heat is transferred – by conduction.

## Action

**Testing Greenhouses**

Greenhouses are often built with the inclusion of some passive heating – e.g. black barrels of water that heat up during the day. At night these barrels then release their heat, keeping the greenhouse warmer. The students will test the greenhouses they built for their capacity to retain heat. They will measure how much and how fast the temperature of a hot beverage inside the greenhouse drops. The greenhouse therefore is used here for its ability to reduce the transfer of heat.

- Experiment will work better with more cups per greenhouse (as we really want to test the greenhouses ability to retain heat – so the less air there is inside that heats up first, the better it will work).
    - You can either add more than one cup per student or have students choose which greenhouses they want to test in groups.
- Give everyone a cup of a hot beverage.
- Place a thermometer inside one of the beverages.
- Place cups inside a greenhouse. Make sure you can read the thermometer without opening the greenhouse!
- Record temperature on worksheet (See Materials/Resource section), keep recording the temperature every 2 to 3 minutes (use a timer to ring at that time interval as a reminder – egg timers or an app will work perfectly).
- At a pre-determined time stop taking data and graph all the data points. Answer questions on worksheet and/or discuss results as a class. Discussion points:
    - This is how greenhouses keep warmer than the outside at night.
    - The Earth works in a very similar way. If we didn't have an atmosphere it would quickly get VERY cold at night. The ground radiates heat into the atmosphere, where it is trapped at night.
    - Passive heating is a really great way to reduce your heating bills. For example:
        - If you have a dark stone floor or wall behind a south facing window it heats up during the day. At night it then radiates the heat and keeps the house warmer.

Teacher should **record temperatures of a hot beverage that is just sitting on the table** – the control. You can then compare how much it cooled, versus how much the beverages in the greenhouses cooled.

**Modes of Heat Transfer using a candle (Demo or activity)**

While we wait for the greenhouse experiment to unfold we can talk about heat transfer by conduction. This first activity is a good recap and introduction to conduction.

- If doing as an activity hand out candles, a metal spoon (or similar object) and matches or lighters.
- Light a candle .
- Hold your hand over the candle. What type of heat transfer dominates here? (Convection – briefly discuss again how it works)
- Hold your hand beside the candle flame (at the same level as flame). What type of heat transfer dominates here? (Radiation – convection does NOT transfer heat sideways. Briefly discuss radiation again.)
- What will happen if I hold a metal spoon in the flame?
    - It will get hot! Why? How is heat transferred? – Conduction!
    - Let's try it
        - NOTE: Do this safely! Once you start feeling the heat, pull the spoon out and place it on the table. It may get hotter for a little while after.
    - How does conduction work?
        - Collision between neighbouring particles.
        - A faster moving particle (hot) hits a slower one (cold), giving it some of its energy. The process then repeats itself. This is how heat spreads in a solid but also in liquids and gases.
        - Here is a fun video explaining conduction that you could show for example. Many other ones exist! https://www.youtube.com/watch?v=wV7gzcKegdU

**Conduction Experiments (Demos)**

We suggest a couple of conduction demonstrations here that are quite neat and really get the concept across. They are both classics:

1. Balloon over Flame
    a. Blow up a balloon and hold over a flame. It will pop quickly. What happened? Got hot (heat transfer) and burst.
    b. Fill the balloon with water and again hold over flame. It will not pop! Why? Because the water quickly conducts the heat away. The balloon membrane stays relatively cool. Of course if you keep holding the balloon there eventually the water will get very hot!
2. Marshmallows (or similar substance) on a metal rod
    a. Place about 5 marshmallows, each a few inches apart on a metal rod.
    b. Attach the metal rod to a retort stand (or hold with vice grips)
    c. Place a heat source under one end of the rod (candle or Bunsen burner)
    d. Watch as the marshmallows fall off the rod one by one…

In each case we see heat conduction in action. With the second experiment we can see how heat conduction gradually moves along the metal rod.

## Consolidation/Extension

Have students finish worksheets to hand in.

There is an Assessment of Learning (summative) evaluation rubric included with this lesson plan.