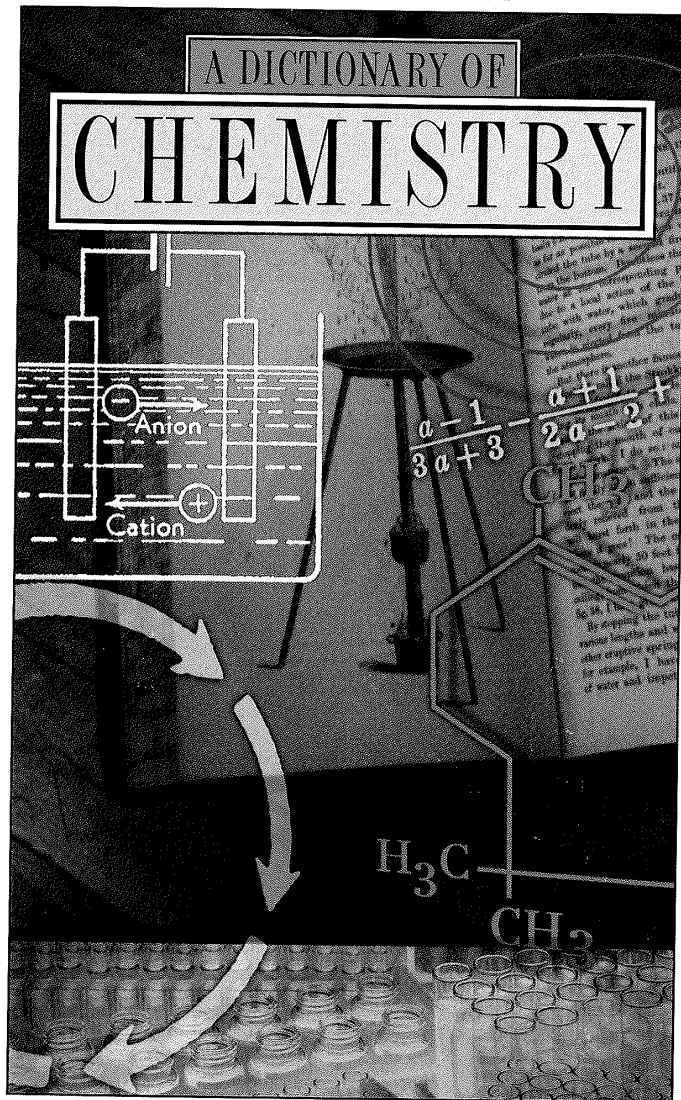


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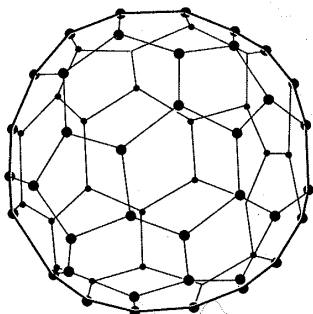
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*Buckminsterfullerene*

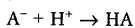
to produce forms of carbon in which the atoms are linked in a cylindrical, rather than spherical, framework with a diameter of a few nanometres. They are known as *buckytubes* (or *nanotubes*).

**buckyball** See **buckminsterfullerene**.

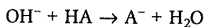
**buckytube** See **buckminsterfullerene**.

**buffer** A solution that resists change in pH when an acid or alkali is added or when the solution is diluted. Acidic buffers consist of a weak acid with a salt of the acid. The salt provides the negative ion  $A^-$ , which is the conjugate base of the acid  $HA$ . An example is carbonic acid and sodium hydrogencarbonate. Basic buffers have a weak base and a salt of the base (to provide the conjugate acid). An example is ammonia solution with ammonium chloride.

In an acidic buffer, for example, molecules  $HA$  and ions  $A^-$  are present. When acid is added most of the extra protons are removed by the base:



When base is added, most of the extra hydroxide ions are removed by reaction with undissociated acid:



Thus, the addition of acid or base changes the pH very little. The hydrogen-ion concentration in a buffer is given by the expression

$$K_a = [H^+] = [A^-]/[HA]$$

i.e. it depends on the ratio of conjugate base to acid. As this is not altered by dilution, the hydrogen-ion concentration for a buffer does not change much during dilution.

In the laboratory, buffers are used to prepare solutions of known stable pH. Natural buffers occur in living organisms, where the biochemical reactions are very sensitive to change in pH. The main natural buffers are  $H_2CO_3/HCO_3^-$  and  $H_2PO_4^-/HPO_4^{2-}$ . Buffer solutions are also used in medicine

(e.g. in intravenous injections), in agriculture, and in many industrial processes (e.g. dyeing, fermentation processes, and the food industry).

**bumping** Violent boiling of a liquid caused by superheating so that bubbles form at a pressure above atmospheric pressure. It can be prevented by putting pieces of porous pot in the liquid to enable bubbles of vapour to form at the normal boiling point.

**Bunsen burner** A laboratory gas burner having a vertical metal tube into which the gas is led, with a hole in the side of the base of the tube to admit air. The amount of air can be regulated by a sleeve on the tube. When no air is admitted the flame is luminous and smoky. With air, it has a faintly visible hot outer part (the oxidizing part) and an inner blue cone where combustion is incomplete (the cooler reducing part of the flame). The device is named after the German chemist Robert Bunsen (1811–99), who used a similar device (without a regulating sleeve) in 1855.

**Bunsen cell** A \*primary cell consisting of a zinc cathode immersed in dilute sulphuric acid and a carbon anode immersed in concentrated nitric acid. The electrolytes are separated by a porous pot. The cell gives an e.m.f. of about 1.9 volts.

**burette** A graduated glass tube with a tap at one end leading to a fine outlet tube, used for delivering known volumes of a liquid (e.g. in titration).

**buta-1,3-diene (butadiene)** A colourless gaseous hydrocarbon,  $\text{CH}_2=\text{CHCH}=\text{CH}_2$ ; m.p.  $-109^\circ\text{C}$ ; b.p.  $-4.5^\circ\text{C}$ . It is made by catalytic dehydrogenation of butane (from petroleum or natural gas) and polymerized in the production of synthetic rubbers. The compound is a conjugated \*diene in which the electrons in the pi orbitals are partially delocalized over the whole molecule. It can have trans and cis forms, the latter taking part in \*Diels–Alder reactions.

**butanal (butyraldehyde)** A colourless flammable liquid aldehyde,  $\text{C}_4\text{H}_7\text{CHO}$ ; r.d. 0.8; m.p.  $-99^\circ\text{C}$ ; b.p.  $75.7^\circ\text{C}$ .

**butane** A gaseous hydrocarbon,  $\text{C}_4\text{H}_{10}$ ; d.  $0.58 \text{ g cm}^{-3}$ ; m.p.  $-138^\circ\text{C}$ ; b.p.  $0^\circ\text{C}$ . Butane is obtained from petroleum (from refinery gas or by cracking higher hydrocarbons). The fourth member of the \*alkane series, it has a straight chain of carbon atoms and is isomeric with 2-methylpropane ( $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_3$ , formerly called *isobutane*). It can easily be liquefied under pressure and is supplied in cylinders for use as a fuel gas. It is also a raw material for making buta-1,3-diene (for synthetic rubber).

**butanedioic acid (succinic acid)** A colourless crystalline fatty acid,  $(\text{CH}_2)_2(\text{COOH})_2$ ; r.d. 1.6; m.p.  $185^\circ\text{C}$ ; b.p.  $235^\circ\text{C}$ . A weak carboxylic acid, it is produced by fermentation of sugar or ammonium tartrate and used as a sequestrant and in making dyes. It occurs in living organisms as an intermediate in metabolism, especially in the \*Krebs cycle.

**butanoic acid (butyric acid)** A colourless liquid water-soluble acid,