CALCULATING HEAT OF REACTION (EXPERIMENT 6)

$$Q_{system} + Q_{cup} + Q_{water} = 0$$

First Law of Thermodynamics: conservation of energy

We want to solve for Qsystem, since it equals the heat of reaction at constant pressure. So, we need to know what Qcup and Qwater equal!

$$Q_{cup} = (\text{heat capacity of cup}) \times \Delta T$$

Heat capacity: The amount of energy required to change the temperature of an object by 1 degree C.

heat capacity of cup $= 10.5\ /^{\circ}C$, for a set of cups like the ones in experiment 6

$$\Delta T = T_{final} - T_{initial}$$

$T_{initial}$: before mixing solutions

T_{final}: after reaction (get this from your temperature graph)

$$Q_{water} = \left(\text{mass of water in cup}\right) \times \left(\text{specific heat of water}\right) \times \Delta T$$

- mass of water in cup: Includes the mass of water from both the acid AND base soultions poured into the cup. In Experiment 6, this will equal about 100 grams.
- specific heat of water: $4.184\ J/g°C$ — Similar to heat capacity, but for a SUBSTANCE instead of an object
- ΔT: This is the same temperature change as for the cup

$$Q_{system} = -Q_{cup} - Q_{water}$$

Rearrange our first equation to solve for Qsystem

$$Q_{system} = -(Q_{cup} + Q_{water})$$

Since Qcup and Qwater are both positive, the sign of Qsystem is negative. In thermodynamics, the SIGN of Q tells the DIRECTION of energy transfer. A NEGATIVE Q means that energy is LEAVING the system. So, the reaction (our system) is EXOTHERMIC. It releases energy to the surroundings!

Qsystem depends on the amount of reactants used for the reaction. The more reactants used, the larger the magnittude of Qsystem will be. So, we'd like to express the heat of reaction in terms that DON'T depend on exactly how much reactant was used. We'll express the heat of reaction in this experiment in terms of the energy per mole reactant!

$$Q_{reaction} = \frac{Q_{system}}{(\text{moles of limiting reactant})}$$

Find the moles of limiting reactant by calculating EITHER the number of moles of acid or the number of moles of base you put into the cup. (Whichever one you put in less of is the limiting reactant)