

Germanium (Ge) - Student Datasheet

Element 32 · Metalloid · source-reviewed learning reference

Germanium is element 32, a Group 14 metalloid whose tetrahedral crystal and semiconductor behavior helped launch solid-state electronics. Today it also matters in infrared optics, fiber-optic systems and specialized semiconductor devices.

Quick reference

Atomic number	32
Relative atomic mass	72.630
Electron configuration	[Ar] 3d ¹⁰ 4s ² 4p ²
Period / group / block	4 / 14 / p
State context	Hard brittle gray-white metalloid · solid at 20 °C
Density	5.323 g/cm ³
Melting / transition	1211.4 K
Boiling / gas reference	3106 K
Oxidation states	+4, +2, −4
Electronegativity	2.01

Structure & orbitals

Crystalline germanium adopts the diamond-cubic network. The viewer uses a conventional tetrahedral-network teaching cell and does not claim exact thermal-displacement or defect information.

The 4s/4p orbital clouds are isolated-atom teaching models. Semiconductor bands arise from many-atom crystal interactions and must not be read directly from one orbital cloud.

Phase behavior

At approximately standard pressure, crystalline germanium remains solid to about 1211.4 K, liquid to about 3106 K, and gaseous above the boiling reference.

Five things to remember

- Atomic number 32 means 32 protons.
- Neutral germanium has [Ar] 3d¹⁰ 4s² 4p².
- Germanium is commonly classified as a metalloid and semiconductor.
- Its ordinary crystal is diamond cubic, related structurally to silicon and diamond carbon.
- Mendeleev predicted an eka-silicon before germanium was discovered.

Germanium: Real World & Signature Science

Element-specific science, uses and history

Big idea

Germanium is not simply “a metal” or “a nonmetal.” Its diamond-cubic network and band structure make metalloid/semiconductor language more useful than forcing it into a simple metallic category.

Why this element is scientifically distinctive

Rotate a ^{74}Ge nucleus and diamond-cubic teaching network, inspect 4s/4p probability clouds, then connect tetrahedral bonding to semiconductor behavior and infrared/optical applications.

Semiconductor history	Germanium was crucial in early transistor development and remains useful in specialized semiconductor devices.
Infrared optics	Germanium transmits important infrared wavelengths and is used in selected IR optical components.
Fiber optics	Germanium compounds are used to modify refractive index in silica-based optical-fiber manufacture.
By-product supply	Germanium is often recovered as a by-product from zinc ores and other metallurgical streams rather than from dedicated germanium mines.
Predicted before discovery	Mendeleev’s eka-silicon prediction closely anticipated several germanium properties before Winkler isolated it.

From by-product streams to high-purity germanium

1. Germanium occurs dispersed in certain zinc, coal and other mineral/material streams.
2. Industrial recovery concentrates germanium compounds from suitable process residues or ores.
3. High-purity refining supports semiconductor and optical grades; this guide does not provide process recipes.
4. End uses include electronics, infrared optics, fiber systems and specialized catalysts/materials.

History checkpoints

1869	Mendeleev predicted eka-silicon and several of its properties.
1886	Clemens Winkler isolated germanium from the mineral argyrodite.
1940s-1950s	Germanium became central to early semiconductor diodes and transistors.
Today	Germanium serves specialty semiconductor, infrared and fiber-optic markets.

Germanium: Isotopes, Questions & Evidence

Evidence status and learner self-check

Isotope context

⁷⁴ Ge	Stable natural isotope	Reference teaching nucleus with 32 protons and 42 neutrons.
⁷⁶ Ge	Very long-lived double-beta-decay isotope	Important in rare-event nuclear-physics research.
Germanium isotope context	Multiple stable/very long-lived natural isotopes	Relative atomic mass is an abundance-weighted value.

Common questions

Is germanium a metal?

Germanium is usually classified as a metalloid and is a semiconductor rather than an ordinary metal.

Is germanium a metalloid?

Yes, that is its common periodic-table classification.

How many valence electrons does germanium have?

Four in the simple outer-shell count, 4s²4p².

What is germanium used for?

Important uses include infrared optics, fiber-optic materials and specialized semiconductors.

Quick self-check

Q: What is germanium's atomic number? | Answer: 32. Atomic number equals proton count.

Q: How is germanium commonly classified? | Answer: Metalloid. Germanium lies in the metalloid region and is a semiconductor.

Q: What crystal structure does ordinary germanium adopt? | Answer: Diamond cubic. Germanium forms a tetrahedrally bonded diamond-cubic network.

Evidence & safety

Atomic and ordinary bulk values are evaluated. The diamond-cubic viewer is a topology-focused conventional teaching model.

Supply geography is by-product context rather than a claim of native germanium deposits.

Elemental germanium and germanium compounds are not interchangeable toxicological categories. Application-specific safety depends on chemical form and exposure route.

Core sources

Royal Society of Chemistry - Germanium

<https://periodic-table.rsc.org/element/32/germanium>

NIST - Atomic Data for Germanium

<https://physics.nist.gov/PhysRefData/Handbook/Tables/germaniumtable1.htm>

USGS - Mineral Commodity Summaries 2026

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