

Oxygen (O)

Oxygen links periodic trends to respiration, combustion, steelmaking and a subtle quantum result: ordinary O₂ is attracted into a magnetic field because its ground state has two unpaired electrons.

8	O	15.999
Atomic number	Oxygen	Relative atomic mass

1. Quick facts

Property	Value	Meaning for a student
Atomic number	8	8 protons
Electrons	8	neutral O atom
Electron configuration	[He] 2s ² 2p ⁴	6 valence electrons
Relative atomic mass	15.999	natural isotope-weighted value
Key isotope	¹⁶ O	8 protons / 8 neutrons
Group / period	16 / 2	p-block nonmetal

2. Atomic structure and electron configuration

Atomic feature	Value	How to read it
Protons	8	Atomic number fixes the proton count.
Electron configuration	[He] 2s ² 2p ⁴	Ground-state orbital bookkeeping.
Shell arrangement	2, 6	Compact shell-count view.
Common oxidation states	-2 common; -1 in peroxides	Formal oxidation-state bookkeeping, not permanent atom charges.

3. Signature idea

Why is oxygen paramagnetic?

A Lewis structure can hide the spin information. In the ground-state molecular-orbital picture of O₂, two electrons occupy separate π* antibonding orbitals with parallel spins.

Model / case	Key result	Why it matters
π* orbital A	↑	One unpaired electron.
π* orbital B	↑	A second unpaired electron with parallel spin in triplet O ₂ .
Result	Paramagnetic	The unpaired spins give molecular oxygen a net magnetic response.

4. Properties, phase behavior and evidence

Property	Value	Meaning for a student
Atomic radius	1.52 Å	RSC non-bonded radius reference.
Covalent radius	0.64 Å	Typical covalent-radius reference.
Electron affinity	140.976 kJ/mol	RSC gaseous-atom reference.
Electronegativity	3.44	High on the Pauling scale.

Evidence context

Atomic and isotope values are evaluated reference data. The paramagnetism explanation is an experimentally established molecular property interpreted with molecular-orbital theory.

5. Where on Earth?

Oxygen is an Earth-system element, not a country commodity

Oxygen is distributed through the atmosphere, oceans, rocks and living systems. The map therefore uses global reservoir labels rather than invented occurrence dots.

Global occurrence view

Atmosphere: O₂ / Oceans + water / Rocks + minerals. Country dots are intentionally not used for this layer.

6. Representative compounds / forms

Water / H₂O

Oxygen commonly forms two covalent bonds in neutral water.

Metal oxides

Oxides such as Fe₂O₃ link oxygen chemistry to minerals, corrosion and metallurgy.

7. Isotope snapshot

Isotope	Nucleus	Natural abundance / status
¹⁶ O	8 p / 8 n	99.757% - Stable
¹⁷ O	8 p / 9 n	0.038% - Stable
¹⁸ O	8 p / 10 n	0.205% - Stable

8. Questions to ask next

Why is oxygen paramagnetic? Ground-state O₂ has two unpaired electrons in separate π* antibonding molecular orbitals.
How many valence electrons does oxygen have? Six valence electrons.

Sources

Royal Society of Chemistry - Oxygen element data

NIST - Oxygen atomic data

NIST - Isotopic compositions of oxygen

Royal Society of Chemistry - ground-state triplet O₂ and paramagnetism

Full interactive guide: <https://elementlookup.com/oxygen/>