**Calorimetry: Specific Heat of a Metal**

* **LEQ: How can calorimetry be used to calculate the energy changes in a substance?**
* **Introduction:**

Chemists indentify substances on the basis of their chemical and physical properties. One physical property of a substance is the amount of energy it will absorb per unit of mass. This property can be measured quite accurately in is called specific heat (Cp). Specific heat is the amount of energy, measured in joules, needed to raise the temperature of one gram of the substance one Celsius degree. Often applied to metallic elements, specific heat can be used as a basis for comparing energy absorption and transfer.

To measure specific heat in the laboratory, a calorimeter of some kind must be used. A calorimeter is a well-insulated container used in measuring energy changes. The calorimeter is insulated to reduce the loss or gain of energy to or from the surroundings. Energy always flows from an object at a higher temperature to an object at a lower temperature. The heat gained by the cooler substance equals the heat lost by the warmer substance, if we assume no loss of heat to the surrounding environment.

*heat lost = heat gained*

In this experiment, you will determine the specific heat of a metal sample. The metal sample will be heated to a high temperature then placed into a calorimeter containing a known quantity of water at a lower temperature. Knowing the mass of the water in the calorimeter (1mL of water = 1g), the temperature change of the water (ΔT), and knowing the specific heat of water (4.184J/g·C), the heat gained by the water (lost by the metal) can be calculated.

**Data Table**

*(Copy into your lab notebook before lab day.)*

|  |  |
| --- | --- |
| **material** | **mass (g)** |
| \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_metal |  |
| 200mL water | 200.00g |
| **material** | **temperature (C)** |
| room temperature water |  |
| boiling water |  |
| water in calorimeter  (after metal was added) |  |

* **Safety:** Goggles and aprons are required. Be careful with the hot plate as with all electrical equipment. Be aware that hot glassware does not look hot.

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Receipt

Calorimetry: Specific Heat of a Metal

Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Period\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* **Procedure:**
* 1. Make a hot water bath by filling a 250mL beaker about half full of water and placing it on a hot plate. Plug in the hot plate to bring the water to boiling.
* 2. Measure the mass of your metal pieces and record.
* 3. Put the metal pieces into your test tube.
* 4. Place the test tube containing the metal into the hot water bath and continue heating. Once the water starts boiling, leave the test tube in the boiling water bath for at least 10 minutes. Continue with steps 5 & 6 while you wait.
* 5. Measure out exactly 200mL of distilled water and place into your calorimeter.
* 6. Measure the temperature of the room temperature water in your calorimeter and record.
* 7. Now, measure the temperature of the boiling water and record. (It will be assumed the temperature of the metal is the same as the boiling water.) When finished recording temperature, run faucet water over the thermometer to bring down the temperature to room temperature and then carefully insert your thermometer into the cork of lid of your calorimeter. (The other small hole in the lid is for the stirrer.)
* 8. After 10 minutes has elapsed since step 4, remove the test tube containing the metal from the boiling water and immediately pour just the metal into your calorimeter and cover immediately!
* 9. Stir slowly and then record the highest temperature reached.
* **Calculations: You will be using the following formula: Q = m x c x ΔT**

**Q = heat m = mass c = specific heat ΔT = change in temperature**

1. **Change in temperature (ΔT) of the water**

Subtract the room temperature water from the temperature of the water in the calorimeter (after the metal was added).

*Temperature of water in calorimeter (after metal was added)*

*– Room temperature water*

*ΔT of the water*

2. **Heat gained by the water**

Multiply the mass of the water (200g) by the change in temperature of the water (*ΔT* ) and by the specific heat of water (4.184J/g·C)

*Mass of water (200g) x ΔT of the water x Specific heat of water(4.184J/g·C)*

*= Heat gained by the water (Heat lost by the metal)*

**3. Change in temperature (ΔT) of the metal**

Subtract the temperature of the water in the calorimeter (after the metal was added) from the hot metal (same as boiling water temperature)

*Hot metal (same as boiling water temp.)*

*– Temperature of water in calorimeter (after metal was added)*

*ΔT of the metal.*

**4. Specific heat of the metal**

Divide the heat gained by the water (heat lost by the metal) by the mass of the metal multiplied by the change in temperature of the water.

*Heat gained by the water (Heat lost by the metal) = Specific heat of the metal*

*Mass of metal x ΔT of the metal*

EXTRA CREDIT:

Calculate the percentage error of your answer.