

# Chemical reactions and equations

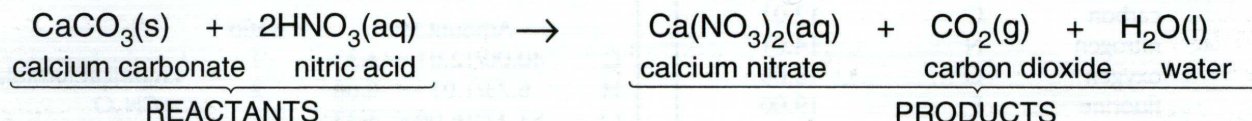
## PROPERTIES OF CHEMICAL REACTIONS

In all chemical reactions:

- new substances are formed.
- bonds in the reactants are broken and bonds in the products are formed resulting in an energy change between the reacting system and its surroundings.
- there is a fixed relationship between the number of particles of reactants and products resulting in no overall change in mass – this is known as the stoichiometry of the reaction.

## CHEMICAL EQUATIONS

Chemical reactions can be represented by chemical equations. Reactants are written on the left hand side and products on the right hand side. The number of moles of each element must be the same on both sides in a balanced chemical equation, e.g. the reaction of nitric acid (one of the acids present in acid rain) with calcium carbonate (the main constituent of marble statues).



## COEFFICIENTS

The coefficients in front of each species give information on the molar ratio. In the above example two moles of nitric acid react with one mole of calcium carbonate to produce one mole of calcium nitrate, one mole of carbon dioxide, and one mole of water.

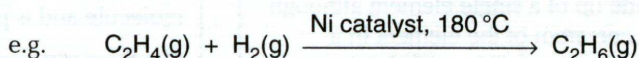
## STATE SYMBOLS

Because the physical state that the reactants and products are in can affect both the rate of the reaction and the overall energy change it is good practice to include the state symbols in the equation.

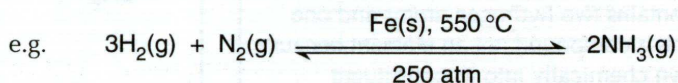
(s) – solid    (l) – liquid    (g) – gas    (aq) – in aqueous solution

→ OR ⇌

A single arrow → is used if the reaction goes to completion. Sometimes the reaction conditions are written on the arrow:

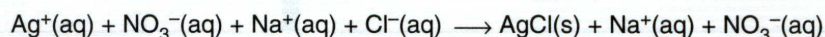


Reversible arrows are used for reactions where both the reactants and products are present in the equilibrium mixture:

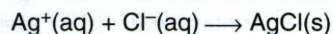


## IONIC EQUATIONS

Because ionic compounds are completely dissociated in solution it is sometimes better to use ionic equations. For example, when silver nitrate solution is added to sodium chloride solution a precipitate of silver chloride is formed.



$\text{Na}^+(\text{aq})$  and  $\text{NO}_3^-(\text{aq})$  are spectator ions and do not take part in the reaction. So the ionic equation becomes:



From this we can deduce that any soluble silver salt will react with any soluble chloride to form a precipitate of silver chloride.