Argon

From Wikipedia, the free encyclopedia

Argon is a chemical element with symbol **Ar** and atomic number 18. It is in group 18 of the periodic table and is a noble gas.[5] Argon is the third most abundant gas in the Earth's atmosphere, at 0.934% (9340 ppmv) more than twice as abundant as water vapor (which averages about 4000 ppmv, but varies greatly), 23 times as abundant as carbon dioxide (400 ppmv), and more than 500 times as abundant as neon (18 ppmv). Argon is the most abundant noble gas in Earth's crust, comprising 0.00015% of the crust.

Nearly all of the argon in Earth's atmosphere is radiogenic argon-40, derived from the decay of potassium-40 in the Earth's crust. In the universe, argon-36 is by far the most common argon isotope, being the preferred argon isotope produced by stellar nucleosynthesis in supernovas.

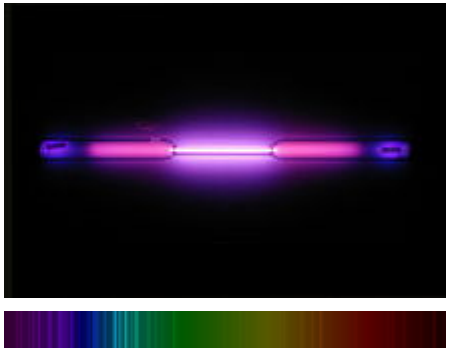
The name "argon" is derived from the Greek word ἀργόν, neuter singular form of ἀργός meaning "lazy" or "inactive", as a reference to the fact that the element undergoes almost no chemical reactions. The complete octet (eight electrons) in the outer atomic shell makes argon stable and resistant to bonding with other elements. Its triple point temperature of 83.8058 K is a defining fixed point in the International Temperature Scale of 1990.

Argon is produced industrially by the fractional distillation of liquid air. Argon is mostly used as an inert shielding gas in welding and other high-temperature industrial processes where ordinarily unreactive substances become reactive; for example, an argon atmosphere is used in graphite electric furnaces to prevent the graphite from burning. Argon is also used in incandescent, fluorescent lighting, and other gas discharge tubes. Argon makes a distinctive blue-green gas laser. Argon is also used in fluorescent glow starters.

Characteristics

Argon has approximately the same solubility in water as oxygen, and is 2.5 times more soluble in water than nitrogen. Argon is colorless, odorless, nonflammable and nontoxic as a solid, liquid, and gas.[6] Argon is chemically inert under most conditions

Argon, $_{18}$Ar



Spectral lines of argon

General properties

Name, symbol	argon, Ar
Appearance	colorless gas exhibiting a lilac/violet glow when placed in an electric field

Argon in the periodic table

Atomic number (Z)	18
Group, block	group 18 (noble gases), p-block
Period	period 3
Element category	□ noble gas
Standard atomic weight (±) (A_r)	39.948(1)[1]
Electron configuration	[Ne] $3s^2\ 3p^6$
per shell	2, 8, 8

A small piece of rapidly melting solid argon.

and forms no confirmed stable compounds at room temperature.

Although argon is a noble gas, it can form some compounds. Argon fluorohydride (HArF), a compound of argon with fluorine and hydrogen that is stable below 17 K, has been demonstrated.[7][8] Although the neutral ground-state chemical compounds of argon are presently limited to HArF, argon can form clathrates with water when atoms of argon are trapped in a lattice of water molecules.[9] Ions, such as ArH^+, and excited state complexes, such as ArF, have been demonstrated. Theoretical calculation predicts several more argon compounds that should be stable[10] but have not yet been synthesized.

Isotopes

The main isotopes of argon found on Earth are ^{40}Ar (99.6%), ^{36}Ar (0.34%), and ^{38}Ar (0.06%). Naturally occurring ^{40}K, with a half-life of 1.25×10^9 years, decays to stable ^{40}Ar (11.2%) by electron capture or positron emission, and also to stable ^{40}Ca (88.8%) via beta decay. These properties and ratios are used to determine the age of rocks by K-Ar dating.[20][21]

In the Earth's atmosphere, ^{39}Ar is made by cosmic ray activity, primarily with ^{40}Ar. In the subsurface environment, it is also produced through neutron capture by ^{39}K. ^{37}Ar is created from the neutron capture by ^{40}Ca followed by an alpha particle emission as a result of subsurface nuclear explosions. It has a half-life of 35 days.[21]

Between locations in the Solar System, the isotopic composition of argon varies greatly. Where the major source of argon is the decay of ^{40}K in rocks, ^{40}Ar will be the dominant isotope, as it is on Earth. Argon produced directly by stellar nucleosynthesis, is dominated by the alpha process nuclide, ^{36}Ar. Correspondingly, solar argon contains 84.6% ^{36}Ar (according to solar wind measurements),[22] and the ratio of the three isotopes ^{36}Ar : ^{38}Ar : ^{40}Ar in the atmospheres of the outer planets is

Physical properties

Phase	gas
Melting point	83.81 K (−189.34 °C, −308.81 °F)
Boiling point	87.302 K (−185.848 °C, −302.526 °F)
Density at stp (0 °C and 101.325 kPa)	1.784 g/L
when liquid, at b.p.	1.3954 g/cm^3
Triple point	83.8058 K, 68.89 kPa[2]
Critical point	150.687 K, 4.863 MPa[2]
Heat of fusion	1.18 kJ/mol
Heat of vaporization	6.53 kJ/mol
Molar heat capacity	20.85[3] J/(mol·K)

Vapor pressure

P (Pa)	**1**	**10**	**100**	**1 k**	**10 k**	**100 k**
at T (K)		47	53	61	71	87

Atomic properties

Oxidation states	**0**
Electronegativity	Pauling scale: no data
Ionization energies	1st: 1520.6 kJ/mol 2nd: 2665.8 kJ/mol 3rd: 3931 kJ/mol (more)
Covalent radius	106±10 pm
Van der Waals radius	188 pm

Miscellanea

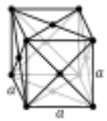
8400 : 1600 : 1.[23] This contrasts with the low abundance of primordial ^{36}Ar in Earth's atmosphere, which is only 31.5 ppmv (= 9340 ppmv × 0.337%), comparable with that of neon (18.18 ppmv) on Earth and with interplanetary gasses, measured by probes.

The atmospheres of Mars, Mercury and Titan (the largest moon of Saturn) contain argon, predominantly as ^{40}Ar, and its content may be as high as 1.93% (Mars).[24]

The predominance of radiogenic ^{40}Ar is the reason the standard atomic weight of terrestrial argon is greater than that of the next element, potassium, a fact that was puzzling when argon was discovered. Mendeleev positioned the elements on his periodic table in order of atomic weight, but the inertness of argon suggested a placement *before* the reactive alkali metal. Henry Moseley later solved this problem by showing that the periodic table is actually arranged in order of atomic number. (See History of the periodic table).

Source

- Wikipedia: Argon (https://en.wikipedia.org/wiki/Argon)

Crystal structure	face-centered cubic (fcc) 
Speed of sound	323 m/s (gas, at 27 °C)
Thermal conductivity	17.72×10^{-3} W/(m·K)
Magnetic ordering	diamagnetic[4]
CAS Number	7440-37-1

History

Discovery and first isolation	Lord Rayleigh and William Ramsay (1894)

Most stable isotopes of argon

iso	NA	half-life	DM	DE (MeV)	DP
^{36}Ar	0.334%	is stable with 18 neutrons			
^{37}Ar	syn	35 d	ε	0.813	^{37}Cl
^{38}Ar	0.063%	is stable with 20 neutrons			
^{39}Ar	trace	269 y	β−	0.565	^{39}K
^{40}Ar	99.604%	is stable with 22 neutrons			
^{41}Ar	syn	109.34 min	β−	2.49	^{41}K
^{42}Ar	syn	32.9 y	β−	0.600	^{42}K