National Aeronautics and Space Administration

NASA eClips™

Guide Lites

Interactive Lesson: Heat & Temperature

Heat & Temperature

National Standards:
MS-PS3-4
Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

PS3.A: Definitions of Energy
Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present.

PS3.B: Conservation of Energy and Energy Transfer
The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment.

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Student Misconception
Students incorrectly think heat and temperature are the same thing.

Objective
In this activity, students will explain the difference between heat and energy as a result of watching the NASA Spotlite video, learning the vocabulary collaboratively, and discussing how the movement of molecules creates thermal energy.

Time Frame
Approximately 45 minutes (pretest, video review and discussion (20 minutes), collaborative vocabulary with Frayer Model (25 minutes), posttest. Additional time needed for completion of extension activities.

Materials:
Per student: copy of pretest and posttest (alternatively, these can be completed online)
Per small group: copy of Frayer Model (alternatively, these can be completed online)
Per classroom: chart paper for posting final vocabulary definitions

Background information:

- Heat is the transfer of energy from a hot object to a colder object.
- Temperature is a measure of the average kinetic energy of the atoms or molecules in the system.
- Measuring temperature describes how fast molecules are moving. The lower the temperature, the slower the movement. The faster the molecules are moving the higher the temperature.
- Although cold and hot things may have the same number of molecules there is more space between the molecules in objects that are warmer.

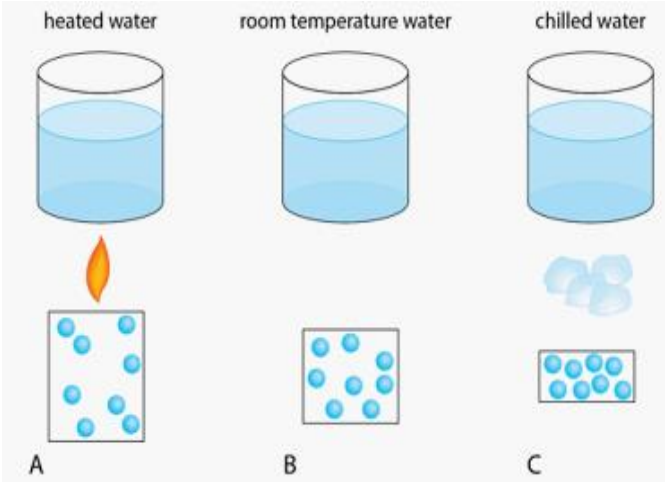


Image credit: **http://tinyurl.com/yb4hx7vp**

Pre-Assessment
Probe for students' prior knowledge using one or both of these pre-assessments.

1. Pre-test items can be found at the ClassFlow Marketplace – *NASA Spotlite Interactive Lesson Plan – **Heat and Temperature** Pre / Post Test.*
https://prod.classflow.com/classflow/#!/product/itemId=b009cca396574473af9243723131112e

2. Discussion questions:
   - ❑ What is the difference between heat and temperature?
   - ❑ What role does the speed of molecules play in an object's temperature?
   - ❑ How does a thermometer work?
   - ❑ What happens to the movement of molecules in a solid when energy is added?

Engage

1. Ask students to watch the Spotlite video on heat and temperature that can be found at the following link, https://youtu.be/L5PTZm2TksE . After viewing the video, lead a discussion with students to identify the misconception addressed in the video.
   (Misconception: Heat and temperature are the same.)

2. Identify key vocabulary words and phrases in the video.
   (Examples: heat, molecules, temperature, energy, thermometer, kinetic. Additional words should be added as needed.)

**These words, and other key vocabulary terms, can be found in the NASA eClips™ Virtual Vocabulary, https://nasaeclips.arc.nasa.gov/teachertoolbox/vocab.

Explore and Explain

Use the Frayer Model to help students develop a conceptual understanding of key vocabulary.

Using a digital interactive Frayer Model enables students to explore ideas collaboratively and simultaneously on the same digital document.

Several digital Frayer models can be found at:

- ClassFlow: **http://tinyurl.com/FrayerModelClassFlow**
- PDF Filler: **http://tinyurl.com/FrayeronPDFfiller**
- Google Slides

https://docs.google.com/presentation/d/1a8RaLcmOmSwlYxZBFPWHgbkoEZrJnnp5gicNeElXzjc/edit?usp=sharing

Implementation Note

Within the Frayer Model, students EXPLORE concepts through brainstorming and researching AND EXPLAIN and synthesize their understanding.

Example: Place the word ***molecules*** in the center of the graphic organizer.

1. Facilitate a discussion with students exploring why this word is key vocabulary to this study.
2. **(EXPLORE):** Ask students to brainstorm *characteristics of* ***molecules*** and add responses to the area with the corresponding heading on the graphic organizer.
3. Ask students to continue their exploration as they research the topic using a variety of resources including their textbook and notes.
4. **(EXPLAIN):** Next, ask students to add *examples* and *non-examples* in the Frayer model. *(Emphasize the higher level thinking skill of comparing and contrasting. How are the examples alike/different than the non-examples?)*
5. Using the information provided, ask students to develop their own definition of the word ***molecules*** that is clear and concise. An example to guide work is started below.
6. After completing the example together, assign a new vocabulary word to each group of students to work on collaboratively.
7. Groups will share their Frayer Models and lead discussions to check for understanding of each vocabulary word.
8. Compile final definitions and post so all students have access for later work.

Implementation Note

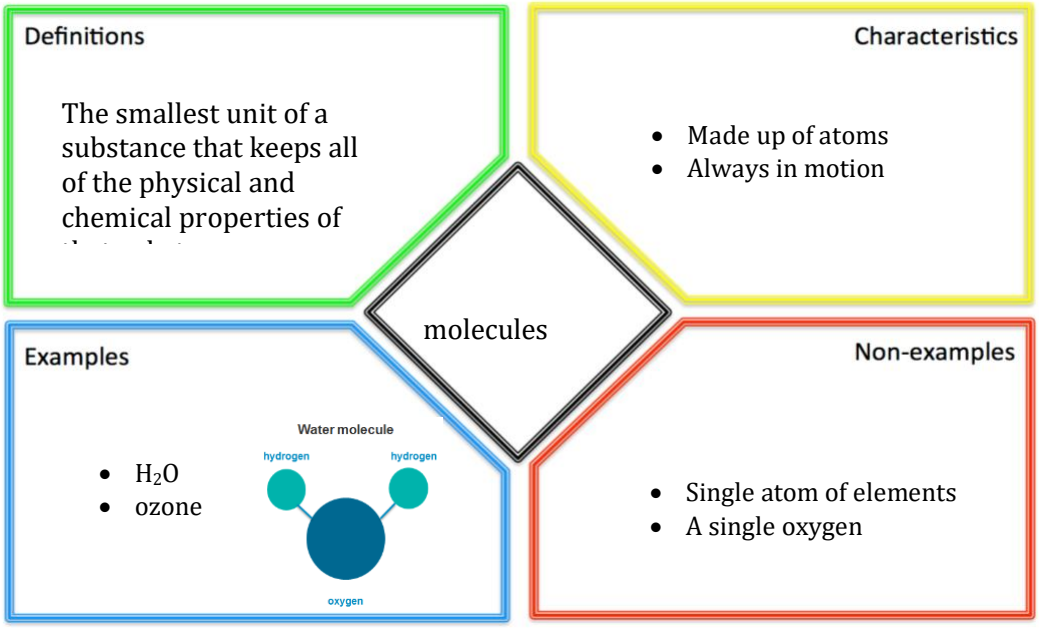
Doing this activity in pairs or teams builds students' collaboration skills.

Implementation Note

Developing their own definitions helps students build conceptual understanding.

Frayer Model for Vocabulary Development

Use the graphic organizer to write definitions, characteristics, examples and non-examples for a vocabulary word. You can include drawings, graphics, and diagrams.



Evaluate

Return to these discussion questions:

- ❑ What is the difference between heat and temperature?
- ❑ What role does the speed of molecules play in an object's temperature?
- ❑ How does a thermometer work?
- ❑ What happens to the movement of molecules in a solid when energy is added?

Compare student responses to Pre-assessment and Evaluate questions to determine if students have a clear understanding of the vocabulary.

Posttest items can be found at the ClassFlow Marketplace – *NASA Spotlite Interactive Lesson Plan – **Heat and Temperature** Pre / Post Test.*
https://prod.classflow.com/classflow/#!/product/itemId=b009cca396574473af9243723131112e

Extend

To reinforce and extend content knowledge, ask students to view any of the following NASA eClips™ videos:

NASA eClips™ video Real World: Space Shuttle Thermal Protection System – Students learn how experts used sand to protect the space shuttle from overheating when entering Earth's atmosphere.
https://nasaeclips.arc.nasa.gov/search/?terms=temperature&playlists=realworld&v=archive-real-world-space-shuttle-thermal-protection-system

NASA eClips™ video Launchpad: Protective Materials for Space crafts - Kevlar is stronger than steel but one-fifth the weight. While watching this segment, discover how Kevlar works and the future of protective materials.
https://nasaeclips.arc.nasa.gov/search/?terms=protective+materials&v=launchpad-protective-materials-for-spacecrafts

NASA eClips™ video Real World: Lessons in Heavy Metal – Students learn how NASA engineers use a special welding technique known as friction-stir welding to bond new composite metals. They also learn to convert degrees Fahrenheit to degrees Celsius.
https://nasaeclips.arc.nasa.gov/search/?terms=heavy+metal&playlists=realworld&v=archive-real-world-lessons-in-heavy-metal

To further extend students understanding of the difference between heat and temperature, have students complete one of these design challenges:

NASA Launchpad: Cooling Off design challenge. This activity introduces students to the challenge of maintaining temperatures while in space. Thinking and acting like scientists and engineers, students learn to measure specific heat capacity and design an improved cooling system like those used in spacesuits. Students utilize a design process to create and evaluate their designs.
https://nasaeclips.arc.nasa.gov/teachertoolbox/guides?r=nasa-launchpad-cooling-off

Feel the Heat Design Challenge. Students follow the engineering design process to do the following to build and test a solar hot water heater to see if the heater can raise the temperature of water.
https://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/OTM_Feel.html

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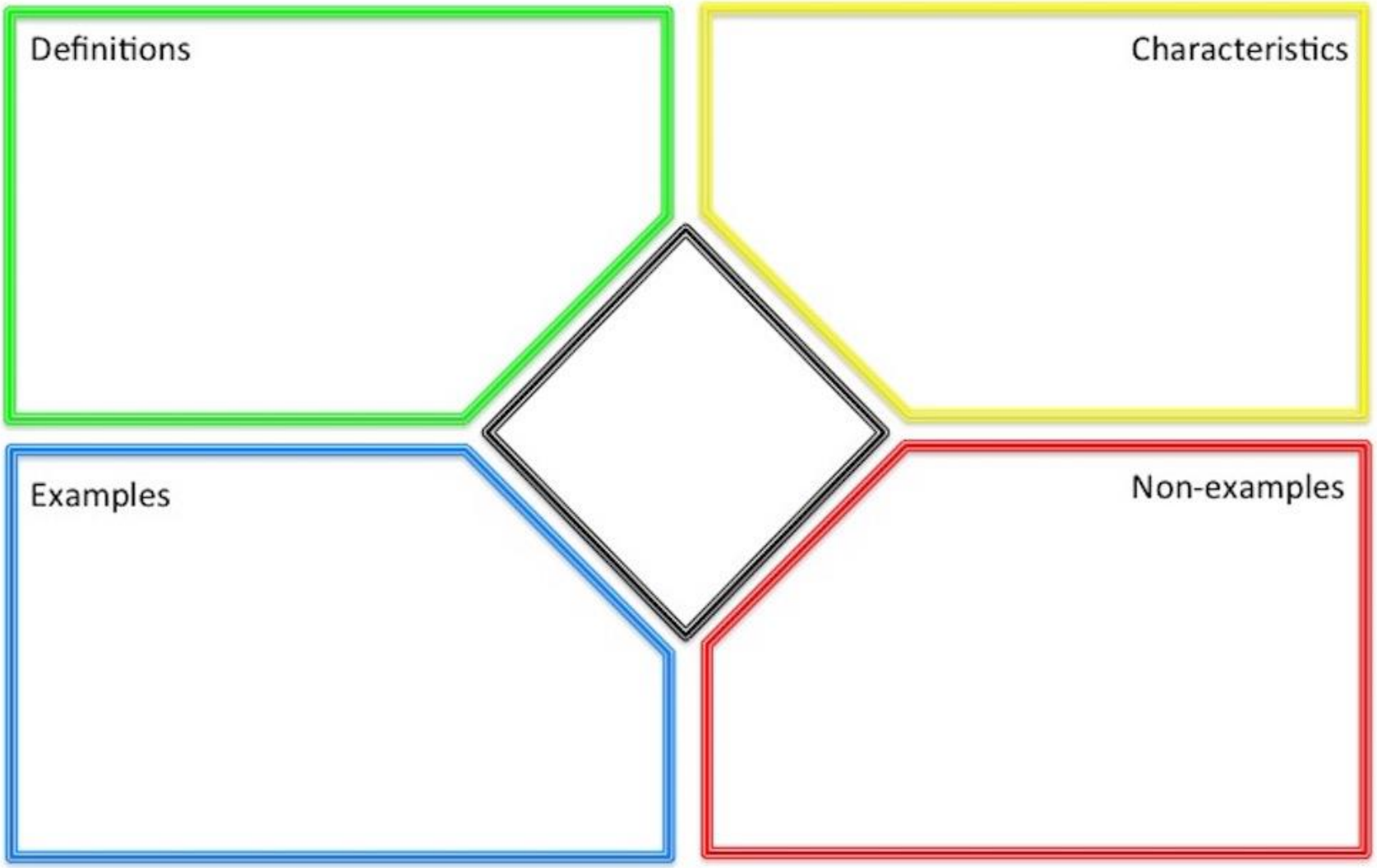


Heat and Temperature 6-9 Pre / Post Test
NASA Spotlite Interactive Lesson

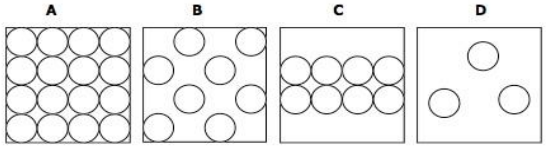
This assessment was designed for the interactive lesson plan featuring the student produced NASA Spotlite video Heat and Temperature. https://youtu.be/22iIVic22aw

1. Sue has a cup of hot chocolate and a cup of cold chocolate milk. Ken wants to know which drink has more kinetic energy (energy in motion). Select the statement that describes the drink that has more kinetic energy.
   A. The cup of hot chocolate because its molecules are moving slowly.
   B. The cup of cold chocolate milk because its molecules are moving quickly.
   C. The cup of hot chocolate because its molecules are moving quickly.
   D. The cup of cold chocolate milk because its molecules are moving slowly.

2. One can tell how fast a molecule is moving by measuring its _____.
   A. Shape
   B. Volume
   C. Temperature
   D. Mass

3. _____ is the energy an object has because of the movement of its molecules.
   A. Heat
   B. Thermometer
   C. Particles
   D. Temperature

4. Which of the following would indicate the molecules with the most heat energy?



5. As you heat something up the speed of the particles moves _____.
   A. not at all
   B. faster
   C. slower
   D. unhurriedly

6. What is the difference between temperature and heat?
   A. **heat** is the measure of kinetic energy and **temperature** is the energy created by the movement of an atom's molecules
   B. **heat** is the amount of mass in an object and **temperature** is the energy created by the movement of an atom's molecules
   C. **temperature** is the transfer from hot to cold and **heat** is the same thing as temperature
   D. **temperature** is the measure of kinetic energy and **heat** is the energy created by the movement of an atom's molecules

7. Higher temperatures mean that the molecules are moving, vibrating, and rotating with _____.
   A. less energy
   B. the same energy
   C. more energy
   D. no energy

ANSWER KEY

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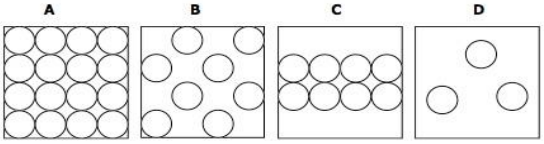

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For an electronic version use this link to view to the NASA Spotlite Interactive Lesson Plan **Heat and Temperature** Pre / Post Test at ClassFlow:
https://prod.classflow.com/classflow/#!/product/itemId=b009cca396574473af9243723131112e