Problem #4: What Is Heat? Lesson Plan
Heat Vs.Temperature

Introduction

This lesson introduces students to thermochemistry by allowing them to discover the difference between heat, temperature and ultimately discovering the specific heat of various substances. The students will work with samples of wood, metal and plastic in order to make these discoveries. The lesson concludes by allowing students to define heat, temperature and specific heat.

Learning outcomes

- The student will distinguish between temperature and heat
- The student will compare the temperature changes and heat absorbed by 3 different solids
- The student will understand and predict how temperature will change in a substance as heat is added to the substance based on the specific heat of the substance.
- The student will explain specific heat and describe how it differs from substance to substance.
- Students will calculate an unknown using $q = mC\Delta T$

Curriculum alignment

NC SCOS Goal 4.02: Analyze the law of conservation of energy, energy transformation, and various forms of energy involved in chemical and physical processes.

- Differentiate between heat and temperature.

National Science Content Standard A: As a result of their activities in grades 9-12, all students should develop an understanding of

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

National Science Content Standard B: As a result of their activities in grades 9-12, all students should develop an understanding of

- Structure and properties of matter
- Conservation of energy and increase in disorder

Classroom time required

1.5 – 85 minute class period

Materials needed

- *Heat vs. Temperature and Specific Heat Student Sheet* (1 per student)
- Samples of wood, metal and plastic (8 sets)
- 8 thermometers
- Student desk should be arranged so they can easily work in groups of 3 or 4
- *Heat vs. Temperature Calorimetry Activity* sheet (1 at each of the 8 lab stations)
- 8 Calorimeters (This may be as simple as 2 styrofoam coffee cups inside each other and a lid made from a piece of cardboard)

- Hot plates (4 shared between lab stations)

Technology resources

None required

Pre-activities

This is the first lesson of the thermochemistry unit, so there are no required pre-activities.

Activities

1. Prior to class, the teacher will place a sample of wood, metal and plastic on the desk for each group of students
2. Have students brainstorm places where they encounter energy in their daily lives.
3. Hand out the *Heat vs. Temperature and Specific Heat with Calorimetry Student Sheet*.
4. Ask students to read the objectives and perform step 1 and 2 of the activity.
5. The teacher should rotate from group to group and check the order of their samples. You may initial their sheets
6. As each group has their order checked, hand out thermometers and ask the groups to record the temperature of each substance in Table 1 on their sheet.
7. Students should continue with steps 3 -5 on their sheet.
8. The teacher will ensure that step 5 has been completed before students go to the lab area.
9. Students go to the lab and perform the *Heat vs. Temperature Calorimetry Activity*
10. When students return to their seats, present notes about heat, specific heat and $q = mC\Delta T$ problems. You may use the *Chemistry and Energy* powerpoint found in Web Sites and Resources section.
11. Students should complete Data Table 2 and steps 7 -13 of the *Heat vs. Temperature and Specific Heat with Calorimetry Student Sheet* as they proceed through this activity.
12. It may be necessary to stop the class around step 11 to ensure that students are able to make a distinction between heat and temperature. If students are getting the idea, allow them continue through step 13.
13. Provide the specific heat of water (4.184 J/g^{o}C or 1 cal/g^{o}C) so students may enter it on the activity sheets after step 13. Most metals have specific heats of less than 1 J/g^{o}C. Lead a discussion that lets students understand that substances with higher specific heats will take longer to acquire heat and change temperature and they will also hold on the heat longer. Again, the *Chemistry and Energy* powerpoint may be useful.
14. At this point, ask each group to write a list of things they have learned so far. Call on a volunteer from each group to state one thing they learned that has not been mentioned.
15. Assign questions 1 – 8 on the Post Activity Questions Sheet for homework.

Assessment

- Student feedback after step 14 of the activity.
- Students will complete the post activity questions and turn them in for assessment.
- Students will use these concepts throughout the unit.
- Students will be assessed on the unit test.

Modifications

This lesson is written for honor chemistry students. In order to use it for academic chemistry students, the teacher may have to stop more often and review key concepts with the students.

Critical vocabulary

Temperature is a property directly proportional to the kinetic energy of a substance. Temperature is measured using a thermometer and has units of K, ^{o}C or ^{o}F. Temperature is represented by the symbol ΔT or T. ΔT is calculated as $T_{final} - T_{initial}$.

Heat is a transfer of energy between 2 objects due to a difference in temperature. Heat always moves from hot to cold. It has units of Joules, calories or Calories (kcal). The symbols used for heat are ΔH or q. Heat is not directly measureable. It must be calculated using the following formula $q = mC\Delta T$.

Specific Heat (C) is the amount of heat it takes to raise the temperature of 1 g of a substance 1^{o}C. The symbol for specific heat is C. It has units of joules / g ^{o}C or calories / g ^{o}C. Every substance has its own unique specific heat that can be found in reference books. The formula used to determine the specific heat of an unknown is $C = q / m\Delta T$.

Heat Capacity is the amount of heat necessary to increase the temperature of an object exactly 1^{o}C.

Websites and Resources:

When using the Heat vs. Temperature Calorimetry activity, it may useful for the teacher to know approximate specific heats of wood, plastic and metal. It is easy to look these up using the internet, but I've included some for your use. $C_{pine\ wood} = 2.5$ J/g^{o}C, $C_{plastic} = 1.67$ J/g^{o}C, $C_{metal} = 0.5$ J/g^{o}C. Please understand that these vary depending on the specific wood, plastic or metal.

Chemistry and Energy powerpoint

Comments:

The samples of wood, plastic and metal used were density kits purchased from Fisher Scientific.

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