Neon

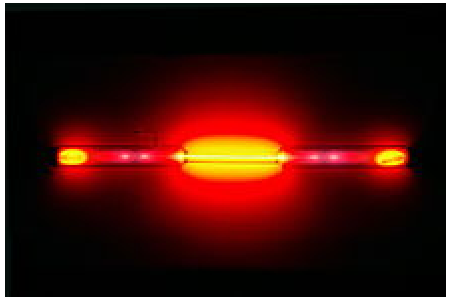
From Wikipedia, the free encyclopedia

Neon is a chemical element with symbol **Ne** and atomic number 10. It is in group 18 (noble gases) of the periodic table.[9] Neon is a colorless, odorless, inert monatomic gas under standard conditions, with about two-thirds the density of air. It was discovered (along with krypton and xenon) in 1898 as one of the three residual rare inert elements remaining in dry air, after nitrogen, oxygen, argon and carbon dioxide were removed. Neon was the second of these three rare gases to be discovered, and was immediately recognized as a new element from its bright red emission spectrum. The name neon is derived from the Greek word, νέον, neuter singular form of νέος (*neos*), meaning new. Neon is chemically inert and forms no uncharged chemical compounds. The compounds of neon include ionic molecules, molecules held together by van der Waals forces and clathrates.

During cosmic nucleogenesis of the elements, large amounts of neon are built up from the alpha-capture fusion process in stars. Although neon is a very common element in the universe and solar system (it is fifth in cosmic abundance after hydrogen, helium, oxygen and carbon), it is very rare on Earth. It composes about 18.2 ppm of air by volume (this is about the same as the molecular or mole fraction), and a smaller fraction in Earth's crust. The reason for neon's relative scarcity on Earth and the inner (terrestrial) planets is that neon is highly volatile and forms no compounds to fix it to solids. As a result, it escaped from the planetesimals under the warmth of the newly ignited Sun in the early Solar System. Even the atmosphere of Jupiter is somewhat depleted of neon, presumably for this reason. It is also lighter than air, causing it to escape even from Earth's atmosphere.

Neon gives a distinct reddish-orange glow when used in low-voltage neon glow lamps, high-voltage discharge tubes and neon advertising signs.[10][11] The red emission line from neon also causes the well known red light of helium–neon lasers. Neon is used in some plasma tube and refrigerant applications but has few other commercial uses. It is commercially extracted by the fractional distillation of liquid air. Since air is the only source, it is considerably more expensive than helium.

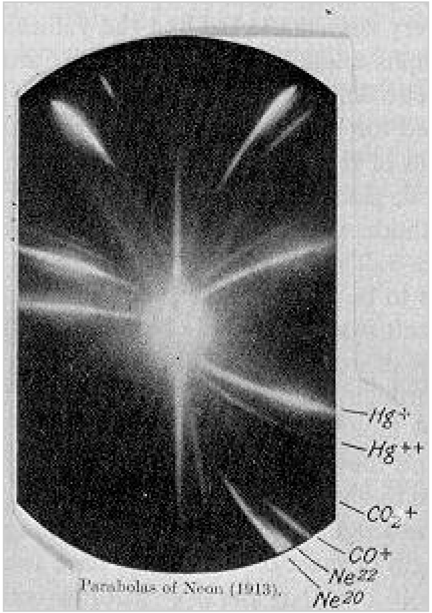
Neon, $_{10}$Ne



Spectral lines of neon in the visible region

General properties	
Name, symbol	neon, Ne
Pronunciation	/ˈniːɒn/
Appearance	colorless gas exhibiting an orange-red glow when placed in an electric field
Neon in the periodic table	
Atomic number (*Z*)	10
Group, block	group 18 (noble gases), p-block
Period	period 2
Element category	□ noble gas
Standard atomic weight (±) (A_r)	20.1797(6)[1]
Electron configuration	[He] $2s^2$ $2p^6$

Isotopes



The first evidence for isotopes of a stable element was provided in 1913 by experiments on neon plasma. In the bottom right corner of J. J. Thomson's photographic plate are the separate impact marks for the two isotopes neon-20 and neon-22.

Neon is the second lightest inert gas. Neon has three stable isotopes: ^{20}Ne (90.48%), ^{21}Ne (0.27%) and ^{22}Ne (9.25%). ^{21}Ne and ^{22}Ne are partly primordial and partly nucleogenic (i.e. made by nuclear reactions of other nuclides with neutrons or other particles in the environment) and their variations in natural abundance are well understood. In contrast, ^{20}Ne (the chief primordial isotope made in stellar nucleosynthesis) is not known to be nucleogenic or radiogenic (save for cluster decay production, which is thought to produce only a small amount). The causes of the variation of ^{20}Ne in the Earth have thus been hotly debated.[20]

The principal nuclear reactions which generate nucleogenic neon isotopes start from ^{24}Mg and ^{25}Mg, which produce ^{21}Ne and ^{22}Ne, respectively, after neutron capture and immediate emission of an alpha particle. The neutrons that produce the reactions are mostly produced by secondary spallation reactions from alpha particles, in turn derived from uranium-series decay chains. The net result yields a trend towards lower $^{20}Ne/^{22}Ne$ and higher $^{21}Ne/^{22}Ne$ ratios observed in uranium-rich rocks such as granites.[21] Neon-21 may also be produced in a nucleogenic reaction, when ^{20}Ne absorbs a neutron from various natural terrestrial neutron sources.

In addition, isotopic analysis of exposed terrestrial rocks has demonstrated the cosmogenic (cosmic ray) production of ^{21}Ne. This isotope is generated by spallation reactions on magnesium, sodium, silicon, and aluminium. By analyzing all three isotopes, the cosmogenic component can be resolved from magmatic neon and nucleogenic neon. This suggests that neon will be a useful tool in determining cosmic exposure ages of surface rocks and meteorites.[22]

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Physical properties

Phase	gas
Melting point	24.56 K (−248.59 °C, −415.46 °F)
Boiling point	27.104 K (−246.046 °C, −410.883 °F)
Density at stp (0 °C and 101.325 kPa)	0.9002 g/L
when liquid, at b.p.	1.207 g/cm^3[2]
Triple point	24.556 K, 43.37 kPa[3][4]
Critical point	44.4918 K, 2.7686 MPa[4]
Heat of fusion	0.335 kJ/mol
Heat of vaporization	1.71 kJ/mol
Molar heat capacity	20.79[5] J/(mol·K)

Vapor pressure

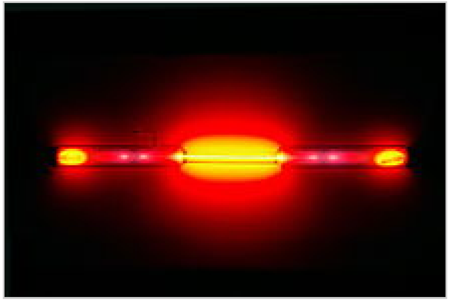
P (Pa)	**1**	**10**	**100**	**1 k**	**10 k**	**100 k**
at T (K)	12	13	15	18	21	27

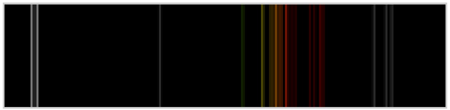
Atomic properties

Oxidation states	**0**
Ionization energies	1st: 2080.7 kJ/mol 2nd: 3952.3 kJ/mol 3rd: 6122 kJ/mol (more)
Covalent radius	58 pm
Van der Waals radius	154 pm

Similar to xenon, neon content observed in samples of volcanic gases is enriched in ^{20}Ne, as well as nucleogenic ^{21}Ne, relative to ^{22}Ne content. The neon isotopic content of these mantle-derived samples represents a non-atmospheric source of neon. The ^{20}Ne-enriched components are attributed to exotic primordial rare gas components in the Earth, possibly representing solar neon. Elevated ^{20}Ne abundances are found in diamonds, further suggesting a solar neon reservoir in the Earth.[23]

Characteristics


Neon discharge tube

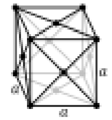

Spectrum of neon with ultraviolet (at left) and infrared (at right) lines shown in white

Neon is the second-lightest noble gas, after helium. It glows reddish-orange in a vacuum discharge tube. Also, neon has the narrowest liquid range of any element: from 24.55 K to 27.05 K (−248.45 °C to −245.95 °C, or −415.21 °F to −410.71 °F). It has over 40 times the refrigerating capacity of liquid helium and three times that of liquid hydrogen (on a per unit volume basis).[2] In most applications it is a less expensive refrigerant than helium.[24][25]

Neon plasma has the most intense light discharge at normal voltages and currents of all the noble gases. The average color of this light to the human eye is red-orange due to many lines in this range; it also contains a strong green line which is hidden, unless the visual components are dispersed by a spectroscope.[26]

Two quite different kinds of neon lighting are in common use. Neon glow lamps are generally tiny, with most operating between 100 and 250 volts.[27] They have been widely used as power-on indicators and in circuit-testing equipment, but light-emitting diodes (LEDs) now dominate in those applications. These simple neon devices were the forerunners of plasma displays and plasma television screens.[28][29] Neon signs typically operate at much higher voltages (2–15 kilovolts), and the luminous tubes are commonly meters long.[30] The glass tubing is often formed into shapes and letters for signage as well as architectural and artistic applications.

Miscellanea

Crystal structure	face-centered cubic (fcc) 
Speed of sound	435 m/s (gas, at 0 °C)
Thermal conductivity	49.1×10^{-3} W/(m·K)
Magnetic ordering	diamagnetic[6]
Bulk modulus	654 GPa
CAS Number	7440-01-9

History

Prediction	William Ramsay (1897)
Discovery and first isolation	William Ramsay & Morris Travers[7][8] (1898)

Most stable isotopes of neon

iso	NA	half-life	DM	DE (MeV)	DP
^{20}Ne	90.48%	is stable with 10 neutrons			
^{21}Ne	0.27%	is stable with 11 neutrons			
^{22}Ne	9.25%	is stable with 12 neutrons			

Source

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