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EDCI 5724

Heat and Temperature Lesson Plan: Eight Grade Physical Science (Probeware Lab)

Purpose/Rationale: The purpose of this lesson is for students to investigate the difference between heat and temperature using the 5-E Learning Model. By participating in discrepant events, students will understand that heat is transferred between objects and substances. Students will explore the relationship between heat and temperature, and how heat transfer occurs in refrigeration.

SOL's:

PS.1 The student will plan and conduct investigations in which

- length, mass, volume, density, temperature, weight, and force are accurately measured and reported using the International System of Units (SI – metric);
- triple beam and electronic balances, thermometers, metric rulers, graduated cylinders, and spring scales are used to gather data;
- research skills are utilized resources;
- independent and dependent variables, constants, controls, and repeated trials are identified;
- valid conclusions are made after analyzing data;
- research methods are used to investigate practical problems and questions.

PS.6 The student will investigate and understand states and forms of energy and how energy is transferred and transformed. Key concepts include:

- heat, light, and sound.

PS.7 The student will investigate and understand temperature scales, heat, and heat transfer. Key concepts include:

- applications of heat transfer (heat engines, thermostats, and refrigeration).

NSES: Content Standard for Science as Inquiry:

- Identify questions that can be answered through scientific investigations.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.
- Communicate scientific procedures and explanations.
- Use mathematics in all aspects of scientific inquiry.

Materials/Resources:

Activity sheet	Electronic scale
Safety goggles	Large bolt
Tongs	Small bolt
Salt	Various metallic objects
Water	(2) Vernier Temperature Probes (Probeware)
Ice	Data Logger
(5) 250-mL beaker	Serial Box Interface and ULI
hot plate	IBM or MAC computer

Learning Websites: http://rpsec.usca.sc.edu/Classwork/729Sp99/lesson/eberhard.htm
http://www.pasco.com/experiments/middle_school/december_2001/boiling_pt.html

Safety: Safety goggles must be worn by the teacher during activities that require use of boiling water.

Procedures:

Engage

1. The teacher will engage the students in learning about heat, temperature, and heat transfer by demonstrating the discrepant event "Boiling Bolts." The teacher will probe students' prior knowledge of heat and temperature by asking open-ended questions (See Activity Sheet). Students will complete the first part of the Activity Sheet as the teacher performs this experiment. [15 minutes]

Explore

2. Students will explore heat transfer by completing the discrepant event "Freezing Objects." Students will select six metallic objects of their choice (such as nails, screws, and bolts) from a freezing ice bath in order to conduct a modified version of the "Boiling Bolts" experiment. [20 minutes]

Explain

3. Students will create a line chart showing the temperature of the water in the beaker over time for two of the objects they tested. In addition, students will create a table listing all tested objects, the mass of each object, the initial water temperature in the beaker, the water temperature in the beaker containing each object at 30-second intervals for a period of 2 minutes, and the difference in initial and final temperatures of the water for each object. [10 minutes]

4. Students will discuss how heat transfer is applied to the refrigeration of food. After this discussion, students can refer to the textbook for more information on how heat travels from one molecule to another (conduction). [20 minutes]

Elaborate

5. Students will extend their understanding of heat transfer by completing the "Melting Ice" activity. Students will discuss heat transfer in the salted and non-salted ice. [20 minutes]

Evaluate

6. Students will provide the following evidence for understanding temperature, heat, and heat transfer.

Performance Criteria	**Evidence**	**Points***
Student understands the difference between temperature and heat.	Completion of "Boiling Bolts" activity with student explanation on activity sheet.	
Student demonstrates ability to create a table and graph of data.	Completion of "Freezing Objects" activity; proper labeling and placement of data in table and graph.	
Student discusses how refrigeration is an application of	Student discussion and reading textbook; answers	

heat transfer.	questions on activity sheet.	
Student discusses why salted ice has a different melting point than unsalted ice.	Student answers questions on activity sheet.	

*2 = completes activity and explanation without mistakes.
1 = completes activity but provides incomplete explanation
0 = does not complete activity or explanation

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Heat and Temperature Activity Sheet

Purpose: In this activity, you will investigate heat and temperature by completing the following activities.

Engage: Boiling Bolts

Materials: three beakers, water, large bolt, small bolt

1. Fill three beakers with 100 mL of tap water. Fill a fourth beaker half full of water. Place a large bolt and small bolt into this beaker (*after* measuring and recording the mass of each object in the table below). Place this beaker on a hot plate and allow the water to boil.

   What do you think will happen to the temperature of the two screws inside the beaker on the hot plate?

2. Measure the temperature (^{o}C) of the water in the first three beakers. Record this information in the table below.

   Using tongs, place the large bolt in the second beaker and the small bolt in the third beaker. Record the temperature (^{o}C) in those two beakers at 30-second intervals over a period of 2 minutes in the table below. Record the temperature of the water in the first beaker (which contains no object) at the end of the 2 minute period.

   What do you think the two objects will do to the water temperature in the two beakers?

Object	**Mass of object (grams)**	**Initial temp. of water (^{o}C)**	**30-second water temp. (^{o}C)**	**60-second water temp. (^{o}C)**	**90-second water temp. (^{o}C)**	**120-second final water temp. (^{o}C)**	**Change in initial and final water temp. (^{o}C)**
No object	----------		----------	----------	----------		

Which object was found in the beaker with the greatest water temperature change?

What do you think that object did to the water to cause a change in water temperature?

Explore: Freezing Objects

Materials: two beakers, water, ice, various metallic objects

3. Select six objects of your choice from the teacher's table. On your own paper, create a table listing all six objects. Determine and record the mass (in grams) of each object in your table. Place these six objects inside a beaker full of ice for at least 3 minutes.

4. For each object, measure and record the initial water temperature in the beaker in your table. Place one object in a beaker that contains 100 mL of tap water, and record the temperature (^oC) of the water in the beaker for 30-second intervals for a period of 2 minutes. Repeat this procedure for all six objects. (If you prefer, you can conduct the experiment testing two objects at one time -- each object in a separate beaker.)

   *Using the computer, create a line chart showing the temperature of the water containing **two** of the six objects over the 2 minute period.*

Explain:

4. In your table, record the **overall** water temperature change (^oC) in the beaker containing each object.

   Which object was found in the beaker with the greatest water temperature change? least temperature change?

   How do you think "temperature" is related to "heat"?

   What happens when you place food inside a refrigerator? (In your answer, use the words "heat" and "temperature." Please refer to the textbook for more information if you like.)

Elaborate: Melting Ice

Materials: two beakers, ice, salt

5. Fill a beaker about one-third full of crushed ice. Carefully pour 70 grams of salt onto the crushed ice. Add another one-third beaker of crushed ice on top. Fill a second beaker with only ice. Allow the two beakers to sit on your table for 3 minutes.

   Write a hypothesis of how you think salt will affect the freezing point of water.

   Measure the temperature of the melted liquid at the bottom of each of the beakers.

   Salted ice beaker: _____^oC Non-salted ice beaker: _____^oC

   Was your hypothesis supported <u>or</u> not supported by your temperature measurements? Why or why not?