Endothermic and exothermic reactions

Science Background

Enthalpy change

Chemical changes are generally accompanied by energy changes; energy is absorbed or released usually as heat. Breaking chemical bonds in reactants requires energy, and energy is released as new bonds form in products. The net result of these steps depends on the relative sizes of the energies associated with breaking and forming bonds and determines if the reaction absorbs or releases energy

The amount of heat involved in a reaction depends not only on what the reaction is, but also on the temperature at which the reaction occurs and whether the reaction occurs under conditions of constant pressure or constant volume. In the laboratory, many reactions are conveniently carried out at constant pressure in beakers or flasks that are open to the atmosphere. The amount of heat absorbed or released under this condition is the *enthalpy change*, ΔH, for the reaction, where $\Delta H = H_{products} - H_{reactants}$.

The heat of reaction

Because reactions occur at constant pressure enthalpy change is the same as *heat of reaction*. In other words

$$Q = \Delta H.$$

The quantity of heat change in a chemical reaction carried out in aqueous solution can be calculated using the equation:

$$Q = c * m * \Delta T$$

Q is the quantity of heat (in joule), *m* is the mass of the substance undergoing the change (in kilograms), c is the specific heat of the substance (in joule/(kg*kelvin), and ΔT is the change in temperature (in kelvin). In this experiment, the substance undergoing the change would be the solvent (water) for which c and m are known. Since the change in temperature is obtained in the experiment, the change in energy can be calculated.

The quantity of heat is measured experimentally by allowing the reaction to take place in a thermally insulated vessel like a calorimeter or a Styrofoam cup placed in a beaker. Ideally, the heat release in the reaction would only cause an increase in the temperature of the solution. However, because no calorimeter is perfect, some of the heat is “lost” to the calorimeter itself and to the surroundings.

Endothermic and exothermic reactions

A reaction in which heat is absorbed from the surroundings (the enthalpy change, $\Delta H = H_{products} - H_{reactants}$, is positive) is called endothermic reaction. During such reaction the heat is gained and the surroundings cool down. A reaction in which the heat is released to the surroundings (the enthalpy change, $\Delta H = H_{products} - H_{reactants}$, is negative) is called exothermic reaction. During such reaction heat is lost and the surroundings heat up.