Measuring Energy Changes

Combustion releases energy.
Respiration ($C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$) releases energy.
Photosynthesis ($6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$) absorbs energy.

Exothermic reactions release energy (for example a reaction that makes the surroundings warmer).
Endothermic reactions absorb energy (for example a reaction that makes the surroundings colder).

Experiments measuring heat change use a calorimeter (an insulated container in which the reaction occurs and a device inside to measure the temperature change of some substance, usually water).

$$E = mc_p\Delta T$$

E is the heat absorbed/released in J

m is the mass of the substance that changes temperature

c_p is the specific heat capacity of the substance that changes temperature

ΔT is the temperature change of the substance

Note: The *reacting* substances are not included anywhere in the above formula – all values are for the substance being heated or cooled by the reaction.

This energy can be divided by the number of moles or mass in grams of the reacting substance to get the energy released/absorbed per mole or per gram.

Assumptions/approximations made during calorimetric calculations:

- The density of a solution is assumed to be the same as water i.e. 1 g mL^{-1}
  So 1 mL of solution has a mass of 1 g
- The specific heat of a solution is assumed the same as water, 4.18 J g^{-1} $°C^{-1}$ (always given)
- All heat energy change is assumed to occur in the water or solution
  So the change in temperature of the water or solution is used to calculate energy change.
- The heat energy is assumed evenly distributed throughout the water/solution.
- It is assumed that the reaction occurs quickly enough for the water or solution to reach maximum or minimum temperature (according to the energy change) before room temperature begins to cool it down or warm it up again.

The enthalpy of reaction depends on the number of moles of something in the reaction:

Kind of reaction	**Number of moles of**
neutralisation	hydrogen ions being transferred
solution	substance dissolving
combustion	substance being burnt completely in oxygen

Writing a thermochemical equation for some reaction simply involves writing the chemical equation as usual (reactants → products) including state symbols, and to the right writing the enthalpy change ΔH

- in kJ mol^{-1} if one of the three "enthalpy of reaction" types
- in kJ or J if not
- including the sign (+ for absorbed energy, - for released energy)

Remember: ΔH is -ve for exothermic reactions, and +ve for endothermic reactions.