Phosphorus - P

Chemical properties of phosphorus - Health effects of phosphorus - Environmental effects of phosphorus

Atomic number	15
Atomic mass	30,9738 g.mol $^{-1}$
Oxidation states	± 3, 4, 5
Electronegativity according to Pauling	2,1
Density	1,82 g/ml at 20°C
Melting point	44,2 °C
Boiling point	280 °C
Vanderwaals radius	1,04 Å
Ionic radius	0,34 Å
Atomic radius	1,28 Å
Electronic shell	[Ne]3s23p3
Energy of first ionisation	10,118 eV
Energy of second ionisation	19,725 eV
Energy of third ionisation	29,141 eV
Discovered by	Hennig Brandt in 1669

Properties

Phosphorous is a multivalent nonmetal of the nitrogen group. It is found in nature in several allotropic forms, and is an essential element for the life of organisms.

There are several forms of phosphorous, called white, red and black phosphorous, although the their colours are more likely to be slightly different. White phosphorous is the one manufactured industrial; it glows in the dark, is spontaneously flammable when exposed to air and is deadly poison. Red phosphorous can vary in colour from orange to purple, due to slight variations in its chemical structure. The third form, black phosphorous, is made under high pressure, looks like graphite and, like graphite, has the ability to conduct electricity.

Applications

Concentrated phosphoric acids are used in fertilizers for agriculture and farm production. Phosphates are used for special glasses, sodium lamps, in steel production, in military applications (incendiary bombs, smoke screenings etc.), and in other applications as: pyrotechnics, pesticides, toothpaste, detergents.

Phosphorous in the environment

In the natural world phosphorous is never encountered in its pure form, but only as phosphates, which consists of a phosphorous atom bonded to four oxygen atoms. This can exists as the negatively charged phosphate ion (PO_4^{3-}), which is how it occurs in minerals, or as organophosphates in which there are organic molecules attached to one, two or three of the oxygen atoms.

The amount of phosphorous that is naturally present in food varies considerably but can be as high as 370 mg/100 g in liver, or can be low, as in vegetable oils. Foods rich in phosphorous include tuna, salmon, sardines, liver, turkey, chicken, eggs and cheese (200 g/100 g).

There are many phosphate minerals, the most abundant being forms of apatite. Fluoroapatite provides the most extensively mined deposits. The chief mining areas are Russia, USA, Morocco, Tunisia, Togo and Nauru. World production is 153 million tones per year. There are concerns over how long these phosphorous deposits will last. In case of depletion there could be a serious problem for the worlds food production since phosphorus is such an essential ingredient in fertilizers.

In the oceans, the concentration of phosphates is very low, particularly at the surface. The reason lies partly within the insolubility of aluminum and calcium phosphates, but in any case in the oceans phosphate is quickly used up and falls into the deep as organic debris. There can be more phosphate in rivers and lakes, resulting in excessive algae growth. For further details go to environmental effects of phosphorous.

Health effects of phosphorus

Phosphorus can be found in the environment most commonly as phosphates. Phosphates are important substances in the human body, because they are a part of DNA materials and they take part in energy distribution. Phosphates can also be found commonly in plants.

Phosphate is a dietary requirement, the recommended intake is 800 mg/day, a normal diet provides between 1000 and 2000 mg/day, depending on the extent to which phosphate rich foods are consumed.

Humans have changed the natural phosphate supply radically by addition of phosphate-rich manures to the soil and by the use of phosphate-containing detergents. Phosphates were also added to a number of foodstuffs, such as cheese, sausages and hams.

Too much phosphate can cause health problems, such as kidney damage and osteoporosis. Phosphate shortages can also occur. These are caused by extensive use of medicine. Too little phosphate can cause health problems.