**MIDDLE SCHOOL**

**Green Chemistry**

**The Heat is On**

**Background:** An exothermic reaction is a chemical reaction which gives off heat. The energy needed for the reaction to occur is less than the total energy released. The extra energy is then released in the form of heat.

**Goal:** Students will observe, measure, and record the amount of heat given off in an exothermic chemical reaction.

**Objectives:** Students will…

* Observe an exothermic chemical reaction
* Measure the amount of heat given off at specific intervals during the reaction
* Record data on a chart
* Create a temperature over time graph showing their results
* Determine ambient temperature strategies to use in the lab

**Materials (for a class of 32 working in groups of 2):**

* 120 ml distilled water
* 8 graduated cylinders
* 40 g sodium hydroxide
* 8 Erlenmeyer flasks
* 8 thermometers
* 8 stopwatches
* 8 scales or triple beam balances
* 8 spatulas
* 8 sheets of weighing paper
* 32 pair of safety gloves
* 32 pair of safety glasses
* 8 copies of The Heat Is On – Student Data Table
* 32 copies of The Heat Is On - Lab Questions
* 32 copies of The Heat Is On – Lab Procedures
* 32 copies of The Heat Is On - Graph

**Time Required:** 45–60 minute class period

**Standards Met:**

* Properties and changes of properties in matter

**Green Chemistry Principles Addressed:**

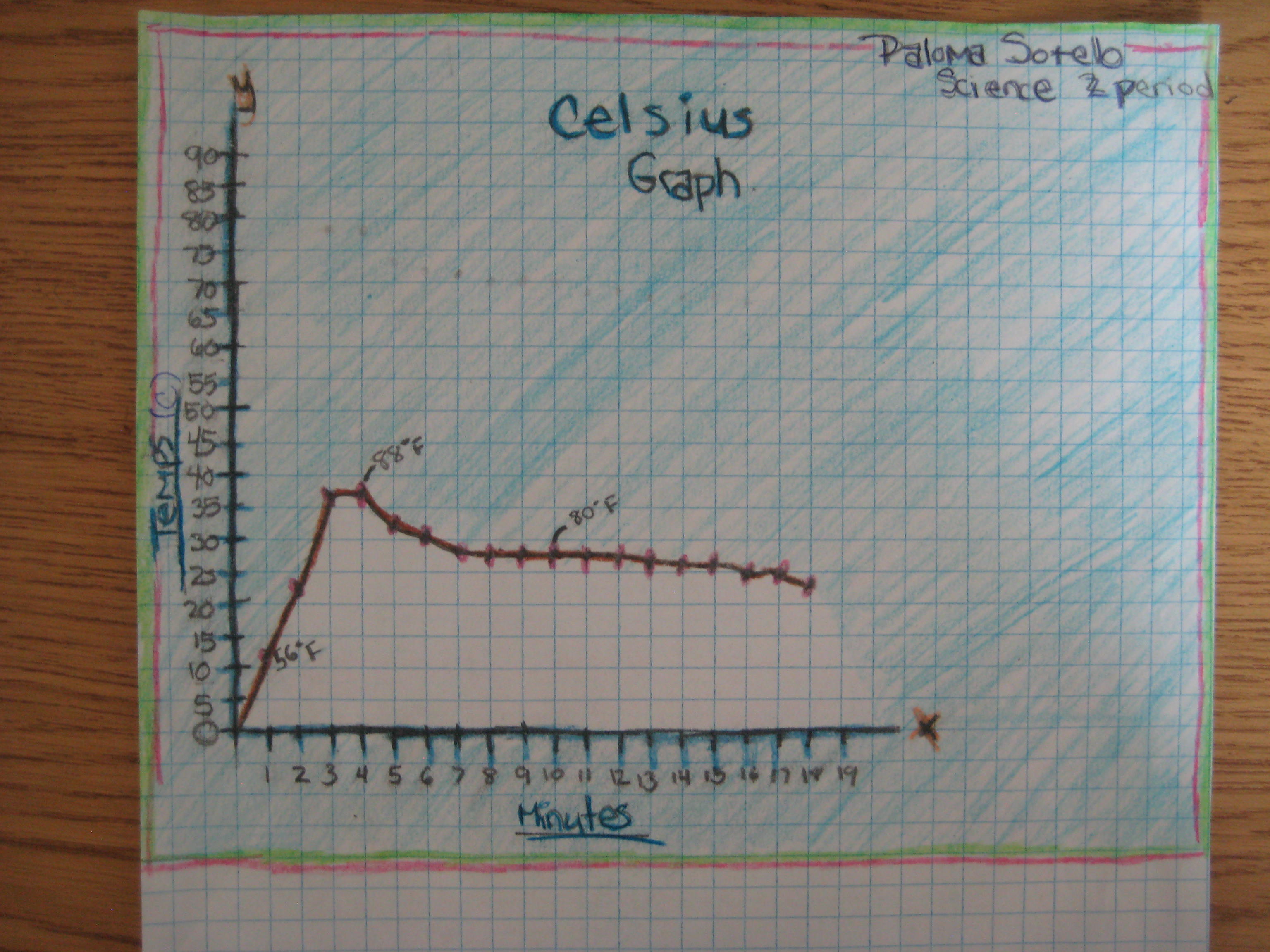
* Design chemicals and their forms (solid, liquid, or gas) to minimize the potential for chemical accidents including explosions, fires, and releases to the environment.
* Include in-process real-time monitoring and control during syntheses to minimize or eliminate the formation of byproducts
* Design syntheses to use and generate substances with little or no toxicity to humans and the environment.

**Procedure:**

* Tell students that they are going to test the properties of one of the substances used to make shampoo, sodium hydroxide
* Ask students if they have ever used Drano. Have one student describe what happens when the water is added to the product.
* Explain to students that sodium hydroxide is used in Drano, and it creates an exothermic reaction when the water is added. (Exothermic means the release of heat)
* Hand out The Heat Is On – Lab Procedures and walk students through the directions
* Place students in groups of 2 to 4
* Allow students time to complete the lab
  + If any group is not following safety procedures, fine the group and note it on their account ledgers!
* When finished with this lab, students should stopper the Erlenmeyer Flask and save the sodium hydroxide solution for the pH neutralization lab.
* Direct students to complete the line graph and lab questions individually

**Assessment:**

* Completed data table that accurately depicts the results of an exothermic reaction
* Completed line graph accurately showing data from the Student Data Table
* Completed lab questions
* Adhering to proper lab safety procedures

**Samples of Student GraphsThe Heat Is On – Lab Procedures**

* 1. Remove all materials from your lab station, paying special attention to the removal of any plastic and aluminum materials.
  2. Get a pair of safety glasses and gloves for each member of the group
* **Put both on**
  1. One member of your group should obtain your lab materials:
     + 1 thermometer
     + 1 balance
     + 15 ml of distilled H2O
     + 1 stopwatch
     + 1 Erlenmeyer flask
     + 1 graduated cylinder
     + 2 sheets of weighing paper
     + 1 metal spatula
     + 5 g NaOH
  2. Use a graduated cylinder to measure 15 ml of distilled H2O and pour into the Erlenmeyer flask.
  3. Take the temperature of the water and record it on your data table
  4. Using the balance and weighing paper, find 5 grams of NaOH
  5. Slowly transfer the NaOH to the Erlenmeyer flask with containing the H2O
  6. Carefully swirl the Erlenmeyer flask to mix the two together
  7. Immediately take the temperature of the mixture and record it on your data table
  8. Using the timer, continue to take the temperature at 1 minute intervals. Remember to record your data on the data table! Do this until the temperature of the mixture equals the initial temperature of the distilled water.
  9. Stopper the Erlenmeyer Flask and save the sodium hydroxide solution
  10. Keeping your data table out, clean up according to your teacher’s instructions
  11. Use the data table to complete your graph and answer the lab questions

**The Heat Is On – Student Data Table**

Temperature of Water = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Time Lapsed in Minutes** | **Temperature of Mixture** |  | **Time Lapsed in Minutes** | **Temperature of Mixture** |
| 0 |  |  | 16 |  |
| 1 |  |  | 17 |  |
| 2 |  |  | 18 |  |
| 3 |  |  | 19 |  |
| 4 |  |  | 20 |  |
| 5 |  |  | 21 |  |
| 6 |  |  | 22 |  |
| 7 |  |  | 23 |  |
| 8 |  |  | 24 |  |
| 9 |  |  | 25 |  |
| 10 |  |  | 26 |  |
| 11 |  |  | 27 |  |
| 12 |  |  | 28 |  |
| 13 |  |  | 29 |  |
| 14 |  |  | 30 |  |
| 15 |  |  | 31 |  |

**The Heat Is On – Graph**

Directions: On the graph paper below, use the data from the Student Data Table to construct a line graph of temperature over time. Your graph must include:

* Title
* Labels
* Temperature on the Y axis, Time on the X axis

**The Heat Is On – Lab Questions**

1. How much time did it take for the temperature of the mixture to match the starting temperature of the water? List a way to speed up the cooling process.
2. Read the principle below. Which part of the shampoo making process adheres to this principle? Which part of the shampoo making process does not adhere to this principle? Explain your answers.

* *Design chemicals and their forms (solid, liquid, or gas) to minimize the potential for chemical accidents including explosions, fires, and releases to the environment.*

1. Shampoo contains sodium hydroxide. Would you want to put this substance on your head regularly? Why or why not?
2. Read the principle below. Does the shampoo making process adhere to this principle? Why or why not?

* *Design syntheses to use and generate substances with little or no toxicity to humans and the environment.*

**The Heat Is On – Lab Questions – Teacher Key**

1. How much time did it take for the temperature of the mixture to match the starting temperature of the water? List a way to speed up the cooling process.

*Answers will vary, but will probably be in the 13-19 minute range.*

*We could put the sodium hydroxide, do the experiment in a giant cooler, or start with colder water.*

1. Read the principle below. Which part of the shampoo making process adheres to this principle? Which part of the shampoo making process does not adhere to this principle? Explain your answers.

* *Design chemicals and their forms (solid, liquid, or gas) to minimize the potential for chemical accidents including explosions, fires, and releases to the environment.*

*Water is a safe component, and it is at room temperature, keeping it in liquid form which is very benign. We had safety equipment and monitored the reaction.*

*The sodium hydroxide goes from a solid to a liquid and creates an exothermic reaction. This seems less safe, especially on a large scale in a shampoo making plant.*

1. Shampoo contains sodium hydroxide. Would you want to put this substance on your head regularly? Why or why not?

*Answers will vary, but may include:*

* *No, the fact that it creates an exothermic reaction with water frightens me. It might burn my head.*
* *Yes, once the reaction ran its course, the sodium hydroxide is not going to burn me.*
* *I don’t know. There are still many properties of sodium hydroxide that I am not familiar with. I’d like to do more tests to see if it is safe.*

1. Read the principle below. Does the shampoo making process adhere to this principle? Why or why not?

* *Design syntheses to use and generate substances with little or no toxicity to humans and the environment.*

*No, it creates an exothermic reaction. As proven by the Bhopal tragedy, this can lead to larger problems. If we could create shampoo without using this solution, we wouldn’t have to worry about equipment failure or human error.*