

Sulphur

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General Information

Discovery

Sulphur was known to ancient civilisations, and referred to in Genesis as brimstone.

Appearance

Sulphur exists as several allotropes, of which orthorhombic sulphur is the most stable. It is a pale yellow, brittle, odourless solid.

Source

Sulphur is widely distributed in nature as iron pyrites, galena, gypsum, Epsom salts and many other minerals. It is commercially recovered from wells sunk into the salt domes along the Gulf Coast of the USA, and from the Alberta gas fields. It is also mined in Poland. The Frasch Process is used to force heated water into the wells to melt the sulphur, which can then be recovered chemically. Sulphur can also be recovered from natural gas and crude oil by conversion into hydrogen sulphide, from which sulphur is liberated.

Uses

Sulphur is used in the vulcanisation of black rubber, as a fungicide and in black gunpowder. Most, however, is used in the production of sulphuric acid, which is the most important chemical manufactured by western civilisations.

Biological Role

Sulphur is essential to life as a component of fats, body fluids and bones. It is non-toxic as the element and in the form of the sulphate, but carbon disulphide, hydrogen sulphide and sulphur dioxide are all toxic, especially hydrogen sulphide which can cause death by respiratory paralysis.

General Information

Sulphur occurs in several allotropic forms whether in the liquid, solid or gaseous state. Amorphous or 'plastic' sulphur is obtained by fast cooling of the crystalline form, and is thought to have a helical structure with eight atoms per spiral. Crystalline sulphur is made up of rings, each containing eight sulphur atoms.

Physical Information

Atomic Number	16
Relative Atomic Mass ($^{12}\text{C}=12.000$)	32.066
Melting Point/K	386.0
Boiling Point/K	717.824
Density/kg m ⁻³	2070 (293K)
Ground State Electron Configuration	[Ne]3s ² 3p ⁴
Electron Affinity (M-M ⁻)/kJ mol ⁻¹	200.4

Key Isotopes

Nuclide	³² S	³³ S	³⁴ S	³⁵ S	³⁶ S
Atomic mass	31.972	32.971	33.968	34.969	35.967
Natural abundance	95.02%	0.75%	4.21%	0%	0.02%
Half-life	stable	stable	stable	87.9 days	stable

Ionisation Energies/kJ mol⁻¹

M - M ⁺	999.6
M ⁺ - M ²⁺	2251
M ²⁺ - M ³⁺	3361
M ³⁺ - M ⁴⁺	4564
M ⁴⁺ - M ⁵⁺	7013
M ⁵⁺ - M ⁶⁺	8495
M ⁶⁺ - M ⁷⁺	27106
M ⁷⁺ - M ⁸⁺	31669
M ⁸⁺ - M ⁹⁺	36578
M ⁹⁺ - M ¹⁰⁺	43138

Other Information

Enthalpy of Fusion/kJ mol⁻¹ 1.23

Enthalpy of Vaporisation/kJ mol⁻¹ 9.62

Oxidation States

Main S^{VI}
Others S^{-II}, S^{-I}, S⁰, S^I, S^{II},
S^{III}, S^{IV}, S^V

Covalent Bonds/kJ mol⁻¹

S - H 347
S - C 272
S = C 476
S - O 265
S = O 525
S - F 328
S - Cl 255
S - S 226