

Energy and chemical reactions

Nearly all chemical reactions involve a change in energy. Some reactions involve electrical energy or light energy, but almost all involve heat energy. The change in energy in a reaction results from the different amounts of energy involved when bonds are broken and formed. The study of heat energy in chemical reactions is called **thermochemistry**.

● **Enthalpy change of reaction or heat of reaction (ΔH)**. The amount of heat energy given out or absorbed during a chemical reaction. If the reaction is a change of state*, this amount is also known, particularly in physics, as the latent heat (see page 30). Hence the

$$\text{Enthalpy} = \text{total enthalpy of products} - \text{total enthalpy of reactants}$$

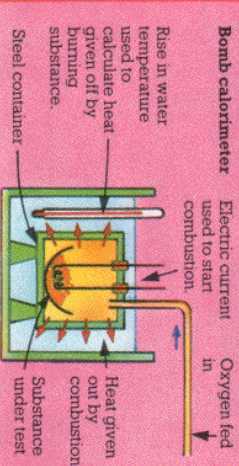
molar enthalpy changes of fusion and vaporization on page 147 are closely allied to the specific latent heats on page 31, though the quantities are different (each being more relevant to its science).



The value of ΔH is only true for the number of moles* and the physical states* of the chemicals in the equation. 1 stands for joule*, a unit of energy, kJ stands for kilojoule (1000 joules).

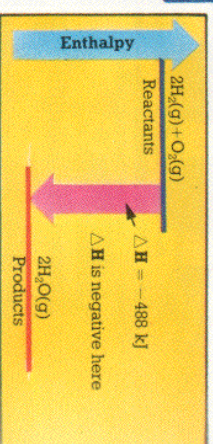
Special enthalpy changes

● **Enthalpy change of combustion or heat of combustion**. The amount of heat energy given out when one mole* of a substance is completely burnt in oxygen. The heat of combustion for a substance is measured using a bomb calorimeter.



● **Enthalpy (H)**. The amount of energy that a substance contains. It is impossible to measure directly, but its change during a reaction can be measured.

● **Energy level diagram**. A diagram which shows the enthalpy change of reaction for a reaction.



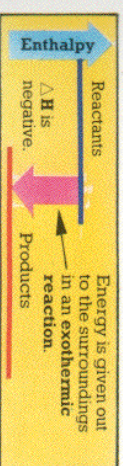
● **Standard enthalpy change of reaction (ΔH°)**. An enthalpy change of reaction measured under standard conditions, i.e. standard temperature and pressure (s.t.p.*). If solutions are used, their concentration* is 1M*.

● **Enthalpy change of neutralization or heat of neutralization**. The amount of heat energy given out when one mole* of hydrogen ions (H^+) is neutralized* by one mole of hydroxide ions (OH^-). If the acid and alkali are fully ionized*, the heat of neutralization is always -57 kJ . The ionic equation* for neutralization is:

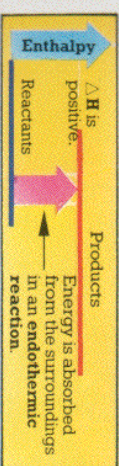


When a weak acid* or a weak base* is involved, the heat produced is less. Some energy must be supplied to ionize the acid fully.

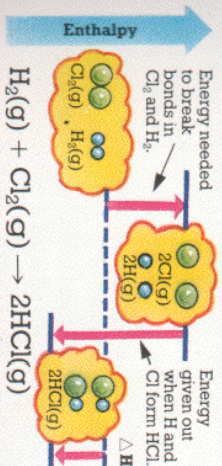
● **Exothermic reaction**. A chemical reaction during which heat is transferred to the surroundings.



● **Endothermic reaction**. A chemical reaction during which heat is absorbed from the surroundings.

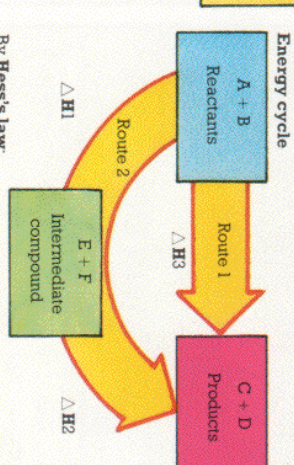


● **Bond energy**. A measure of the strength of a covalent bond* formed between two atoms. Energy must be supplied to break bonds and is given out when bonds are formed. A difference in these energies produces a change in energy during a reaction.



● **Law of conservation of energy**. During a chemical reaction, energy cannot be created or destroyed. In a closed system* the amount of energy is constant.

● **Hess's law**. This states that the enthalpy change of reaction that occurs during a particular chemical reaction is always the same, no matter what route is taken in going from the reactants to the products. Hess's law is illustrated by an energy cycle.



By Hess's law:

$$\Delta H_1 + \Delta H_2 = \Delta H_3$$
 (for reaction $A + B \rightarrow E + F$) + (for reaction $E + F \rightarrow C + D$) = (for reaction $A + B \rightarrow C + D$)

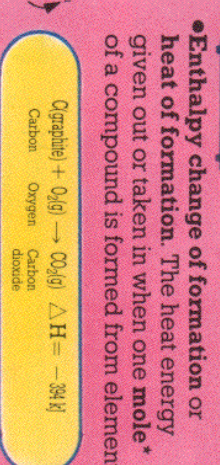
Hess's law is used to find enthalpy changes of reaction which cannot be measured directly, e.g. the enthalpy change of formation of methane.

● **Enthalpy change of solution or heat of solution**. The amount of heat energy given out or taken in when one mole* of a substance dissolves in such a large volume of solvent* that further dilution produces no heat change.

● **Molar enthalpy change of fusion or molar heat of fusion**. The amount of heat energy required to change one mole* of a solid into a liquid at its melting point. Energy must be supplied to break the bonds in the crystal lattice* of the solid.



● **Molar enthalpy change of vaporization or molar heat of vaporization**. The heat energy needed to change one mole* of a liquid into a vapour at its boiling point.



● **Enthalpy change of formation or heat of formation**. The heat energy given out or taken in when one mole* of a compound is formed from elements.

