

Copper (Cu)

Copper combines a filled 3d shell, one 4s electron, excellent electrical conduction and a rare reddish metallic color. It also connects directly to Gold through Group 11 while telling a different electronic story.

29	Cu	63.546
Atomic number	Copper	Relative atomic mass

1. Quick facts

Property	Value	Meaning for a student
Atomic number	29	29 protons
Electrons	29	neutral Cu atom
Electron configuration	[Ar] 3d ¹⁰ 4s ¹	filled 3d + one 4s electron
Relative atomic mass	63.546	natural isotope-weighted value
Key isotopes	⁶³ Cu / ⁶⁵ Cu	both stable
Group / period	11 / 4	d-block transition metal

2. Atomic structure and electron configuration

Atomic feature	Value	How to read it
Protons	29	Atomic number fixes the proton count.
Electron configuration	[Ar] 3d ¹⁰ 4s ¹	Ground-state orbital bookkeeping.
Shell arrangement	2, 8, 18, 1	Compact shell-count view.
Common oxidation states	+1 and +2 common	Formal oxidation-state bookkeeping, not permanent atom charges.

3. Signature idea

Why is copper reddish and conductive?

Copper's optical response is not uniform across visible wavelengths. Classic reflectance measurements show a threshold for interband transitions below about 0.6 μm ; at longer wavelengths free-electron behavior dominates more strongly.

Color + conduction

Copper reflects red/orange wavelengths more strongly than shorter visible wavelengths, so it looks reddish rather than silvery. Its high electrical conductivity is a collective solid-state band property with mobile charge carriers; neither effect is explained by drawing one isolated 4s electron orbit.

4. Properties, phase behavior and evidence

Property	Value	Meaning for a student
Atomic radius	1.96 Å	RSC non-bonded radius.
Covalent radius	1.22 Å	RSC reference.
Electron affinity	119.159 kJ/mol	Gaseous atom reference.
Electronegativity	1.90	Pauling scale.

Evidence context

Atomic values are evaluated reference data. The Earth markers are 2025 estimated mine production and therefore time-dependent; optical/conduction explanations are solid-state interpretations, not isolated-atom pictures.

5. Where on Earth?

Modern copper mining has a measurable geography

Copper occurs in many ore systems worldwide, but production changes year by year. These markers show 2025 estimated mine output from USGS rather than pretending they are timeless natural-abundance points.

Country	2025 estimate	What the map means
Chile	5.3 Mt	2025 source-year production layer
DR Congo	3.2 Mt	2025 source-year production layer
Peru	2.7 Mt	2025 source-year production layer
China	1.8 Mt	2025 source-year production layer
United States	1.0 Mt	2025 source-year production layer

6. Representative compounds / forms

Copper(I) oxide / Cu ₂ O A red Cu(I) oxide illustrating the +1 oxidation state.	Copper(II) oxide / CuO A black Cu(II) oxide illustrating the common +2 state.
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7. Isotope snapshot

Isotope	Nucleus	Natural abundance / status
⁶³ Cu	29 p / 34 n	69.15% - Stable
⁶⁵ Cu	29 p / 36 n	30.85% - Stable

8. Questions to ask next

Why is copper reddish instead of silvery? Copper absorbs more short-wavelength visible light than a typical silvery metal, so reflected light is enriched toward red and orange.

Why does copper conduct electricity so well? Mobile electronic states in the metallic solid carry charge efficiently.

Sources

Royal Society of Chemistry - Copper element data
NIST - Copper atomic data
NIST - Isotopic compositions of copper
USGS Mineral Commodity Summaries 2026 - Copper
Physical Review - Optical Properties of Copper (1960)

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