Coffee Cup Calorimetry

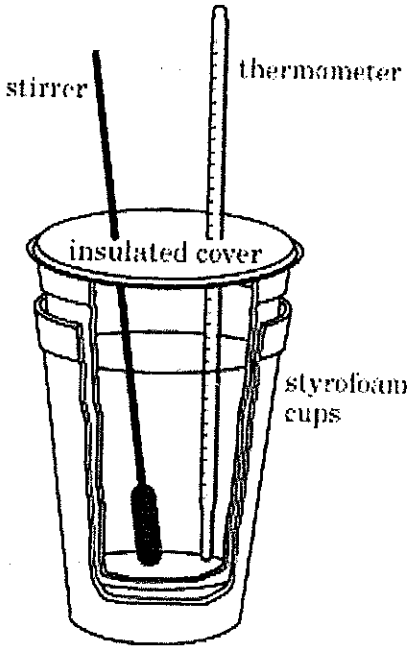
Introduction:

In order to study heat we will perform calorimetry. Calorimetry means the measure (metry) of heat (calor). We will measure the amount of heat produced in two different reactions.

Equipment/Materials:

Two Styrofoam cups
Computer
Vernier Temperature Probe
50 mL of HCl
50 mL of NaOH
5g of Ammonium nitrate
100 mL of H_2O
Mass Balance
Cardboard lid with a hole in the top

Set-up:



Procedure: Neutralization Reaction

1. Set-up coffee cup calorimeter according to the picture above.
2. Connect the temperature probe to the computer.
3. Open LoggerPro Light.
4. Measure approx. 50 mL of HCl. Record exact volume here: _____mL
5. Pour the HCl into the Styrofoam cup.
6. Record the temperature of the HCl. Record the temp. here: _____°C
7. Measure approx. 50 mL of NaOH. Record exact volume here: _____mL
8. Pour the NaOH into the cup with the HCl. Immediately begin recording the temperature by pressing the green Collect button.

9. Record the temperature until the reading stabilizes. Press the red Stop button.

10. Record the final temperature here: _____ °C

11. Print the graph and data table from LoggerPro.

12. Pour the contents of the Styrofoam cup down the sink.

Procedure: Heat of Solution

1. Set-up coffee cup calorimeter according to the picture above.
2. Connect the temperature probe to the computer.
3. Open LoggerPro.
4. Measure approx. 100mL of water. Record exact volume here: _____mL
5. Pour the water into the Styrofoam cup.
6. Record the temperature of the water. Record the temp. here: _____°C
7. Measure approx. 5g of NH_4NO_3. Record exact mass here: _____ g
8. Pour the NH_4NO_3 into the cup with the water. Stir with the temperature probe. Immediately begin recording the temperature by pressing the green Collect button.
9. Record the temperature until the reading stabilizes. Press the red Stop button.

10. Record the final temperature here: _____ °C

11. Print the graph and data table from LoggerPro.

12. Pour the contents of the Styrofoam cup down the sink.

Calculations:

Heat of Neutralization:

1. First calculate the heat of the surroundings (the water).
2. What is the mass of the water used in the experiment? Remember that the HCl and NaOH solutions you used were essentially water. (Hint: density of water is 1 g/mL)
3. The heat capacity (C) of water is 1 cal/g°C
4. What was the change in temperature during the experiment? $\Delta T = T_f - T_i$
5. Calculate q of the surroundings: $q_{surroundings} = m_{water} \times C_{water} \times \Delta T$
6. The heat of reaction is the opposite sign of the heat of the surroundings. What is the heat of the reaction?

Heat of Solution:

1. First calculate the heat of the surroundings (the water).
2. What is the mass of the water used in the experiment? (Hint: density of water is 1 g/mL)
3. The heat capacity (C) of water is 1 cal/g°C
4. What was the change in temperature during the experiment? $\Delta T = T_f - T_i$
5. Calculate q of the surroundings: $q_{surroundings} = m_{water} \times C_{water} \times \Delta T$
6. The heat of reaction is the opposite sign of the heat of the surroundings. What is the heat of the reaction?

Post Lab Questions:

1. What was the heat of neutralization calculated in the lab?

2. What was the heat of solution calculated in the lab?

3. Compare and contrast endothermic and exothermic reactions.

4. Was the heat of neutralization reaction endothermic or exothermic?

5. Was the heat of solution reaction endothermic or exothermic?