[Template:Pp-protected](/wiki/Template:Pp-protected" \o "Template:Pp-protected) [Template:Pp-move-indef](/wiki/Template:Pp-move-indef) [Template:Infobox nitrogen](/wiki/Template:Infobox_nitrogen) **Nitrogen** is a [chemical element](/wiki/Chemical_element) with symbol **N** and [atomic number](/wiki/Atomic_number) 7. It is the lightest [pnictogen](/wiki/Pnictogen) and at room temperature, it is a transparent, odorless [diatomic](/wiki/Diatomic_molecules) gas. Nitrogen is a common element in the [universe](/wiki/Universe), estimated at about seventh in total abundance in the [Milky Way](/wiki/Milky_Way) and the [Solar System](/wiki/Solar_System). On Earth, the element forms about 78% of [Earth's atmosphere](/wiki/Atmosphere_of_Earth) and is the most abundant uncombined element. The element nitrogen was discovered as a separable component of air by Scottish physician [Daniel Rutherford](/wiki/Daniel_Rutherford) in 1772.

Many industrially important compounds, such as [ammonia](/wiki/Ammonia), [nitric acid](/wiki/Nitric_acid), organic [nitrates](/wiki/Nitrate) ([propellants](/wiki/Propellant) and [explosives](/wiki/Explosive)), and [cyanides](/wiki/Cyanide), contain nitrogen. The extremely strong triple bond in elemental nitrogen (N≡N) dominates nitrogen chemistry, causing difficulty for both organisms and industry in converting the N2 into useful [compounds](/wiki/Chemical_compound), but at the same time causing release of large amounts of often useful energy when the compounds burn, explode, or decay back into nitrogen gas. Synthetically produced ammonia and nitrates are key industrial [fertilizers](/wiki/Fertilizer), and fertilizer nitrates are key [pollutants](/wiki/Pollutant) in the [eutrophication](/wiki/Eutrophication) of water systems.

Apart from its use in fertilizers and energy-stores, nitrogen is a constituent of organic compounds as diverse as [Kevlar](/wiki/Kevlar) fabric and [cyanoacrylate](/wiki/Cyanoacrylate) "super" glue. Nitrogen is a constituent of every major pharmacological drug class, including [antibiotics](/wiki/Antibiotic). Many drugs are mimics or [prodrugs](/wiki/Prodrug) of natural nitrogen-containing [signal molecules](/wiki/Cell_signaling): for example, the organic nitrates [nitroglycerin](/wiki/Nitroglycerin) and [nitroprusside](/wiki/Nitroprusside) control [blood pressure](/wiki/Blood_pressure) by metabolizing into [nitric oxide](/wiki/Nitric_oxide). Plant [alkaloids](/wiki/Alkaloid) (often defense chemicals) contain nitrogen by definition, and many notable nitrogen-containing drugs, such as [caffeine](/wiki/Caffeine) and [morphine](/wiki/Morphine), are either alkaloids or synthetic mimics that act (as many plant alkaloids do) on receptors of animal [neurotransmitters](/wiki/Neurotransmitter) (for example, synthetic [amphetamines](/wiki/Amphetamine)).

Nitrogen occurs in all organisms, primarily in [amino acids](/wiki/Amino_acid) (and thus [proteins](/wiki/Protein)), in the [nucleic acids](/wiki/Nucleic_acid) ([DNA](/wiki/DNA) and [RNA](/wiki/RNA)) and in the energy transfer molecule [adenosine triphosphate](/wiki/Adenosine_triphosphate). The [human body contains](/wiki/Composition_of_the_human_body) about 3% by mass of nitrogen, the fourth most abundant element in the body after oxygen, carbon, and hydrogen. The [nitrogen cycle](/wiki/Nitrogen_cycle) describes movement of the element from the air, into the [biosphere](/wiki/Biosphere) and organic compounds, then back into the atmosphere.

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## History and etymology[[edit](/index.php?title=(none)&action=edit&section=1)]

Nitrogen is formally considered to have been discovered by Scottish physician [Daniel Rutherford](/wiki/Daniel_Rutherford) in 1772, who called it *noxious air*.[[1]](#cite_note-1)[[2]](#cite_note-2)[[3]](#cite_note-3) Though he did not recognize it as an entirely different chemical substance, he clearly distinguished it from Joseph Black's ["fixed air"](/wiki/Joseph_Black#Carbon_Dioxide), or carbon dioxide.[[4]](#cite_note-4) The fact that there was a component of air that does not support [combustion](/wiki/Combustion) was clear to Rutherford. Nitrogen was also studied at about the same time by [Carl Wilhelm Scheele](/wiki/Carl_Wilhelm_Scheele),[[5]](#cite_note-5) [Henry Cavendish](/wiki/Henry_Cavendish),[[6]](#cite_note-6) and [Joseph Priestley](/wiki/Joseph_Priestley),[[7]](#cite_note-7) who referred to it as *burnt air* or [*phlogisticated air*](/wiki/Phlogiston_theory). Nitrogen gas was [inert](/wiki/Inert) enough that [Antoine Lavoisier](/wiki/Antoine_Lavoisier) referred to it as "[mephitic air](/wiki/Wikt:mephitic_air)" or *azote*, from the [Greek](/wiki/Greek_language) word [Template:Lang](/wiki/Template:Lang) *azotos*, "lifeless".[[8]](#cite_note-8) In an atmosphere of pure nitrogen, animals died and flames were extinguished. This "mephitic air" consisted mostly of N2, but might have included more than 1% [argon](/wiki/Argon).

Lavoisier's name for nitrogen is used in many languages (French, Italian, Portuguese, Polish, Russian, Albanian, Turkish, etc.) and still remains in English in the common names of many compounds, such as [hydrazine](/wiki/Hydrazine) and compounds of the [azide](/wiki/Azide) ion. The English word nitrogen (1794) entered the language from the French *nitrogène*, coined in 1790 by French chemist [Jean-Antoine Chaptal](/wiki/Jean-Antoine_Chaptal) (1756–1832),[[9]](#cite_note-9) from the French [*nitre*](/wiki/Niter) ([potassium nitrate](/wiki/Potassium_nitrate), also called [saltpeter](/wiki/Saltpeter)) and the French *-gène*, "producing", from the [Greek](/wiki/Greek_language) -γενής (*-genes*, "producer, begetter"). Chaptal's meaning was that nitrogen gas is the essential part of [nitric acid](/wiki/Nitric_acid), which in turn was produced from niter. In earlier times, niter had been confused with Egyptian "natron" ([sodium carbonate](/wiki/Sodium_carbonate)) — called *nitron* (νίτρον) in Greek — which contained no nitrate.[[10]](#cite_note-10) Nitrogen compounds were well known by the Middle Ages. [Alchemists](/wiki/Alchemy) knew nitric acid as [*aqua fortis*](/wiki/Aqua_fortis) (strong water). The mixture of nitric and [hydrochloric acids](/wiki/Hydrochloric_acid) was known as [*aqua regia*](/wiki/Aqua_regia) (royal water), celebrated for its ability to dissolve [gold](/wiki/Gold) (the *king* of metals). The earliest military, industrial, and agricultural applications of nitrogen compounds used saltpeter ([sodium nitrate](/wiki/Sodium_nitrate) or potassium nitrate), most notably in [gunpowder](/wiki/Gunpowder), and later as [fertilizer](/wiki/Fertilizer). In 1910, [Lord Rayleigh](/wiki/John_William_Strutt,_3rd_Baron_Rayleigh) discovered that an electrical discharge in nitrogen gas produced "active nitrogen", a [monatomic](/wiki/Monatomic) [allotrope](/wiki/Allotrope) of nitrogen. The "whirling cloud of brilliant yellow light" produced by his apparatus reacted with [quicksilver](/wiki/Mercury_(element)) to produce explosive [mercury nitride](/wiki/Mercury_nitride).[[11]](#cite_note-11) For a long time, sources of nitrogen compounds were limited. Natural sources originated either from biology or deposits of nitrates produced by atmospheric reactions. [Nitrogen fixation](/wiki/Nitrogen_fixation) by industrial processes like the [Frank–Caro process](/wiki/Frank–Caro_process) (1895–1899) and [Haber–Bosch process](/wiki/Haber–Bosch_process) (1908–1913) eased this shortage of nitrogen compounds, to the extent that half of global [food production](/wiki/Food_production) (see Applications) now relies on synthetic nitrogen fertilizers.[[12]](#cite_note-12) At the same time, use of the [Ostwald process](/wiki/Ostwald_process) (1902) to produce nitrates from industrial nitrogen fixation allowed the large-scale industrial production of nitrates as [feedstock](/wiki/Feedstock) in the manufacture of [explosives](/wiki/Explosives) in the [World War](/wiki/World_war)s of the 20th century.

## Production[[edit](/index.php?title=(none)&action=edit&section=2)]

[Template:Further](/wiki/Template:Further) Nitrogen gas is an [industrial gas](/wiki/Industrial_gas) produced by the fractional [distillation](/wiki/Distillation) of liquid [air](/wiki/Air), or by mechanical means using gaseous air (i.e., pressurized reverse [osmosis membrane](/wiki/Osmotic_pressure) or [pressure swing adsorption](/wiki/Pressure_swing_adsorption)). Nitrogen gas generators using membranes or PSA are typically more cost and energy efficient than bulk delivered nitrogen.[[13]](#cite_note-13) Commercial nitrogen is often a byproduct of air-processing for industrial concentration of [oxygen](/wiki/Oxygen) for steelmaking and other purposes. When supplied compressed in cylinders it is often called OFN (oxygen-free nitrogen).[[14]](#cite_note-14) In a chemical laboratory, it is prepared by treating an aqueous solution of [ammonium chloride](/wiki/Ammonium_chloride) with [sodium nitrite](/wiki/Sodium_nitrite).[[15]](#cite_note-15):NH4Cl(aq) + NaNO2(aq) → N2(g) + NaCl(aq) + 2 H2O (l)

Small amounts of impurities NO and HNO3 are also formed in this reaction. The impurities can be removed by passing the gas through aqueous sulfuric acid containing [potassium dichromate](/wiki/Potassium_dichromate).[[15]](#cite_note-15) Very pure nitrogen can be prepared by the thermal decomposition of [barium azide](/wiki/Barium_azide) or [sodium azide](/wiki/Sodium_azide).[[16]](#cite_note-16):2 NaN3 → 2 Na + 3 N2

## Properties[[edit](/index.php?title=(none)&action=edit&section=3)]

Nitrogen is a [nonmetal](/wiki/Nonmetal), with an [electronegativity](/wiki/Electronegativity) of 3.04.[[17]](#cite_note-17) It has five [electrons](/wiki/Electron) in its [outer shell](/wiki/Electron_shell) and is, therefore, [trivalent](/wiki/Valence_(chemistry)) in most compounds. The [triple bond](/wiki/Triple_bond) in molecular nitrogen ([Template:Chem](/wiki/Template:Chem)) is one of the strongest. The resulting difficulty of converting [Template:Chem](/wiki/Template:Chem) into other compounds, and the ease (and associated high energy release) of converting nitrogen compounds into elemental [Template:Chem](/wiki/Template:Chem), have dominated the role of nitrogen in both nature and human economic activities.[Template:Citation needed](/wiki/Template:Citation_needed)

At [atmospheric pressure](/wiki/Atmospheric_pressure), molecular nitrogen [condenses](/wiki/Condensation) ([liquefies](/wiki/Liquid)) at 77 [K](/wiki/Kelvin) (−195.79 °[C](/wiki/Celsius)) and [freezes](/wiki/Freezing) at 63 K (−210.01 °C)[[18]](#cite_note-18) into the beta [hexagonal close-packed](/wiki/Hexagonal_close-packed) crystal [allotropic](/wiki/Allotropy) form. Below 35.4 K (−237.6 °C) nitrogen assumes the [cubic](/wiki/Cubic_crystal_system) crystal allotropic form (called the alpha phase).[[19]](#cite_note-19) [Liquid nitrogen](/wiki/Liquid_nitrogen), a fluid resembling water in appearance, but with 80.8% of the density (the density of liquid nitrogen at its boiling point is 0.808 g/mL), is a common [cryogen](/wiki/Cryogen).[[20]](#cite_note-20) Unstable allotropes of nitrogen consisting of more than two nitrogen atoms, such as [Template:Chem](/wiki/Template:Chem) and [Template:Chem](/wiki/Template:Chem),[[21]](#cite_note-21) have been produced in the laboratory. Under extremely high pressures (1.1 million [atm](/wiki/Atmosphere_(unit))) and high temperatures (2000 K), as produced in a [diamond anvil cell](/wiki/Diamond_anvil_cell), nitrogen polymerizes into the single-bonded cubic gauche crystal structure. This structure is similar to that of [diamond](/wiki/Diamond), and both have extremely strong [covalent bonds](/wiki/Covalent_bond). [Template:Chem](/wiki/Template:Chem) is nicknamed "nitrogen diamond".[[22]](#cite_note-22) Other (theoretical but not yet synthesized) allotropes include [hexazine](/wiki/Hexazine) ([Template:Chem](/wiki/Template:Chem), a [benzene](/wiki/Benzene) analog)[[23]](#cite_note-23) and [octaazacubane](/wiki/Octaazacubane) ([Template:Chem](/wiki/Template:Chem), a [cubane-type cluster](/wiki/Cubane-type_cluster)).[[24]](#cite_note-24) The former is predicted to be highly unstable, while the latter is predicted to be kinetically stable, by reason of its [orbital symmetry](/wiki/Orbital_symmetry).[[25]](#cite_note-25)

### Isotopes[[edit](/index.php?title=(none)&action=edit&section=4)]

[Template:See also](/wiki/Template:See_also)

There are two stable [isotopes](/wiki/Isotope) of nitrogen: 14N and 15N. By far the most common is 14N (99.634%), which is produced in the [CNO cycle](/wiki/CNO_cycle) in [stars](/wiki/Star).[[26]](#cite_note-26) Of the ten isotopes produced synthetically, 13N has a [half-life](/wiki/Half-life) of ten minutes and the remaining isotopes have half-lives on the order of seconds or less.[[27]](#cite_note-27) Biologically mediated reactions (e.g., [assimilation](/wiki/Assimilation_(biology)), [nitrification](/wiki/Nitrification), and [denitrification](/wiki/Denitrification)) strongly control nitrogen dynamics in the soil. These reactions typically result in 15N enrichment of the [substrate](/wiki/Substrate_(chemistry)) and depletion of the [product](/wiki/Product_(chemistry)).[[28]](#cite_note-28) A small part (0.73%) of the molecular nitrogen in Earth's atmosphere is the [isotopologue](/wiki/Isotopologue) 14N15N, and almost all the rest is 14N2.[[29]](#cite_note-29) The [radioisotope](/wiki/Radioisotope) 16N is the dominant [radionuclide](/wiki/Radionuclide) in the coolant of [pressurized water reactors](/wiki/Pressurized_water_reactor) or [boiling water reactors](/wiki/Boiling_water_reactor) during normal operation. It is produced from 16O (in water) via [(n,p) reaction](/wiki/Np_reaction). It has a short half-life of about 7.1 s,[[27]](#cite_note-27) but during its decay back to 16O produces high-energy [gamma radiation](/wiki/Gamma_radiation) (5 to 7 MeV).[[27]](#cite_note-27)[[30]](#cite_note-30) Because of this, access to the primary coolant piping in a [pressurized water reactor](/wiki/Pressurized_water_reactor) must be restricted during [reactor](/wiki/Nuclear_reactor) power operation. 16N is a sensitive and immediate indicator of leaks from the primary coolant system to the secondary steam cycle, and is the primary means of detection for such leaks.[[30]](#cite_note-30) Similarly, access to any of the steam cycle components in a [boiling water reactor](/wiki/Boiling_water_reactor) nuclear power plant must be restricted during operation. Condensate is typically retained for 10 minutes to allow for decay of 16N to radioactive depletion.[Template:Citation needed](/wiki/Template:Citation_needed)

### Electromagnetic spectrum[[edit](/index.php?title=(none)&action=edit&section=5)]

[right|thumb|upright|Nitrogen discharge (spectrum) tube](/wiki/File:Nitrogen_discharge_tube.jpg)

Molecular nitrogen (14N2) is largely [transparent](/wiki/Transparency_(optics)) to [infrared](/wiki/Infrared) and [visible](/wiki/Visible_spectrum) radiation because it is a [homonuclear molecule](/wiki/Homonuclear_molecule) and has no [dipole moment](/wiki/Molecular_dipole_moment) to couple to [electromagnetic radiation](/wiki/Electromagnetic_radiation) at these [wavelengths](/wiki/Wavelength). Significant [absorption](/wiki/Absorption_(electromagnetic_radiation)) occurs at extreme [ultraviolet](/wiki/Ultraviolet) wavelengths,[[31]](#cite_note-31) beginning around 100 [nanometres](/wiki/Nanometre). This is associated with [electronic transitions](/wiki/Electronic_transition) in the molecule to states in which charge is not distributed evenly between nitrogen atoms. Nitrogen absorption leads to significant absorption of ultraviolet radiation in the Earth's upper atmosphere and the atmospheres of other planetary bodies. For similar reasons, pure molecular [nitrogen lasers](/wiki/Nitrogen_laser) typically emit light in the ultraviolet range.

Nitrogen also makes a contribution to visible [air glow](/wiki/Air_glow) from the Earth's upper atmosphere, through electron impact excitation followed by emission. This visible blue air glow (seen in the polar [aurora](/wiki/Aurora_(astronomy)) and in the re-entry glow of returning spacecraft) typically results not from molecular nitrogen but rather from free nitrogen atoms combining with oxygen to form [nitric oxide](/wiki/Nitric_oxide) (NO).

Nitrogen gas also exhibits [scintillation](/wiki/Scintillation_(physics)).

### Reactions[[edit](/index.php?title=(none)&action=edit&section=6)]

[thumb|120px|right|Structure of dinitrogen, N2](/wiki/File:Dinitrogen-2D-dimensions.png) [thumb|right|Structure of [Ru(NH3)5(N2)]2+](/wiki/File:RuA5N2.png)

In general, nitrogen is unreactive at standard temperature and pressure. N2 reacts spontaneously with few [reagents](/wiki/Reagent), being resilient to [acids](/wiki/Acid) and [bases](/wiki/Base_(chemistry)) as well as oxidants and most reductants. When nitrogen reacts spontaneously with a reagent, the net transformation is often called [nitrogen fixation](/wiki/Nitrogen_fixation).[[32]](#cite_note-32) Elemental [lithium](/wiki/Lithium) reacts ("burns") in an atmosphere of N2 to give [lithium nitride](/wiki/Lithium_nitride):[[33]](#cite_note-33)

6 Li + N2 → 2 Li3N

[Magnesium](/wiki/Magnesium) also burns in nitrogen, forming [magnesium nitride](/wiki/Magnesium_nitride).[Template:Citation needed](/wiki/Template:Citation_needed)

3 Mg + N2 → Mg3N2

N2 forms a variety of [adducts](/wiki/Adduct) with transition metals. The first example of a [dinitrogen complex](/wiki/Dinitrogen_complex) is [Ru(NH3)5(N2)]2+ (see figure at right). Notably, N2 ligand was obtained by the decomposition of hydrazine, and not coordination of free dinitrogen. Many such compounds are now known, including IrCl(N2)(PPh3)2, W(N2)2([Ph2PCH2CH2PPh2](/wiki/Dppe))2, and [(η5-C5Me4H)2Zr]2([μ](/wiki/Bridging_ligand)2, [η](/wiki/Hapticity)2,η2-N2). These [complexes](/wiki/Complex_(chemistry)) illustrate how N2 might bind to the metal(s) in [nitrogenase](/wiki/Nitrogenase) and the [catalyst](/wiki/Catalysis) for the [Haber process](/wiki/Haber_process).[[34]](#cite_note-34) A catalytic process to [reduce](/wiki/Redox) N2 to ammonia with the use of a [molybdenum](/wiki/Molybdenum) complex in the presence of a proton source was published in 2005.[[33]](#cite_note-33) The starting point for industrial production of nitrogen compounds is the [Haber process](/wiki/Haber_process), in which nitrogen is fixed by reacting [Template:Chem](/wiki/Template:Chem) and [Template:Chem](/wiki/Template:Chem) over an iron(II, III) oxide ([Template:Chem](/wiki/Template:Chem)) catalyst at about 500 °C and 200 atmospheres pressure. Biological nitrogen fixation in free-living [cyanobacteria](/wiki/Cyanobacteria) and in the [root nodules](/wiki/Root_nodule) of plants also produces ammonia from molecular nitrogen. The reaction, which is the source of the bulk of nitrogen in the [biosphere](/wiki/Biosphere), is catalyzed by the [nitrogenase](/wiki/Nitrogenase) [enzyme](/wiki/Enzyme) complex that contains Fe and Mo atoms, using energy derived from hydrolysis of [adenosine triphosphate](/wiki/Adenosine_triphosphate) (ATP) into [adenosine diphosphate](/wiki/Adenosine_diphosphate) and [inorganic](/wiki/Inorganic) [phosphate](/wiki/Phosphate) (−20.5 kJ/mol).[Template:Citation needed](/wiki/Template:Citation_needed)

## Occurrence[[edit](/index.php?title=(none)&action=edit&section=7)]

[Template:Category see also](/wiki/Template:Category_see_also)

Nitrogen gas (N2) is the largest constituent of [Earth's atmosphere](/wiki/Earth's_atmosphere) (78.082% by volume of dry air, 75.3% by weight in dry air).[[35]](#cite_note-35) However, this high concentration does not reflect nitrogen's overall low abundance in the makeup of the Earth, from which most of the element escaped by solar evaporation, early in the planet's formation.[Template:Citation needed](/wiki/Template:Citation_needed)

Nitrogen is a common element in the universe, and is considered the [seventh most abundant](/wiki/Abundance_of_the_chemical_elements) [chemical element](/wiki/Chemical_element) by mass in the universe, the Milky Way, and the Solar System. According to physical cosmology theory, it was originally created by [fusion](/wiki/Stellar_nucleosynthesis) processes from carbon and hydrogen in [supernovas](/wiki/Supernova).[[36]](#cite_note-36) [Molecular](/wiki/Molecule) nitrogen and nitrogen [compounds](/wiki/Chemical_compound) have been detected in [interstellar space](/wiki/Interstellar_medium) by astronomers using the [Far Ultraviolet Spectroscopic Explorer](/wiki/Far_Ultraviolet_Spectroscopic_Explorer).[[37]](#cite_note-37) Due to the volatility of elemental nitrogen and its common compounds with hydrogen and oxygen, nitrogen was driven out of the [planetesimals](/wiki/Planetesimal) in the early Solar System by the heat of the Sun and lost to the rocky planets of the inner Solar System. Nitrogen is consequently a relatively rare element on these inner planets, including Earth. Neon, which occurs in equal abundance in the universe, is rare in the inner Solar System for the same reason. Nitrogen is estimated at 31st [element in crustal abundance](/wiki/Abundance_of_elements_in_earth's_crust). Nitrogen also occurs in some relatively uncommon minerals, such as [saltpeter](/wiki/Potassium_nitrate) (potassium nitrate), [Chile saltpeter](/wiki/Sodium_nitrate) (sodium nitrate) and [sal ammoniac](/wiki/Sal_ammoniac) (ammonium chloride). Because of the ready solubility of naturally-occurring nitrogen compounds, these minerals were concentrated from the crust by the leaching of rivers and collected in ancient seas which then evaporated, leaving the deposits of present day. A similar process occurred with the water-soluble compounds of the uncommon light element [boron](/wiki/Boron).[Template:Citation needed](/wiki/Template:Citation_needed)

Nitrogen and its compounds occur far more commonly as gases in the atmospheres of planets and moons that are large enough to have atmospheres.<ref group=lower-alpha>Nitrogen and its compounds are far more common in atmospheres of smaller rocky moons and planets than neon, due to nitrogen being less volatile than neon.</ref> Molecular nitrogen is a major constituent of not only Earth's atmosphere, but also the [Saturnian](/wiki/Saturn) moon [Titan's](/wiki/Titan_(moon)) thick atmosphere. Also, held by gravity at colder temperatures, nitrogen and its compounds occur in variable amounts in the planetary atmospheres of the gas giant planets.[[38]](#cite_note-38) Nitrogen is present in all known living organisms, in proteins, nucleic acids, and other molecules. It typically makes up around 4% of the dry weight of plant matter, and around 3% of the weight of the human body. It is a large component of animal waste (for example, [guano](/wiki/Guano)), usually in the form of [urea](/wiki/Urea), [uric acid](/wiki/Uric_acid), [ammonium](/wiki/Ammonium) compounds, and derivatives of these nitrogenous products, which are essential [nutrients](/wiki/Nutrient) for all plants that cannot [fix atmospheric nitrogen](/wiki/Nitrogen_fixation).[Template:Citation needed](/wiki/Template:Citation_needed)

## Compounds[[edit](/index.php?title=(none)&action=edit&section=8)]

[right|400px|thumb|the Frost Diagram of nitrogen](/wiki/File:Frost_azoto_smallsize.gif) [Template:Category see also](/wiki/Template:Category_see_also)

The main neutral [hydride](/wiki/Hydride#Appendix_on_nomenclature) of nitrogen is [ammonia](/wiki/Ammonia) ([Template:Chem](/wiki/Template:Chem)), although [hydrazine](/wiki/Hydrazine) ([Template:Chem](/wiki/Template:Chem)) is also commonly used. Ammonia is more [basic](/wiki/Basic_(chemistry)) than [water](/wiki/Water) by 6 orders of magnitude. In [solution](/wiki/Solution), ammonia forms the [ammonium](/wiki/Ammonium) [ion](/wiki/Ion) ([Template:Chem](/wiki/Template:Chem)). Liquid ammonia (boiling point 240 K) is [amphiprotic](/wiki/Amphiprotic) (displaying either [Brønsted–Lowry](/wiki/Brønsted–Lowry_acid–base_theory) acidic or basic character) and forms ammonium and the less common [amide](/wiki/Amide) ions ([Template:Chem](/wiki/Template:Chem)); both amides and [nitride](/wiki/Nitride) ([Template:Chem](/wiki/Template:Chem)) [salts](/wiki/Salt) are known, Many of these salts [decompose](/wiki/Chemical_decomposition) in water, but there are exceptions like [gallium nitride](/wiki/Gallium_nitride) or [boron nitride](/wiki/Boron_nitride) that have strong polar covalent network structures. Singly, doubly, triply and quadruply substituted alkyl compounds of ammonia are called [amines](/wiki/Amine) (four substitutions, to form commercially and biologically important quaternary amines, results in a positively charged nitrogen, and thus a water-soluble, or at least [amphiphilic](/wiki/Amphiphilic), compound). Larger chains, rings and structures of nitrogen hydrides are also known, but are generally unstable.[Template:Citation needed](/wiki/Template:Citation_needed)

Other classes of nitrogen [anions](/wiki/Anion) (negatively charged ions) are the poisonous [azides](/wiki/Azide) ([Template:Chem](/wiki/Template:Chem)), which are linear and [isoelectronic](/wiki/Isoelectronicity) to [carbon dioxide](/wiki/Carbon_dioxide), but which bind to important iron-containing enzymes in the body in a manner more resembling [cyanide](/wiki/Cyanide). Another [molecule](/wiki/Molecule) of the same structure is the colorless and relatively inert anesthetic gas [Nitrous oxide](/wiki/Nitrous_oxide) (dinitrogen monoxide, [Template:Chem](/wiki/Template:Chem)), also known as laughing gas. This is one of a variety of nitrogen [oxides](/wiki/Oxide) that form a family often abbreviated as **NOx**. [Nitric oxide](/wiki/Nitric_oxide) ([nitrogen monoxide](/wiki/Nitrogen_monoxide), NO), is a natural [free radical](/wiki/Free_radical) used in [signal transduction](/wiki/Signal_transduction) in both plants and animals. It is used, for example, in [vasodilation](/wiki/Vasodilation), causing the smooth muscle of blood vessels to relax. The reddish and poisonous [nitrogen dioxide](/wiki/Nitrogen_dioxide) [Template:Chem](/wiki/Template:Chem) contains an unpaired [electron](/wiki/Electron) and is an important component of [smog](/wiki/Smog). Nitrogen molecules containing unpaired electrons show a tendency to [dimerize](/wiki/Dimer_(chemistry)) (thus pairing the electrons), and are, in general, highly reactive. The corresponding[Template:Clarify](/wiki/Template:Clarify) acids are [nitrous](/wiki/Nitrous_acid) [Template:Chem](/wiki/Template:Chem) and [nitric acid](/wiki/Nitric_acid) [Template:Chem](/wiki/Template:Chem), with the corresponding salts called [nitrites](/wiki/Nitrite) and [nitrates](/wiki/Nitrate).

The higher oxides [dinitrogen trioxide](/wiki/Dinitrogen_trioxide) [Template:Chem](/wiki/Template:Chem), [dinitrogen tetroxide](/wiki/Dinitrogen_tetroxide) [Template:Chem](/wiki/Template:Chem) and [dinitrogen pentoxide](/wiki/Dinitrogen_pentoxide) [Template:Chem](/wiki/Template:Chem), are unstable and explosive, a consequence of the low energy state of [Template:Chem](/wiki/Template:Chem). Nearly every [hypergolic](/wiki/Hypergolic) rocket engine uses [Template:Chem](/wiki/Template:Chem) as the oxidizer; the fuels, one of the various forms of [hydrazine](/wiki/Hydrazine), are also nitrogen compounds. These engines are extensively used on spacecraft such as the [space shuttle](/wiki/Space_shuttle) and those of the [Apollo Program](/wiki/Apollo_Program) because their propellants are liquids at room temperature and ignition occurs spontaneously without an ignition system, allowing many precisely controlled burns. Some launch vehicles such as the [Titan II](/wiki/Titan_(rocket_family)) and [Ariane](/wiki/Ariane_(rocket_family)) 1 through 4 also use hypergolic fuels, although the trend is away from such engines for cost and safety reasons. [Template:Chem](/wiki/Template:Chem) is an intermediate in the manufacture of nitric acid [Template:Chem](/wiki/Template:Chem), a strong acid and a fairly strong [oxidizing agent](/wiki/Oxidizing_agent).

Nitrogen is notable for the range of explosively unstable compounds. [Nitrogen triiodide](/wiki/Nitrogen_triiodide) [Template:Chem](/wiki/Template:Chem) is an extremely sensitive [contact explosive](/wiki/Contact_explosive). [Nitrocellulose](/wiki/Nitrocellulose), produced by nitration of cellulose with nitric acid, is also known as guncotton. [Nitroglycerin](/wiki/Nitroglycerin), made by nitration of [glycerin](/wiki/Glycerin), is the dangerously unstable explosive ingredient of [dynamite](/wiki/Dynamite). The comparatively stable, but less powerful explosive [trinitrotoluene](/wiki/Trinitrotoluene) (TNT) is the standard explosive against which the power of nuclear explosions are measured.[[39]](#cite_note-39) Nitrogen can also be found in many [organic compounds](/wiki/Organic_compound). Common nitrogen [functional groups](/wiki/Functional_group) include: [amines](/wiki/Amine), [amides](/wiki/Amide), [nitro](/wiki/Nitro_compound) groups, [imines](/wiki/Imine), and [enamines](/wiki/Enamine). The amount of nitrogen in a [chemical substance](/wiki/Chemical_substance) can be determined by the [Kjeldahl method](/wiki/Kjeldahl_method).[[40]](#cite_note-40)[[41]](#cite_note-41)

## Applications[[edit](/index.php?title=(none)&action=edit&section=9)]

### Nitrogen gas[[edit](/index.php?title=(none)&action=edit&section=10)]

Nitrogen gas has a variety of applications, including serving as an [inert](/wiki/Inert) replacement for [air](/wiki/Air) where [oxidation](/wiki/Redox) is undesirable;[[42]](#cite_note-42)\* As a [modified atmosphere](/wiki/Modified_atmosphere), pure or mixed with [carbon dioxide](/wiki/Carbon_dioxide), to nitrogenate and preserve the freshness of packaged or bulk foods (by delaying [rancidity](/wiki/Rancidification) and other forms of [oxidative damage](/wiki/Redox)). Pure nitrogen as food additive is labeled in the [European Union](/wiki/European_Union) with the [E number](/wiki/E_number) [E941](/wiki/E941).[[43]](#cite_note-43)\* In [incandescent light bulbs](/wiki/Incandescent_light_bulb) as an inexpensive alternative to [argon](/wiki/Argon).[[44]](#cite_note-44)\* In [fire suppression systems for Information technology (IT) equipment](/wiki/Gaseous_fire_suppression)

* In [photolithography](/wiki/Photolithography) in deep ultraviolet, nitrogen is used to avoid the strong oxygen absorption of UV at these wavelengths.
* Dried and pressurized, it is used as an [dielectric](/wiki/Dielectric) [gas](/wiki/Gas) for [high voltage](/wiki/High_voltage) equipment.[Template:Citation needed](/wiki/Template:Citation_needed)
* In the manufacture of [stainless steel](/wiki/Stainless_steel).[[45]](#cite_note-45)\* In some aircraft fuel systems to reduce fire hazard, (see [inerting system](/wiki/Inerting_system)).[[46]](#cite_note-46)\* In packaging [liquid explosives](/wiki/Explosive_material) as a safety measure.[Template:Citation needed](/wiki/Template:Citation_needed)
* To inflate race car and aircraft [tires](/wiki/Tire),[[47]](#cite_note-47) reducing the problems caused by moisture and [oxygen](/wiki/Redox) in natural air.

Nitrogen is commonly used during sample preparation in [chemical analysis](/wiki/Chemical_Analysis). It is used to concentrate and reduce the volume of liquid samples. Directing a pressurized stream of nitrogen gas perpendicular to the surface of the liquid causes the solvent to evaporate while leaving the solute(s) and un-evaporated solvent behind.[[48]](#cite_note-48) Nitrogen can be used as a replacement, or in combination with, [carbon dioxide](/wiki/Carbon_dioxide) to pressurize kegs of some [beers](/wiki/Beer), particularly [stouts](/wiki/Ale) and British [ales](/wiki/Ale), due to the smaller [bubbles](/wiki/Liquid_bubble) it produces, which makes the dispensed beer smoother and [headier](/wiki/Beer_head).[[49]](#cite_note-49) A pressure-sensitive nitrogen capsule known commonly as a "[widget](/wiki/Widget_(beer))" allows nitrogen-charged beers to be packaged in [cans](/wiki/Beverage_can) and [bottles](/wiki/Bottle).[[50]](#cite_note-50)[[51]](#cite_note-51) Nitrogen tanks are also replacing carbon dioxide as the main power source for [paintball guns](/wiki/Paintball_gun). Nitrogen must be kept at higher pressure than CO2, making N2 tanks heavier and more expensive.[[52]](#cite_note-52) Nitrogen gas has become the inert gas of choice for [inert gas asphyxiation](/wiki/Inert_gas_asphyxiation), and is under consideration as a replacement for lethal injection in [Oklahoma](/wiki/Oklahoma).[[53]](#cite_note-53) Nitrogen is promoted by euthanasia advocate [Philip Nitschke](/wiki/Philip_Nitschke) to end life in a "peaceful, reliable [and] totally legal" manner.[[54]](#cite_note-54)

### Liquid nitrogen[[edit](/index.php?title=(none)&action=edit&section=11)]

[thumb|Air balloon submerged in liquid nitrogen](/wiki/File:Nitrogen.ogg) [Template:Main](/wiki/Template:Main) Liquid nitrogen is a [cryogenic liquid](/wiki/Cryogen). At atmospheric pressure, it boils at [Template:Convert](/wiki/Template:Convert). When insulated in proper containers such as [Dewar flasks](/wiki/Dewar_flask), it can be transported without much [evaporative loss](/wiki/Evaporation).[[55]](#cite_note-55) Like [dry ice](/wiki/Dry_ice), the main use of liquid nitrogen is as a [refrigerant](/wiki/Refrigerant). Among other things, it is used in the [cryopreservation](/wiki/Cryopreservation) of blood, reproductive cells ([sperm](/wiki/Sperm) and [egg](/wiki/Ovum)), and other biological samples and materials. It is used in the clinical setting in [cryotherapy](/wiki/Cryotherapy) to remove cysts and warts on the skin.[[56]](#cite_note-56) It is used in [cold traps](/wiki/Cold_trap) for certain laboratory equipment and to cool [infrared detectors](/wiki/Infrared_detector) or [X-ray detectors](/wiki/X-ray_detector). It has also been used to cool [central processing units](/wiki/Central_processing_unit) and other devices in computers that are [overclocked](/wiki/Overclocking), and that produce more heat than during normal operation.[[57]](#cite_note-57)

### Solid nitrogen[[edit](/index.php?title=(none)&action=edit&section=12)]

[Template:Main](/wiki/Template:Main)

The solid form of the element nitrogen forms a significant dynamic surface coverage on [Pluto](/wiki/Pluto)[[58]](#cite_note-58) and outer moons of the Solar System such as [Triton](/wiki/Triton_(moon)).[[59]](#cite_note-59) Even at the low temperatures of solid nitrogen it is fairly volatile and can [sublime](/wiki/Sublimation_(phase_transition)) to form an atmosphere, or condense back into nitrogen frost. It is very weak and flows in the form of glaciers and on Triton [geysers](/wiki/Geyser) of nitrogen gas come from the polar ice cap region.[[60]](#cite_note-60) There are a variety of crystalline forms of solid nitrogen known, not all with discrete dinitrogen molecular structures. Such non-molecular forms of solid nitrogen are of interest as they possess a higher energy density than any other non-nuclear material.

### Nitrogen compounds[[edit](/index.php?title=(none)&action=edit&section=13)]

Molecular nitrogen (N2) in the atmosphere is relatively non-reactive due to its strong triple bond, N≡N, and molecular nitrogen plays an inert role in the human body, being neither produced nor destroyed. In nature, nitrogen is converted into biologically (and industrially) useful compounds by lightning, and by some living organisms, notably certain [bacteria](/wiki/Bacteria) (i.e., [nitrogen-fixing bacteria](/wiki/Nitrogen-fixing_bacteria)—see [*Biological role*](/wiki/#Biological_role) below). Molecular nitrogen is released into the atmosphere in the process of [decay](/wiki/Decomposition), in dead plant and animal tissues.

The ability to combine, or fix, molecular nitrogen is a key feature of modern industrial chemistry. Previously to the 20th century, access to nitrogen compounds for fertilizers and gunpowder had been through deposits of natural nitrates, such as Chilean [saltpeter](/wiki/Saltpeter). However, first the [Frank–Caro process](/wiki/Frank–Caro_process) for producing [cyanamide](/wiki/Cyanamide), and then the [Haber–Bosch process](/wiki/Haber–Bosch_process) for producing ammonia from air and natural gas[[18]](#cite_note-18) (developed just before the first world war) eased this shortage of nitrogen compounds, to the extent that half of global food production now relies on synthetic nitrogen fertilizers.

The [Ostwald process](/wiki/Ostwald_process), developed a few years before the Haber process, allowed large-scale production of nitric acid and nitrate from ammonia, thus freeing large-scale industrial production of nitrate explosives and weapons propellants from the need to mine nitrate salt deposits.[[42]](#cite_note-42) The organic and inorganic [salts](/wiki/Salt_(chemistry)) of nitric acid have been important historically as convenient stores of chemical energy for warfare and rocket fuels. Historically, such compounds included important compounds such as [potassium nitrate](/wiki/Potassium_nitrate), used in [gunpowder](/wiki/Gunpowder)[[61]](#cite_note-61) which was often produced by biological means (bacterial fermentation) before natural mineral sources were discovered. Later, all such sources were displaced by industrial production, in the early 1900s.

[thumb|360px|Table tennis ball made from nitrocellulose.](/wiki/File:40mm_table_tennis_ball_Celluloid.jpg)

[Ammonium nitrate](/wiki/Ammonium_nitrate) has been used as both fertilizer[[35]](#cite_note-35) and explosive (see [ANFO](/wiki/ANFO)). Various other nitrated organic compounds, such as [nitroglycerin](/wiki/Nitroglycerin), [trinitrotoluene](/wiki/Trinitrotoluene),[[61]](#cite_note-61) and [nitrocellulose](/wiki/Nitrocellulose),[[62]](#cite_note-62) are used as explosives and propellants for modern firearms. [Nitric acid](/wiki/Nitric_acid) is used as an [oxidizing agent](/wiki/Oxidizing_agent) in liquid fueled [rockets](/wiki/Rocket). [Hydrazine](/wiki/Hydrazine) and hydrazine derivatives find use as rocket [fuels](/wiki/Fuel) and [monopropellants](/wiki/Monopropellant). In most of these compounds, the basic instability and tendency to burn or explode is derived from the fact that nitrogen is present as an oxide, and not as the far more stable nitrogen molecule (N2), which is a product of the compounds' thermal decomposition. When nitrates burn or explode, the formation of the powerful triple bond in the N2 produces most of the energy of the reaction.[Template:Citation needed](/wiki/Template:Citation_needed)

Nitrogen is a constituent of molecules in every major drug class in pharmacology and medicine. [Nitrous oxide](/wiki/Nitrous_oxide) (N2O) was discovered early in the 19th century to be a partial anesthetic, though it was not used as a surgical anesthetic until later. Called "[laughing gas](/wiki/Nitrous_oxide)", it was found capable of inducing a state of social disinhibition resembling drunkenness. Other notable nitrogen-containing drugs are drugs derived from plant [alkaloids](/wiki/Alkaloid), such as [morphine](/wiki/Morphine) (there exist many alkaloids known to have pharmacological effects; in some cases, they appear as natural chemical defenses of plants against predation). Drugs that contain nitrogen include all major classes of antibiotics and organic nitrate drugs like [nitroglycerin](/wiki/Nitroglycerin) and [nitroprusside](/wiki/Nitroprusside) that regulate blood pressure and heart action by mimicking the action of [nitric oxide](/wiki/Nitric_oxide).[Template:Citation needed](/wiki/Template:Citation_needed)

## Biological role[[edit](/index.php?title=(none)&action=edit&section=14)]

[Template:See also](/wiki/Template:See_also) Nitrogen is an essential building block of [amino](/wiki/Amino_acid) and [nucleic acids](/wiki/Nucleic_acid), essential to life on Earth.[[35]](#cite_note-35) Elemental nitrogen in the atmosphere cannot be used directly by either plants or animals, and must be converted to a reduced (or 'fixed') state to be useful for higher plants and animals. [Precipitation](/wiki/Precipitation_(meteorology)) often contains substantial quantities of [ammonium](/wiki/Ammonium) and [nitrate](/wiki/Nitrate), thought to result from [nitrogen fixation](/wiki/Nitrogen_fixation) by [lightning](/wiki/Lightning) and other atmospheric electric phenomena.[[63]](#cite_note-63) This was first proposed by [Liebig](/wiki/Justus_von_Liebig) in 1827 and later confirmed.[[63]](#cite_note-63) However, because [ammonium](/wiki/Ammonium) is preferentially retained by the [forest canopy](/wiki/Forest_canopy) relative to atmospheric nitrate, most fixed nitrogen reaches the [soil](/wiki/Soil) surface under trees as nitrate. Soil nitrate is preferentially assimilated by tree [roots](/wiki/Root) relative to soil ammonium, however this is not the case for all species.[[64]](#cite_note-64)[[65]](#cite_note-65) Specific [bacteria](/wiki/Bacteria) (e.g., [*Rhizobium*](/wiki/Rhizobia) *trifolium*) possess [nitrogenase](/wiki/Nitrogenase) [enzymes](/wiki/Enzyme) that can fix atmospheric nitrogen (see [nitrogen fixation](/wiki/Nitrogen_fixation)) into a form ([ammonium](/wiki/Ammonium) ion) that is chemically useful to higher organisms. This process requires a large amount of energy and [anoxic](/wiki/Wikt:anoxia) conditions. Such bacteria may live freely in soil (e.g., [*Azotobacter*](/wiki/Azotobacter)) but normally exist in a [symbiotic](/wiki/Symbiosis) relationship in the [root nodules](/wiki/Root_nodule) of [leguminous](/wiki/Legume) plants (e.g. [clover](/wiki/Clover), *Trifolium*, or [soybean](/wiki/Soybean) plant, *Glycine max*) and [fertilizer trees](/wiki/Fertilizer_tree). Nitrogen-fixing bacteria are also symbiotic with a number of unrelated plant species such as alders ([*Alnus*](/wiki/Alnus)) spp., lichens, [*Casuarina*](/wiki/Casuarina), [*Myrica*](/wiki/Myrica), [liverworts](/wiki/Marchantiophyta), and [*Gunnera*](/wiki/Gunnera).<ref name=cycle/>

As part of the symbiotic relationship, the plant converts the 'fixed' ammonium ion to nitrogen oxides and amino acids to form [proteins](/wiki/Protein) and other molecules, (e.g., [alkaloids](/wiki/Alkaloids)). In return for the 'fixed' nitrogen, the plant secretes sugars to the symbiotic bacteria.<ref name=cycle/> [Legumes](/wiki/Legume) maintain an anaerobic (oxygen free) environment for their nitrogen-fixing bacteria.[Template:Citation needed](/wiki/Template:Citation_needed)

Plants are able to assimilate nitrogen directly in the form of nitrates that may be present in soil from natural mineral deposits, artificial fertilizers, animal waste, or organic decay (as the product of bacteria, but not bacteria specifically associated with the plant). Nitrates absorbed in this fashion are converted to nitrites by the enzyme [*nitrate* reductase](/wiki/Nitrate_reductase), and then converted to ammonia by another enzyme called [*nitrite* reductase](/wiki/Nitrite_reductase).<ref name=cycle/>

Nitrogen compounds are basic building blocks in animal biology as well. Animals use nitrogen-containing [amino acids](/wiki/Amino_acid) from plant sources as starting materials for all nitrogen-compound animal biochemistry, including the manufacture of [proteins](/wiki/Protein) and [nucleic acids](/wiki/Nucleic_acid). Plant-feeding insects are dependent on nitrogen in their diet, such that varying the amount of nitrogen fertilizer applied to a plant can affect the reproduction rate of insects feeding on fertilized plants.[[66]](#cite_note-66) Soluble nitrate is an important limiting factor in the growth of certain bacteria in ocean waters.<ref name=ocean>[Template:Cite book](/wiki/Template:Cite_book)</ref> In many places in the world, artificial [fertilizers](/wiki/Fertilizer) applied to crop-lands to increase yields result in run-off delivery of soluble nitrogen to oceans at river mouths. This process can result in [eutrophication](/wiki/Eutrophication) of the water, as nitrogen-driven bacterial growth depletes water oxygen to the point that all higher organisms die. Well-known ["dead zone"](/wiki/Dead_zone_(ecology)) areas in the U.S. [Gulf Coast](/wiki/Gulf_Coast) and the [Black Sea](/wiki/Black_Sea) are due to this important polluting process.[Template:Citation needed](/wiki/Template:Citation_needed)

Many saltwater fish manufacture large amounts of [trimethylamine oxide](/wiki/Trimethylamine_oxide) to protect them from the high [osmotic](/wiki/Osmosis) effects of their environment; conversion of this compound to [dimethylamine](/wiki/Dimethylamine) is responsible for the early odor in unfresh saltwater fish.[[67]](#cite_note-67) In animals, [free radical](/wiki/Free_radical) [nitric oxide](/wiki/Nitric_oxide) (**NO**) (derived from an [amino acid](/wiki/Amino_acid)), serves as an important regulatory molecule for circulation.<ref name=ocean/>

Nitric oxide's rapid reaction with water in animals results in production of its metabolite [nitrite](/wiki/Nitrite). Animal [metabolism](/wiki/Metabolism) of nitrogen in proteins, in general, results in [excretion](/wiki/Excretion) of [urea](/wiki/Urea), while animal metabolism of [nucleic acids](/wiki/Nucleic_acids) results in excretion of [urea](/wiki/Urea) and [uric acid](/wiki/Uric_acid). The characteristic odor of animal flesh decay is caused by the creation of long-chain, nitrogen-containing [amines](/wiki/Amine), such as [putrescine](/wiki/Putrescine) and [cadaverine](/wiki/Cadaverine), which are breakdown products of the amino acids [ornithine](/wiki/Ornithine) and [lysine](/wiki/Lysine), respectively, in decaying proteins.[[68]](#cite_note-68) Decay of organisms and their waste products may produce small amounts of nitrate, but most decay eventually returns nitrogen content to the atmosphere, as molecular nitrogen. The circulation of nitrogen from atmosphere, to organic compounds, then back to the atmosphere, is referred to as the [nitrogen cycle](/wiki/Nitrogen_cycle).<ref name=cycle>[Template:Cite book](/wiki/Template:Cite_book)</ref>

## Safety[[edit](/index.php?title=(none)&action=edit&section=15)]

Although nitrogen is non-toxic, when released into an enclosed space it can displace oxygen, and therefore presents an [asphyxiation](/wiki/Nitrogen_asphyxiation) hazard. This may happen with few warning symptoms, since the human [carotid body](/wiki/Carotid_body) is a relatively poor and slow low-oxygen (hypoxia) sensing system.[[69]](#cite_note-69) An example occurred shortly before the launch of the first Space Shuttle mission in 1981, when two technicians died from asphyxiation after they walked into a space located in the Shuttle's [Mobile Launcher Platform](/wiki/Mobile_Launcher_Platform) that was pressurized with pure nitrogen as a precaution against fire.[[70]](#cite_note-70) A closed space, initially filled with air, will ultimately contain only nitrogen, carbon dioxide, and trace gases if some oxidative process, such as the rusting of iron, consumes all the oxygen.

When inhaled at high [partial pressures](/wiki/Partial_pressure) (more than about 4 bar, encountered at depths below about 30 m in [scuba diving](/wiki/Scuba_diving)), nitrogen is an anesthetic agent, causing [nitrogen narcosis](/wiki/Nitrogen_narcosis), a temporary state of mental impairment similar to [nitrous oxide](/wiki/Nitrous_oxide) intoxication.[[71]](#cite_note-71)[[72]](#cite_note-72) Nitrogen dissolves in the [blood](/wiki/Blood) and body fats. Rapid decompression (as when divers ascend too quickly or astronauts decompress too quickly from cabin pressure to spacesuit pressure) can lead to a potentially fatal condition called [decompression sickness](/wiki/Decompression_sickness) (formerly known as caisson sickness or *the bends*), when nitrogen bubbles form in the bloodstream, nerves, joints, and other sensitive or vital areas.[[73]](#cite_note-73)[[74]](#cite_note-74) Bubbles from other "inert" gases (gases other than carbon dioxide and oxygen) cause the same effects, so replacement of nitrogen in [breathing gases](/wiki/Breathing_gas) may prevent nitrogen narcosis, but does not prevent decompression sickness.[[75]](#cite_note-75) Direct skin contact with [liquid nitrogen](/wiki/Liquid_nitrogen) will cause severe [frostbite](/wiki/Frostbite) (cryogenic "burns"). This may happen almost instantly on contact, or after a second or more, depending on the form of liquid nitrogen. Bulk liquid nitrogen causes less rapid freezing than a spray of nitrogen mist (such as is used to freeze certain skin growths in the practice of [dermatology](/wiki/Dermatology)). The extra surface area provided by nitrogen-soaked materials is also important, with soaked clothing or cotton causing far more rapid damage than a spill of direct liquid to skin. Full "contact" between naked skin and large collected-droplets or pools of liquid nitrogen may be prevented for a second or two, by a layer of insulating gas from the [Leidenfrost effect](/wiki/Leidenfrost_effect). This may give the skin a second of protection from nitrogen bulk liquid. However, liquid nitrogen applied to skin in mists, and on fabrics, bypasses this effect, and causes local frostbite immediately.[Template:Citation needed](/wiki/Template:Citation_needed)

[Oxygen sensors](/wiki/Oxygen_sensor) are sometimes used as a safety precaution when working with liquid nitrogen to alert workers of gas spills into a confined space.[[76]](#cite_note-76) Nitrogen that evaporates from liquid is still colder and heavier than (oxygenated) air, therefore any spill of liquid nitrogen tends to stay at the bottom of a closed space, expelling oxygen.

## See also[[edit](/index.php?title=(none)&action=edit&section=16)]

* [Reactive nitrogen species](/wiki/Reactive_nitrogen_species)
* [Yeast assimilable nitrogen](/wiki/Yeast_assimilable_nitrogen)
* [Nitrogen fixation](/wiki/Nitrogen_fixation)
* [Nitrogen deficiency](/wiki/Nitrogen_deficiency) in plants
* [nitrogen execution](/wiki/Inert_gas_asphyxiation#Capital_punishment)

## Notes[[edit](/index.php?title=(none)&action=edit&section=17)]

[Template:Notes](/wiki/Template:Notes)

## References[[edit](/index.php?title=(none)&action=edit&section=18)]

[Template:Reflist](/wiki/Template:Reflist)

## Bibliography[[edit](/index.php?title=(none)&action=edit&section=19)]

* [Template:Cite book](/wiki/Template:Cite_book)

## Further reading[[edit](/index.php?title=(none)&action=edit&section=20)]

* [Template:Cite book](/wiki/Template:Cite_book)

## External links[[edit](/index.php?title=(none)&action=edit&section=21)]

* [Etymology of Nitrogen](http://www.balashon.com/2008/07/neter-and-nitrogen.html)
* [Nitrogen](http://www.periodicvideos.com/videos/007.htm) at [*The Periodic Table of Videos*](/wiki/The_Periodic_Table_of_Videos) (University of Nottingham)
* [Nitrogen podcast](http://www.rsc.org/periodic-table/podcast/7/nitrogen) from the Royal Society of Chemistry's [*Chemistry World*](/wiki/Chemistry_World)

[Template:Diatomicelements](/wiki/Template:Diatomicelements) [Template:E number infobox 930-949](/wiki/Template:E_number_infobox_930-949) [Template:Compact periodic table](/wiki/Template:Compact_periodic_table) [Template:GABAAR PAMs](/wiki/Template:GABAAR_PAMs)

[Template:Authority control](/wiki/Template:Authority_control)

[Category:Nitrogen](/wiki/Category:Nitrogen) [Category:Chemical elements](/wiki/Category:Chemical_elements) [Category:Pnictogens](/wiki/Category:Pnictogens) [Category:Diatomic nonmetals](/wiki/Category:Diatomic_nonmetals) [Category:Coolants](/wiki/Category:Coolants) [Category:Laser gain media](/wiki/Category:Laser_gain_media) [Category:Biology and pharmacology of chemical elements](/wiki/Category:Biology_and_pharmacology_of_chemical_elements) [Category:Dielectric gases](/wiki/Category:Dielectric_gases) [Category:Industrial gases](/wiki/Category:Industrial_gases) [Category:GABAA receptor positive allosteric modulators](/wiki/Category:GABAA_receptor_positive_allosteric_modulators) [Category:Articles containing video clips](/wiki/Category:Articles_containing_video_clips)