NYC Companion Lesson

Reading "Icy Heat"

Overview

The article "Icy Heat" expands students' understanding of thermal energy and heat transfer by connecting to what they know about temperature and molecular movement. Following the Active Reading approach, students first read and annotate the article on their own, then they discuss their annotations with a partner. To refine their understanding of the scientific meaning of *heat*, students reread a section of the article that distinguishes everyday perceptions of heat from the scientific meaning of *heat*—even objects that feel cool can transfer energy to other objects if they are at a lower temperature. The purpose of this lesson is for students to understand that in science, *heat* refers to the thermal energy transfer due to temperature differences between objects.

Recommended Placement: *Phase Change*, after Lesson 2.2
Suggested Time Frame: 60 minutes (first and second reads can be spread across two class periods)

NYS P–12 Science Learning Standards

Performance Expectations	• **MS-PS1-4:** Develop a model that predicts and describes changes in particle motion, temperature, and phase (state) of a substance when thermal energy is added or removed.
Disciplinary Core Ideas	• **PS3.A: Definitions of Energy:** ° (NYSED) The term "heat" as used in everyday language refers both to thermal energy (the motion of particles within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. (secondary to MS-PS1-4)

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Disciplinary Core Ideas	• **PS3.A: Definitions of Energy:** ° (NYSED) Temperature is not a form of energy. Temperature is a measurement of the average kinetic energy of the particles in a sample of matter. (secondary to MS-PS1-4)
Science and Engineering Practices	• **Practice 1:** Asking Questions • **Practice 8:** Obtaining, Evaluating, and Communicating Information
Crosscutting Concepts	• Energy and Matter • Stability and Change

Vocabulary

- heat
- kinetic energy
- molecule
- temperature
- thermal energy

Materials & Preparation

Materials

For the Class

- Reading "Icy Heat" copymaster
- Annotation Tracker
- 2 large index cards*
- marker*

For Each Student

- Student Edition: "Icy Heat" article
- student sheets*
  - Reading "Icy Heat"
  - Second Read of "Icy Heat"

*teacher provided

Preparation

1. **Print Reading "Icy Heat" copymaster.** Locate the Reading "Icy Heat" copymaster on the New York City Resources webpage: www.amplify.com/amplify-science-new-york-city-resources. Make one copy of all pages for each student.
2. **Create and post vocabulary cards on the classroom wall.** With a marker, write "thermal energy" and "heat" in large print on separate index cards. Post both cards on the classroom wall.

Preparation (continued)

3. **Prepare for Active Reading.** Before class, preview the "Icy Heat" article. Review the first few sentences carefully as you prepare to model Active Reading. For a full description of preparing for an Active Reading day, see *Phase Change* Lesson 1.4, Lesson Brief, Preparation. It is highly recommended to have students annotate the Student Editions directly with sticky notes in order to achieve the full benefits of this approach.
4. **Print one copy of the Annotation Tracker for each class.** A blank copy is available in your digital teacher's guide in *Phase Change* Lesson 1.4, Lesson Brief, Digital Resources. If you plan to use the Annotation Summary Sheet to track students' annotations or wish to review the Annotation Tracker Instructions, these are also available in Lesson 1.4, Digital Resources.
5. **Make sure the Active Reading Guidelines are clearly visible.** If they are not posted on your classroom wall, write them on the board before class. (See Active Reading Guidelines on the Reading "Icy Heat" student sheet.)
6. **Plan to model Active Reading.** To model the Active Reading approach, you will need to have students follow along as you read aloud the first few sentences of the article. If you have a document camera in your classroom, consider projecting and annotating the article as you read aloud. Alternatively, you can project the article from the PDF available on the the New York City Resources webpage.
7. **Prepare for On-the-Fly Assessment.** The second read section of this lesson provides an opportunity to informally assess students' understanding of heat transfer. Refer to the On-the-Fly Assessment in the Assessment section of this lesson for details about what to look for and how you can use the information to maximize learning by all students.
8. **Immediately before the lesson, have on hand the following materials:**
   - "Icy Heat" article
   - student sheets
   - Annotation Trackers

Science Background

The relationship between thermal energy, temperature, and heat can be confusing. We define the term *thermal energy* as the total kinetic energy of all the molecules that make up a sample. Thermal energy is different from temperature because it refers to the total kinetic energy of an object, and temperature is a measure of the average kinetic energy of the molecules in an object. Even though thermal energy is sometimes referred to as heat energy, heat is actually thermal energy that is currently being transferred. Substances do not have heat; they have thermal energy. In nonscientific contexts, the word *heat* is used both as a verb (to heat something) and a noun (the heat is unbearable). However, these common uses may encourage the mistaken idea that heat is a tangible thing that substances can possess. In a scientific context, heat is the thermal energy transferred from something at a higher temperature to something at a lower temperature. Heat refers only to the energy that is transferred between objects, not the thermal energy an object has.

Heat will spontaneously transfer from a warmer sample to a cooler sample. This is because, at the molecular level, the individual molecules of the warmer sample have more kinetic energy than the individual molecules of a cooler sample. When the molecules of the samples collide, the higher-energy molecules of the warmer sample transfer kinetic energy to the lower-energy molecules of the cooler sample. At the macroscale, the molecules' change in kinetic energy is shown by the change in thermal energy of the samples. Therefore, when the molecules' kinetic energy changes, there is a change to the thermal energy of the sample, which is reflected by the temperature of the sample. During a thermal energy transfer, the thermal energy that moves out of one sample moves into another. Therefore, if one sample heats up because it has gained thermal energy, the other sample in contact must cool down because it has lost thermal energy.

Instructional Guide

First Read of "Icy Heat"

1. **Introduce the article and make a connection to students' background knowledge.**

   You have been learning about temperature. Today, you will read an article called "Icy Heat" that builds on what you already know. The term *icy heat* sounds strange. What could *icy heat* mean? In a moment, you will read to find out more.

2. **Have students share initial ideas about the word *heat*.** Write "heat" on the board.

   What kinds of things do you think about when you hear the word *heat*?

   Accept all responses.

3. **Model Active Reading.** Read the first few sentences of the article aloud. Ask questions and make connections as you model the Active Reading process.
4. **Review Active Reading Guidelines.** Before students begin reading, point out the Active Reading Guidelines on the classroom wall.
5. **Distribute copies of the Reading "Icy Heat" student sheets.**
6. **Prompt students to read and annotate independently.** Direct students to the "Icy Heat" article in their Student Editions. Circulate as students read, providing support as needed.
7. **Review the process for discussing annotations.** When most students have finished reading and annotating, explain that students will choose one or two annotations to share with a partner. They should select questions or connections that they find interesting or those that will help them better understand what they read.
8. **Provide a moment for students to select annotations to share with their partners.**
9. **Prompt partners to discuss annotations.** Circulate as pairs discuss, using the Annotation Tracker and listening for questions and connections that you would like to invite students to share during the class discussion.
10. **Prompt partners to prepare for class discussion.** Ask them to choose a question or connection that they would like to share with the class. Explain that they can discuss the same annotations they shared with their partners if the questions are still unresolved.
11. **Facilitate a brief class discussion about annotations.** Invite students to share their questions and connections. Encourage students to respond to one another and to look back at the article in order to answer their peers' questions.
12. **Highlight exemplary or noteworthy annotations.** Refer to your Annotation Tracker and invite students to share those annotations you noted. Provide specific, positive feedback as students share, noting when annotations show evidence of Active Reading. Examples might include annotations that make a connection to science ideas, use vocabulary from the unit, or instances in which students were able to answer their own questions.

13. **Connect *thermal energy* to what students have been learning about phase change.**

    In this unit, we have been thinking about how increasing or decreasing the molecules' kinetic energy leads a substance to change phases. Kinetic energy is the energy a molecule has because it is moving. Thermal energy is the energy an entire substance has because its molecules are moving. This article helps us understand how some of the thermal energy can transfer between substances.

    Point out that the vocabulary word is posted on the classroom wall. Note that students can also find the definition in the glossary at the back of their Student Editions.

Second Read of "Icy Heat"

14. **Set purpose for rereading "Icy Heat."** Explain that students will reread paragraph 5 of the article in order to build their understanding of the scientific meaning of the word *heat*.
15. **Distribute the Second Read of "Icy Heat" student sheets and direct students to complete Part 1.**
16. **Have partners share information that they found.** Partners should discuss information that helps them understand the scientific meaning of the word *heat*. After students share, introduce the definition of the word *heat*. Refer back to the activity where you wrote the word *heat* on the board and students offered their ideas.

    Heat is the thermal energy transferred from something at a higher temperature to something at a lower temperature.

    Point out that the vocabulary word is posted on the classroom wall. Note that students can also find the definition in the glossary at the back of their Student Editions.
17. **Direct students to complete Part 2 of Second Read of "Icy Heat."**
18. **Have partners share ideas.** Partners should discuss how it is possible that heat is transfering from the water in the tank to the water in the bag, even though the water in the tank does not feel hot. Circulate as partners discuss so you can listen to their responses.
19. **On-the-Fly Assessment: Understanding Heat Transfer.** For further suggestions on how to support students' understanding of heat transfer, refer to the On-the-Fly Assessment in the Assessment section of this lesson.
20. **Lead a brief discussion of Part 2.** Invite students to share ideas. If it does not come up, help students understand that thermal energy transfers from the water with the higher temperature to the water with the lower temperature. It doesn't matter whether the water feels warm or cool to us, heat will transfer when there is a difference in temperature.
21. **Make a connection to the unit.** Remind students that they have been learning about how transferring energy to a substance affects how its molecules move. Heat transfer from a warmer substance to a cooler substance is one way that energy can be transferred.

On-the-Fly Assessment: Students' Understanding of Heat Transfer

Look for:

Students should be building the understanding that in science, the word *heat* is only used to mean "transfer of thermal energy from one object to another." As students discuss the question in Part 2 of Second Read of "Icy Heat," they should demonstrate the understanding that heat will transfer from the water in the tank to the water in the bag because the temperature of the water in the tank is higher. Listen for students who might have difficulty with the idea that even though the water in the tank might not feel hot, it still has energy and it can still transfer heat.

Now what?

If students are struggling to reconcile their everyday understanding of the word *heat* with the scientific definition, consider having them make additional predictions of heat transferring between objects. Consider using several scenarios from the list below and drawing them on the board. Ask students to predict if there will be heat transfer and, if so, in which direction. Help students see that heat will transfer between objects whenever there is a temperature difference: heat transfer can happen between two objects that we perceive to be warm; between two objects that we perceive to be cold; and between one object that we perceive to be warm, and one that we perceive to be cold. Emphasize that in science, heat is the thermal energy transferred; it is not related to what "feels" warm.

Additional scenarios:

- Ice cube (0°C) floating in a swimming pool (27°C)
  [Heat transfers from the pool water to the ice cube.]
- Cooked hot dog (74°C) placed in a bun (20°C)
  [Heat transfers from the hot dog to the bun.]
- Hot pizza (70°C) placed on the seat of a car (24°C)
  [Heat transfers from the pizza to the car seat.]
- Box of crackers (20°C) placed on a countertop (19°C)
  [Heat transfers from the crackers to the countertop.]

Possible Student Responses

Reading "Icy Heat"

1. Read and annotate the "Icy Heat" article.
2. Choose and mark annotations to discuss with your partner. Once you have discussed these annotations, mark them as discussed.
3. Now, choose and mark a question or connection, either one you already discussed or a different one that you would like to discuss with the class.
4. Answer the reflection question below.

   Rate how successful you were at using Active Reading skills by responding to the following statement:

   As I read, I paid attention to my own understanding and recorded my thoughts and questions.

   - ☐ Never
   - ☐ Almost never
   - ☐ Sometimes
   - ☐ Frequently/often
   - ☐ All the time

Active Reading Guidelines

1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.

Second Read of "Icy Heat"

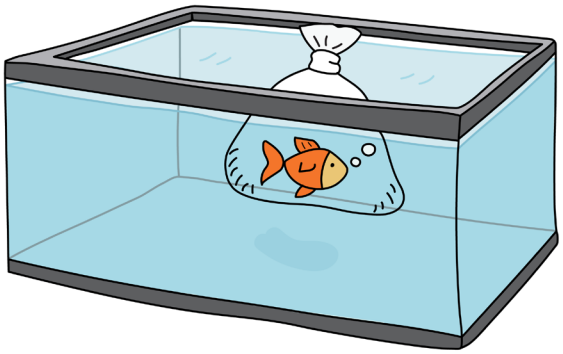
Part 1

Reread paragraph 5 of the article. As you read, highlight and annotate information that helps you understand the scientific meaning of the word *heat*. You will use that information to help you answer the question in Part 2.

Part 2

Read the following information. Use what you learned from "Icy Heat" to answer the questions.

Miguel bought a new fish for his fish tank. He brought the fish home in a plastic bag that was filled with water from the fish tank at the store. Before releasing the fish, he put the entire bag into his tank so the fish could get used to the temperature of the water in his tank at home.



Temperature of the water in his home tank: 21°C

Temperature of the water in the bag: 18°C

Miguel explains to his sister that heat is transferring from the water in the tank to the water in the bag. Miguel's sister doesn't believe him because the water in the tank doesn't feel hot.

How is it possible that heat is transferring from the water in the tank to the water in the bag, even though the water in the tank doesn't feel hot?

It's possible because the temperature of the water in the tank is higher than the temperature of the water in the bag. Heat is the thermal energy transferred between two things. Thermal energy transfers from the thing with the higher temperature to the thing with the lower temperature, so it is transferring from the water in the tank to the water in the bag.