

Vanadium (V) - Student Datasheet

Element 23 · Transition metal · source-reviewed learning reference

Vanadium is element 23, a Group 5 transition metal whose BCC metal, multiple oxidation states and strong alloying chemistry connect atomic d electrons to high-strength steels, catalysts and redox-flow batteries.

Quick reference

Atomic number	23
Relative atomic mass	50.942
Electron configuration	[Ar] 3d ³ 4s ²
Period / group / block	4 / 5 / d
State context	Silvery-gray transition metal
Density	6.0 g/cm ³
Melting / transition	2183 K
Boiling / gas reference	3680 K
Oxidation states	+5, +4, +3, +2
Electronegativity	1.63

Structure & orbitals

Pure vanadium is BCC under ordinary conditions. The viewer shows a conventional body-centred cubic teaching cell.

Representative 3d and 4s probability models describe an isolated atom. Metallic bands and compound ligand fields reorganize these electrons.

Phase behavior

At approximately standard pressure, vanadium is solid below 2183 K, liquid to about 3680 K, and gaseous above the boiling reference.

Five things to remember

- Atomic number 23 means 23 protons.
- Vanadium is a Group 5 transition metal.
- Ordinary vanadium metal is BCC.
- Several oxidation states—especially +2 to +5—are chemically important.
- Most vanadium use is through alloys or compounds, not decorative pure metal.

Vanadium: Real World & Signature Science

Element-specific science, uses and history

Big idea

Vanadium is not defined by a single “valence.” Its transition-metal chemistry uses several oxidation states, commonly +2 through +5, which is why vanadium compounds show such varied colors and redox behavior.

Why this element is scientifically distinctive

Explore V across the teaching nucleus, isolated-atom orbitals, evidence-aware material structure and temperature/evidence views, then connect those models to uses, isotopes and source-backed context.

Steel alloys	Vanadium additions can strengthen steels through controlled alloy and microstructure chemistry.
Catalysts	Vanadium(V) oxide is used as a catalyst in important industrial oxidation chemistry.
Redox-flow batteries	Vanadium ions in different oxidation states enable rechargeable liquid-electrolyte energy storage.
Titanium alloys	Vanadium is a component of important titanium alloy systems.
Color chemistry	Different oxidation states produce distinct solution/compound colors; the metal itself is not “multicolored.”

From vanadium-bearing feedstocks to alloys and compounds: high-level path

1. Vanadium is obtained from several resource types, including vanadiferous titanomagnetite, slags and other mineral or petroleum-related streams.
2. Industrial refining converts vanadium into metal-alloy feedstocks or chemical compounds.
3. Steel and titanium metallurgy use controlled additions, while chemical industries use vanadium compounds.
4. Recovery from industrial residues and spent catalysts can contribute secondary supply.

History checkpoints

1801	Andrés Manuel del Río discovered the element in Mexico but his claim was not initially accepted.
1830	Nils Gabriel Sefström rediscovered the element and named it vanadium.
1831	Friedrich Wöhler recognized that del Río’s earlier material had contained the same element.
Modern era	Vanadium became important in alloy steels, catalysts and electrochemical energy storage.

Vanadium: Isotopes, Questions & Evidence

Evidence status and learner self-check

Isotope context

⁵¹ V	Stable natural isotope	Dominant natural isotope and reference teaching nucleus.
⁵⁰ V	Extremely long-lived natural radioisotope	A minor natural isotope with a very long half-life.
Natural vanadium	Mostly ⁵¹ V	Relative atomic mass is close to 51 because ⁵¹ V dominates.

Common questions

What is vanadium?

Vanadium is chemical element 23, a transition metal in Group 5.

Is vanadium a metal?

Yes. It is a transition metal.

What is the symbol for vanadium?

V.

What is vanadium used for?

Major roles include alloy steels, titanium alloys, catalysts and vanadium redox-flow batteries.

Quick self-check

Q: What is vanadium's atomic number? | Answer: 23. Atomic number equals proton count.

Q: What is its ordinary metal structure? | Answer: BCC. Pure vanadium is body-centred cubic.

Q: Why are several oxidation states important? | Answer: d electrons can participate in different redox states.

Transition-metal d electrons enable varied chemistry.

Evidence & safety

Atomic and phase values are evaluated. The BCC material model is a conventional teaching cell. Oxidation-state examples are compound chemistry and are not treated as colors/properties of pure metal.

Vanadium metal and vanadium compounds have different hazards. Industrial dusts and compounds require substance-specific occupational controls.

Core sources

Royal Society of Chemistry - Vanadium

<https://periodic-table.rsc.org/element/23/vanadium>

USGS - Mineral Commodity Summaries 2026

<https://pubs.usgs.gov/publication/mcs2026>