

CALCULATING HEAT OF REACTION (EXPERIMENT 6)

1/3

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

First Law of Thermodynamics: conservation of energy

We want to solve for Q_{system} , since it equals the heat of reaction at constant pressure. So, we need to know what Q_{cup} and Q_{water} equal!

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

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

$\Delta T = 10.3 / ^\circ\text{C}$, for a set of cups like the ones in experiment 6

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

before mixing solutions

after reaction (get this from your temperature graph)

$$Q_{\text{water}} = \left(\text{mass of water in cup} \right) \times \left(\text{specific heat of water} \right) \times \frac{\Delta T}{1}$$

This is the same temperature change as for the cup

4.184 J/g°C Similar to heat capacity, but for a SUBSTANCE instead of an object

Includes the mass of water from both the acid AND base solutions poured into the cup. In Experiment 6, this will equal about 100 grams.

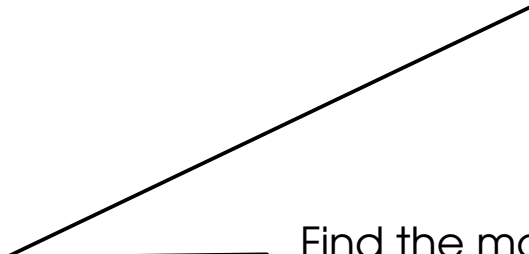
$$Q_{\text{system}} = -Q_{\text{cup}} - Q_{\text{water}} \quad \left[\text{Rearrange our first equation to solve for } Q_{\text{system}} \right]$$

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

Since Q_{cup} and Q_{water} are both positive, the sign of Q_{system} 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!

Q_{system} depends on the amount of reactants used for the reaction. The more reactants used, the larger the magnitude of Q_{system} 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!

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



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)