Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Student Activity- Heat of Neutralization**

**Learning Objective** **ENE-2.C** Explain the relationship between the transfer of thermal energy and molecular collisions.

**ENE-2.D** Calculate the heat *q* absorbed or released by a system undergoing heating/cooling based on the amount of the substance, the heat capacity, and the change in temperature.

**ENE-3.A**Calculate the enthalpy change of a reaction based on the average bond energies of bonds broken and formed in the reaction.

**Science Practice**s: **6.D** Provide reasoning to justify a claim using chemical principles or laws, or using mathematical justification.

**4.C** Explain the connection between particulate-level and macroscopic properties of a substance using models and representations.

**5.F** Calculate, estimate, or predict an unknown quantity from known quantities by selecting and following a logical computational pathway and attending to precision.

When acids and bases combine, they neutralizer ach other forming a salt and water. This type of reaction will release heat. You will determine the amount of heat energy released from this type of reaction. Then you will discover what happens when the concentrations of the acid and base are changed.

**Mixing Acids with Bases**

1. Carefully measure 25.0 mL of 1.00 M HCl (aq) and pour this into a Styrofoam cup.

2. Place your thermometer in the cup and record the temperature.

3. Carefully measure 25.0 mL of 1.00 M NaOH (aq) and pour this into a Styrofoam cup with the HCl(aq).

4. Stir using the thermometer and record the final temperature.

5. Rinse out the cup and repeat this experiment using 0.500 M solutions of the acid and base.

**Data Table: Heat of Neutralization**

|  |  |  |
| --- | --- | --- |
|  | **1.00 M HCl + 1.00 M NaOH** | **.500 M HCl + .500 M NaOH** |
| **Starting Temperature (oC)** |  |  |
| **Final Temperature (oC)** |  |  |

**Answer the following questions:**

1. Write out the reaction for HCl(aq) and. NaOH (aq).

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2. Using q = mCT, calculate the heat of both reactions. (Assume the mass of the acid and base combined was 50.0 grams and that C = 4.184 J/g **.** oC ).

**Reaction 1 (1.00 M)** :

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**Reaction 2 (0.500 M)** :

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3. List the measurements that must be made in order to obtain the value of *q .*

4. Calculate the moles of water formed during each experiment?

**Reaction 1 (1.00 M)** :

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Reaction 2 (0.500 M)** :

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5. Calculate The value of the molar enthalpy of neutralization, *Hneut*, in kJ/mol*rxn* for the reaction between HCl(*aq*)and NaOH(*aq*).for each experiment.

(Remeber the reactions were exothermic).

**Reaction 1 (1.00 M)** :

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**Reaction 2 (0.500 M)** :

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6. Are the *Hneut* similar or different for the two experiments? Explain.

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7. We are assuming that the thermometer and the Styrofoam cup did not absorb any energy during these reactions. Did this assumption lead to a calculated value that was higher than, lower than or the same as it would have been if we had taken the heat capacities of the thermometer and the cup into account? Justify your answer.

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