

# Carbon

# C

## ***General Information***

### **Discovery**

Carbon is an element of prehistoric discovery and is widely distributed in nature.

### **Appearance**

Can exist as either black graphite (known as charcoal in the powdered form) or as the colourless gem diamond.

### **Source**

Carbon is found in abundance in the sun, stars, comets and atmospheres of most planets.

Graphite is found naturally in many locations. Diamond is found in the form of microscopic crystals in some meteorites. Natural diamonds are found in the mineral kimberlite, sources of which are in South Africa, Arkansas and elsewhere. Diamonds are now also being recovered from the ocean floor off the Cape of Good Hope.

About 30% of all industrial diamonds used in the United States are made synthetically.

Carbon is found in combination in hydrocarbons (methane gas, oil and coal), and carbonates (limestone and dolomite).

### **Uses**

Carbon is unique among the elements in the vast number and variety of compounds it can form. With hydrogen, oxygen, nitrogen and other elements it forms very large numbers of compounds, carbon atom often being linked to carbon atom.

This ability to form chains is unique to carbon, and is thought to be an important reason for the dependence of life on this element. It is also an indispensable source of such varied everyday products as nylon and petrol, perfume and plastics, shoe polish, DDT and TNT.

### **Biological Role**

Carbon is the basis of all life as part of the DNA molecule. There are more than a million known carbon compounds, many thousands of which are vital to organic and life processes.

## **General Information**

Carbon is found free in nature in three allotropic forms; amorphous, graphite and diamond. A fourth form known as "white" carbon is now thought to exist. Graphite is one of the softest known materials and diamond one of the hardest. This difference is purely because of the arrangement of atoms in each of the two forms. In graphite, hexagonal rings are joined together to form sheets, and the sheets lie one on top of the other. In diamond, the atoms are arranged tetrahedrally in a vast continuous array. "White" carbon is a transparent birefringent material produced during the sublimation of graphite at low pressures.

In 1961 the International Union of Pure and Applied Chemistry adopted the isotope carbon-12 as the basis for atomic masses.

Carbon-14, an isotope with a half-life of 5730 years, has been widely used to date materials such as wood, archeological specimens etc.

## Physical Information

Atomic Number	6
Relative Atomic Mass ( $^{12}\text{C}=12.000$ )	12.011
Melting Point/K	3820 (diamond)
Boiling Point/K	5100 (sublimes)
Density/kg m <sup>-3</sup>	3513 (diam.) 2260
Ground State Electron Configuration	[He]2s <sup>2</sup> 2p <sup>2</sup>
Electron Affinity (M-M <sup>-</sup> )/kJ mol <sup>-1</sup>	121

## Key Isotopes

Nuclide	$^{12}\text{C}$	$^{13}\text{C}$	$^{14}\text{C}$
Atomic mass	12.000	13.003	14.003
Natural abundance	98.90%	1.10%	trace
Half-life	stable	stable	5730 yrs

### Ionisation Energies/kJ mol<sup>-1</sup>

M - M <sup>+</sup>	1086.2
M <sup>+</sup> - M <sup>2+</sup>	2352
M <sup>2+</sup> - M <sup>3+</sup>	4620
M <sup>3+</sup> - M <sup>4+</sup>	6222
M <sup>4+</sup> - M <sup>5+</sup>	37827
M <sup>5+</sup> - M <sup>6+</sup>	47270

## Other Information

Enthalpy of Fusion/kJ mol<sup>-1</sup> 105.0

Enthalpy of Vaporisation/kJ mol<sup>-1</sup> 710.9

### Oxidation States

This concept is rarely used in discussing carbon in its compounds because of subtleties of bonding. However, in single compounds it can be regarded as having oxidation states of C<sup>-IV</sup>, C<sup>II</sup>, C<sup>IV</sup>

### Covalent Bonds/kJ mol<sup>-1</sup>

C - H	411
C - C	348
C = C	614
C $\equiv$ C	839
C = N	615
C $\equiv$ N	891
C = O	745
C $\equiv$ O	1074