Name: ______________________

Understanding Specific Heat

Prelab
Read through the lab and answer these questions. Teacher initials ________
1. What is specific heat? What is the symbol for specific heat?

2. List the equipment needed for this lab.

3. List the chemicals needed for this lab.

Background
If you mix a bucket of hot water with a bucket of cold water, the final temperature will lie somewhere in between, right? What if you mixed water with some other liquid, would you get the same results?

One characteristic or property of all solids and liquids is something called the specific heat \((c)\). This quantity is the amount of heat required to raise or lower 1 g of a substance by 1 °C. Water’s specific heat is 4.18 J/g °C. In other words, it takes 4.18 J of energy to raise the temperature of 1 g of water by 1° C. That’s what makes it such a wonderful substance for heating and cooling, because relative to other substances, that’s a lot of energy. Blacksmiths use water to quench hot steel, and cars use water to cool their engines.

A rule of thermodynamics (the study of heat and heat transfer) is that when two objects are placed in contact, they eventually reach thermal equilibrium. Energy, in the form of heat, flows from the warmer object to the cooler one until the substances both reach the same temperature (equilibrium). Even when liquids are mixed this rule is obeyed.

Procedure
PART I: The same liquids
1. Read the procedure and make a data table. Get your teacher’s approval before collecting data.
2. Fill one beaker about halfway (at least a few hundred mL) with hot water. Put the same amount of cold water in another beaker. Record the temperatures of each.
3. Predict what the final temperature will be when they are mixed (when they reach thermal equilibrium).
4. Pour the two beakers of water into a third container and measure the final temperature (make sure the third container is big enough to hold the contents of the two beakers before you pour).
5. Is there a difference between your prediction and what you observed? What might have caused this?
6. Pour the water down the sink.

PART II: Different liquids
1. Read the procedure and make a data table. Get your teacher’s approval before collecting data.
2. Similar to Part I, obtain a sample of hot water (a few hundred mL) in a beaker and record its initial temperature.
3. Obtain an equal quantity of nontoxic antifreeze in your other beaker and measure its temperature.
4. Predict the final temperature the two substances should measure when they reach thermal equilibrium.
5. Pour the contents of the two beakers into a third container and measure the final temperature.
6. Compare this to your predicted value. You were off this time, weren’t you?
7. Pour the solution down the sink. Rinse the beakers with lots of water.

Analysis
1. Antifreeze has a much lower specific heat than water. The specific heat of antifreeze is 2.40 J/g°C. For every 1 g of antifreeze, it takes 2.40 J of energy to raise the temperature 1 °C. Find the specific heat of water:
   Using the specific heat and antifreeze, explain why the temperatures were so different when equal amounts of liquid was mixed together in each part.

2. Complete the table with each element’s specific heat.

<table>
<thead>
<tr>
<th>Element</th>
<th>Specific heat (J/g °C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron (Fe)</td>
<td></td>
</tr>
<tr>
<td>Gold (Au)</td>
<td></td>
</tr>
<tr>
<td>Neon (Ne)</td>
<td></td>
</tr>
</tbody>
</table>

a. If all three elements were heated with the same amount of hot water, which would feel the hottest? Explain.

b. If all three elements were heated with the same amount of hot water, which would feel the coolest? Explain.