W 1229

HEAT TRANSFER

The Movement of Heat

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Author(s)

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Skill Level
Beginner (5th grade), Intermediate (6th grade)

Learner Outcomes

The learner will be able to:

- Explain the difference between heat and temperature

- Define the three ways heat can move between objects

Educational Standard(s) Supported

6PS3.4

Success Indicator

Learners will be successful if they:

- Explain how heat moves by conduction

- Explain how heat moves by convection

Tags
4-H Science

Time Needed
30 minutes

Materials List
Student Handout (one per student)

Experience 1
Two round balloons
Candle
Matches or lighter
Water

Experience 2
Piece of Styrofoam
Wood board
Piece of metal larger than the size of your hand

Introduction to Content

Heat transfer is the name for the movement of thermal energy due to temperature differences. Although many get the two confused, heat and temperature are not the same thing. Heat is a form of energy, called thermal energy, and temperature is a measure of how hot or cold something is. All objects are made up of atoms. Atoms are the building blocks of molecules, and they are always moving. When you add heat energy to an object, the molecules in that object move faster, which in turn raises the temperature. Heat flows from higher temperature objects to lower temperature objects because of their difference in temperature. When cool objects absorb energy, they become warmer. When warm objects lose energy, they become cooler. There are three different ways heat can move between objects: conduction, convection, and radiation.

Terms and Concepts

Heat - thermal energy that an object has because of the movement of its molecules
Temperature – the measure of how hot or cold something is
Conduction - the movement of heat from a warm object to a cool object that are touching each other
Convection – process through which heat is transferred by the movement of a heated liquid or gas
Radiation - the transfer of thermal energy through waves or fast traveling particles

Setting the Stage/Opening Questions
Say, "There are three different ways heat can move between objects: conduction, convection, and radiation. Conduction occurs when objects are in direct contact with one another."

Call a student up to the front of the room. Ask him to hold a cup of cold beverage in a Styrofoam cup. Then ask him to hold a stainless steel mug. Ask what he feels and what differences there are.

Explain, "You feel conduction when you hold a cold drink or a cup of hot chocolate."

Then explain, "Convection occurs when a fluid (such as air or water) flows over an object. You feel convection when you stand outside in the wind on a cold winter day. Can anyone give me another example you may think of for convection?"

Say, "Finally, heat can be transferred by radiation. The heating of the Earth by the sun is an example of transfer of energy by radiation."

Ask the students to explain the difference between conduction and convection heat transfer. **ANSWER: In conduction, heat transfer takes place between objects by direct contact. In convection, the heat transfer takes place within a fluid such as water and air.**

Say, "The rate at which an object can transfer heat is due to its thermal conductivity. Materials with a higher thermal conductivity can transfer heat faster than materials with a lower thermal conductivity. Let's conduct some experiments to learn how heat moves among objects through conduction and convection."

Experience 1
Youth will generate a hypothesis about which objects move heat faster. Ask students to state their hypothesis in question 1 on the Student Worksheet, and then perform the experiment.

1. Have students place their palms on the Styrofoam, wood board and the piece of metal and compare how cold they feel.

2. Have the students arrange the materials they think feel the warmest to the coolest.

Strategies to Increase Student Engagement

- Have a Styrofoam cup, wood board, and stainless steel mug on hand for students to touch
- Fill the Styrofoam cup and the stainless steel mug with cool water
- Walk around the room as students are conducting their experiment and ask them about their hypothesis

Share

Ask students, “Is heat being moved from your warmer hand to the cooler objects by conduction or convection?” **ANSWER: Conduction is the movement of heat from a warm object to a cool object that are in contact with one another.**

Process

Take a poll of students to determine their answer to: “Which material feels the warmest?” **ANSWER: The Styrofoam should feel warmest. Styrofoam is a very poor conductor of heat, which is why it is used as an insulator in coolers. When their hand touched the Styrofoam, heat flowed from their hand to the Styrofoam by conduction. This caused the Styrofoam surface to warm and because this heat was not conducted away very fast, the surface of the Styrofoam soon became as warm as their hand. Since their hand and the Styrofoam are at the same temperature, the temperature-sensitive nerves in their fingers don’t detect any difference in temperature.**

Take a poll of students to determine their answer to: “Which material feels the coolest?” **Metal is a good conductor of heat. Heat flows from their hand into the metal and then is conducted rapidly away into the metal by conduction. This leaves the metal surface and their skin surface relatively cool. That's why the metal feels cooler.**

Generalize

Ask students if they drink hot chocolate. Ask how many of them use Styrofoam. Ask how many of them use stainless steel mugs or tumblers such as Yeti, RTIC, Ozark Trail, etc. Explain that the reason people carry their coffee in stainless steel mugs is because metal is a good conductor of heat. Say, “Metal will hold the heat longer than plastic or Styrofoam.”

Notes

Experience 2

Ask students to state their hypothesis in question 5 on the Student Worksheet, and then perform the experiment.

1. Blow up one of the balloons.
2. Light the candle with a matchstick or lighter.
3. Hold the balloon filled up with air very close to the flame and observe what happens.
4. Put some water in the other balloon and add a little air.
5. Bring it close to the flame and observe what happens.

TIPPS
Life Skills

- Head – Thinking
- Head – Managing
- Hands – Working

Share

Ask the students "Is heat moving through the air and water in the balloon by conduction or convection?" **Answer: Heat is moving through the air or water in the balloon by convection.**

Process

Ask the students, "Why did the balloon filled with air pop and the balloon filled with water did not?" **ANSWER: Air is not a good conductor of heat. When you place the balloon over the flame, the heat does not move rapidly away from the spot near the flame. This causes the balloon to melt. The air inside the balloon pushes against the melted part which causes the balloon to pop. Water, on the other hand, is a good conductor of heat. The heat from the flame moves into the water and away from the wall of the balloon by convection. The rubber does not heat up enough to burn or melt. Because there is no weak point, the balloon doesn't pop.**

Generalize

Have the students, "Explain the difference between heat and temperature." **ANSWER: Heat is a form of energy, while temperature is a measure of how hot or cold something is.**

Have the students, "Explain the difference in how heat moves by conduction and convection." **ANSWER: Conduction is the movement of heat from a warmer object to a cooler object that are touching each other. Convection is a process through which heat is transferred by the movement of a heated liquid or gas.**

Apply

Ask the students “Why do we place insulation in the walls of your home?” ANSWER: Insulation will help you keep the desired temperature in your house all year round, protecting it against cold in winter and excess heat in summer. Insulation is also useful to reduce noise pollution. A well-insulated house is very energy efficient and will need very little additional heating and cooling.

Supplemental Information

Educational Standards Met

Physical Science

6PS3.4 Conduct an investigation to demonstrate the way that heat (thermal energy) moves among objects through radiation, conduction, or convection.

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Student Worksheet

Name: _____ Date: _____

Answer the following questions.

1. What is your hypothesis for Experience 1?

_____

_____

2. Now perform the experiment:
    a. Place your hand on the piece of Styrofoam, wood board and the piece of metal.
    b. Arrange the materials you think feel the warmest to the coolest.

3. Circle the material that feels the warmest and underline the material that feels the coolest.

    Styrofoam Wood Metal

4. Were you correct in your hypothesis? Yes No

5. What is your hypothesis for Experience 2?

_____

_____

6. Now perform the experiment:
    a. Blow up one of the balloons.
    b. Light the candle with a match or lighter.
    c. Hold the balloon filled with air very close to the flame and observe what happens.
    d. Put some water in the other balloon and add a little air.
    e. Bring the balloon close to the flame and observe what happens.

7. Were you correct in your hypothesis? Yes No

8. What other liquids can you think of that may change the experiment?

_____

_____



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