

Cobalt (Co) - Student Datasheet

Atomic number 27 - Transition metal - Group 9 - Period 4 - d-block

Cobalt is element 27, a ferromagnetic transition metal used in high-performance alloys, magnets, catalysts and many battery materials. It also undergoes an HCP-to-FCC solid-state transition before melting.

Quick reference

Atomic number	27
Relative atomic mass	58.933194
Electron configuration	[Ar] 3d ⁷ 4s ²
State at 20 C	Hard grey ferromagnetic solid at 20 deg C
Density	8.86 g/cm ³
Melting point	1768 K
Boiling point	3200 K
Common oxidation state	+2 and +3
Electronegativity	1.88

Structure & orbitals

Cobalt is HCP at ordinary temperature and transforms to an FCC form on heating at roughly 700 K. Both viewers are idealized teaching cells.

The atomic 3d/4s clouds are isolated-atom probability models. Ferromagnetism and conductivity are collective solid-state effects and are not literal orbital animations.

Temperature / phase context

The teaching path shows HCP cobalt at lower temperature, an HCP -> FCC solid transition around 700 K, melting near 1768 K and boiling near 3200 K. The solid-transition temperature can depend on sample history and conditions.

Five things to remember

- Atomic number 27 means 27 protons.
- Neutral cobalt has [Ar] 3d⁷4s².
- ⁵⁹Co is the only stable natural isotope.
- Cobalt is ferromagnetic at room temperature.
- Cobalt changes from HCP to FCC on heating before it melts.

Cobalt: Real World & Signature Science

Cobalt metal, cobalt ions and cobalt-containing battery compounds are different materials. A battery cathode containing cobalt is not a block of elemental cobalt, and supply geography is not chemistry.

Why this element matters

Superalloys Cobalt-based and cobalt-containing superalloys retain useful properties in demanding high-temperature environments.	Magnets Cobalt appears in permanent-magnet materials such as samarium-cobalt and alnico families.
Battery compounds Cobalt can be part of cathode compounds in several rechargeable-battery chemistries; this is compound chemistry, not elemental cobalt metal.	Catalysts & pigments Cobalt compounds serve in selected catalysts, pigments and chemical processes.
Mining & recycling Primary cobalt supply is strongly concentrated geographically; recycling of battery and alloy materials is increasingly important.	

From cobalt-bearing ore to metal, alloy or compound: high-level context

1. Cobalt is commonly recovered as a coproduct or byproduct from copper and nickel ores rather than from a single universal "cobalt ore."
2. Mining and beneficiation feed hydrometallurgical or pyrometallurgical industrial circuits; detailed process recipes are outside this guide.
3. Refining produces cobalt metal or chemical compounds to application-specific specifications.
4. Alloys, catalysts, magnets and battery materials use different cobalt forms, while recycling can recover cobalt from end-of-life products.

Where on Earth?

Mine + refining geography

DR Congo and Indonesia dominate recent mine context, while refining and battery-material manufacture have different geography.

History

1735 - Georg Brandt identified cobalt as a distinct metal, helping separate its chemistry from bismuth and other ores.

19th-20th centuries - Cobalt pigments, magnets and alloys expanded industrial use.

Jet age - Cobalt-bearing superalloys became important in high-temperature turbine applications.

Today - Battery demand, concentrated mine supply and recycling have made cobalt an important critical-mineral topic.

Uses

Superalloys Cobalt helps selected alloys retain strength and corrosion resistance at high temperatures.	Permanent magnets Cobalt-containing magnet families support high-temperature and high-performance applications.
Battery materials Cobalt-containing cathodes are used in several lithium-ion battery chemistries.	Catalysts & pigments Cobalt compounds are used in selected catalysts, drying agents, pigments and ceramics.

Cobalt: Isotopes, Questions & Evidence

Isotopes

⁵⁹Co - Stable - essentially all natural cobalt

Reference teaching nucleus: 27 protons and 32 neutrons.

⁶⁰Co - Radioactive - important gamma source

Used in controlled industrial/medical contexts and as a tracer; it requires radiation-safety management.

Cobalt isotope context - One stable natural isotope

Natural cobalt is effectively monoisotopic, although many radioactive isotopes are known.

Common questions

What is cobalt's atomic number?

27.

Is cobalt a metal?

Yes. It is a transition metal and is ferromagnetic at room temperature.

What is cobalt metal used for?

Important uses include superalloys, magnets and specialty materials; cobalt compounds also appear in batteries, catalysts and pigments.

How many valence electrons does cobalt have?

Transition-metal valence counting depends on context; the neutral ground state is [Ar] 3d⁷4s².

Does cobalt change crystal structure when heated?

Yes. Cobalt has a lower-temperature HCP form and a higher-temperature FCC form before melting.

Is cobalt in a battery elemental cobalt?

Usually no. It is present in engineered compounds such as cathode materials.

Quick self-check

1. Atomic number? Answer: 27

2. Stable natural isotope? Answer: ⁵⁹Co

3. Room-temperature structure? Answer: HCP

4. Higher-temperature solid structure? Answer: FCC

5. Battery cobalt is usually present as... Answer: a compound/ion in cathode material

Evidence & provenance

Bulk properties and HCP/FCC structure are measured/evaluated. The ~700 K solid transition is a teaching reference, not an immutable value. Production maps use dated commodity data and are not maps of battery chemistry.

Core sources

Royal Society of Chemistry - Cobalt	https://periodic-table.rsc.org/element/27/cobalt
NIST - Atomic Data for Cobalt	https://physics.nist.gov/PhysRefData/Handbook/Tables/cobalttable1.htm
USGS - Mineral Commodity Summaries 2026	https://pubs.usgs.gov/publication/mcs2026