

5th Grade Lesson 1: Heat Transfer

NC State Science Standards:

- 5.P.3.1 Explain the effects of the transfer of heat (either by direct contact or at a distance) that occurs between objects at different temperatures. (conduction, convection or radiation)
- 5.P.3.2 Explain how heating and cooling affect some materials and how this relates to their purpose and practical applications.

Essential Questions:

- How is heat energy transferred from one object to another?
- Compare and contrast conduction, convection, and radiation.
- How are different materials affected by heating and cooling?

Brief Lesson Description:

Students will investigate the 3 methods of heat transfer by working through a station lab to explain the phenomenon of a heat carousel. Students will then apply what they have learned to identify the type of heat transfer in a real world situation. This lesson is one of three lessons relating heat transfer to processes in atmospheric circulation.

Performance Expectation(s) and Specific Learning Outcomes:

- Students will be able to demonstrate characteristics of air. Students will be able to show that air has mass and it takes up space.
- Students will be able to explain the 3 forms of heat transfer.
- Students will be able to apply their knowledge of heat transfer to identify it in “real world” scenarios.

Prior Student Knowledge:

- Air is made up of molecules.
- Heat is a form of energy.

Possible Preconceptions/Misconceptions:

- Objects and materials produce their own heat.
- Heat is a substance. Heat is not energy.
- Heat can not be transferred.
- Molecules do not have mass because they are too small.
- Air does not have mass or exert pressure.

Materials:

Print outs from the Supplemental Materials
Candles and carousel for demonstration
Plastic soda or water bottles (enough for each student)
Standard size balloons (enough for each student)
Kabob skewers (1 for each student)
Beakers (2 per lab group)
Thermometers (2 per lab group)
Sand
Water

Heat lamp (1- 2 per lab group)
 Density boxes (1 per group, recommended but not required, <https://www.flinnsci.com/density-box---demonstration-kit/ap4784/>)
 Food coloring (blue and red)
 Red and blue colored pencils (1 per student)
 Jars (two per group)
 Balloons (two per group)
 Bucket or container of ice
 Rubberbands (two per group)
 Wooden spoons (1 per group)
 Plastic spoons (1 per group)
 Metal spoons (1 per group)
 Bowls or cups to hold hot water (1 per group)
 Hot (boiling) water
 Butter or Coconut oil (small amount per group)

LESSON PLAN - 5-E Model

ENGAGE: Opening Activity - Access Prior Learning / Stimulate Interest / Generate Questions:

Time: 30 Minutes

1. Start lesson by asking students if they have ever been in an attic in the summertime. What does it feel like? What about a basement in the summertime? Why do they feel so different in temperature?
 - a. *Students should give answers along the lines of warm or hot in the attic and cool or not as warm in the basement.*
2. Explain to students that you are going to use this concept of “warm in the attic and cool in the basement” to make a paper carousel magically turn.
 - a. Perform candle carousel demo for students. *Here is a great video on how to make a simple carousel for the demonstration: <https://www.youtube.com/watch?v=59DnNL4oCYI>*
 - b. Have students write down their observations in their notebooks.
 - c. Ask students: what do they think happened? What is causing the carousel to turn? What information might they need to know in order to figure it out?
 - d. Have students write down their ideas on a brainstorm map. Save this as an anchor chart for later in the lesson.
3. Explain to students that they are going to see if their ideas are correct by investigating how heat affects fluid materials through a series of investigations. *Note: you may want to discuss with students what constitutes a fluid matter here.*

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:

Time: 180+ Minutes

Note: This section includes a series of investigations by students. This section will likely take several class periods to complete. We recommend completing each investigation in one class period.

1. Divide students into pairs. Present the Heat Transfer Investigation Lab to students. *Each investigation should be done with their lab partner, but facilitated by the teacher.*
 - a. **Investigation 1: Characteristics of Air**
 - i. Explain to students they are going to be investigating some of the characteristics of air using a balloon and a bottle.
 - ii. Use turn and talk to have students discuss some of the things they already know about air. Discuss as a whole class.
 - iii. Facilitate the Characteristics of Air Investigation with students.
 - iv. When finished, discuss the findings with students.
 - b. **Investigation 2: Radiation**
 - i. Start with asking why we feel warm in the sunlight? The sun is very far away, so how do we feel warm when we stand in it? Discuss ideas with students.
 - ii. Facilitate the Radiation Investigation with students.
 - iii. When finished, discuss the findings with students.
 - c. **Investigation 3: Convection**
 - i. Start by having students model what happens to molecules when they gain and lose energy with the *Molecules in Motion* demonstration.. To do this have students spread out around the room. Explain to students that the music you play is going to represent energy that they (as molecules) are absorbing. When fast music comes on (lots of energy) the student molecules dance fast and spread apart, becoming less dense. When slow music comes on (less energy) the student molecules slow down and come closer together, becoming more dense. Play around with the music slow/fast/medium speeds to see if students can simulate what is happening as molecules gain and lose energy.
 - ii. Facilitate the Convection in a Liquid Investigation
 1. When finished, discuss the findings with students.
 - iii. Facilitate Convection in a Gas Investigation with students.
 1. When finished, discuss the findings with students.
 - d. **Investigation 4: Conduction**
 - i. Facilitate the Conduction Investigation
 - ii. When finished, discuss the findings with students.
 - e. **Investigation 5: Putting it all together**
 - i. Revisit demo and brainstorm anchor chart with students.
 1. Use turn and talk to have students discuss what they learned from the investigation and if they figured out the things they would need to know in order to explain how the carousel was spinning.

- ii. Have students draw a diagram of the carousel demonstration. Have students label the diagram where conduction, radiation, and convection are happening.
- iii. Ask students to create a CER explaining how the candle made the carousel turn using evidence from their investigations. Encourage students to use vocabulary they have learned through the investigations.

EXPLAIN: Concepts Explained and Vocabulary Defined:

Time: 60 Minutes

1. Have students read the article from Newsela and complete the activities associated with it. *We would suggest using a reading strategy such as a symbol read to help students engage with the article. Note: Newsela allows for differentiation of reading levels for their articles. Article: https://newsela.com/read/natgeo-transfer-thermal-energy-heat/id/2000002407?search_id=2147b777-a246-44d1-a2ca-990c1abb5da5*
2. Work through the Heat Transfer Foldable with students. *Be sure to clarify any misconceptions students may have at this point.*

Vocabulary: conduction, radiation, convection, density, molecules

ELABORATE: Applications and Extensions:

Time: 60 Minutes

1. Explain to students that they are now going to put their new knowledge to use. Put students into pairs. Allow students to move through example stations of different types of real world examples of heat transfer in nature.
2. Students will discuss which type of transfer is happening (could be multiple types) and give their reasoning on the student sheet. *Encourage students to utilize the vocabulary terms they learned in the Explore and Explain portions of the lesson.*
3. When students have finished moving through all the stations, show the video on biomimicry: <https://www.youtube.com/watch?v=QpEsb-fun44>
4. Have them choose one of the real world examples as a team. Explain to students that they are going to brainstorm ideas for ways humans can utilize this form of heat transfer. Allow students time to brainstorm.
5. Have students choose their favorite idea and design a product. Students will then draw out a model with labels of their product. *Note: If you wanted to extend this section, you could have students build prototypes of their models.*

EVALUATE:	Time: Full Lesson
<p>Formative Monitoring (Questioning / Discussion): Formative assessment can be conducted throughout the lesson.</p> <p>Summative Assessment (Quiz / Project / Report): Summative assessment can be conducted during the elaborate portion where students explain their reasoning for identifying the real world examples and then apply to a product humans can use. It can also be assessed on the comic strip in the Extend portion of the lesson.</p>	
Elaborate Further / Reflect: Enrichment:	Time: Variable
<p>Create a Heat Transfer Comic Strip</p> <ol style="list-style-type: none"> In order to extend student's thinking on heat transfer, have them create a comic strip depicting the 3 types of heat transfer in an informative way. The following link is for an Heat Transfer Comic Activity that provides directions and a rubric: http://cclow.weebly.com/uploads/2/8/6/0/2860244/heat_transfer_comic.pdf or students could create their comic on a digital platform such as Storyboard That: https://www.storyboardthat.com/storyboards/0cd271a4/heat-transfer-comic-strip Share comic strips in the hallway, in an online platform, or in a compiled book. 	