

Manganese (Mn) - Student Datasheet

Element 25 · Transition metal · source-reviewed learning reference

Manganese is element 25, a transition metal with a half-filled 3d⁵ subshell, multiple oxidation states and an unusually rich sequence of solid allotropes before melting. Much of its industrial importance comes from steel and manganese compounds rather than pure metal.

Quick reference

Atomic number	25
Relative atomic mass	54.938
Electron configuration	[Ar] 3d ⁵ 4s ²
Period / group / block	4 / 7 / d
Ordinary state	Hard brittle silvery solid at 20 °C
Density	7.3 g/cm ³
Melting point	1519 K
Boiling point	2334 K
Oxidation states	+2, +3, +4, +6, +7
Electronegativity	1.55

Structure & orbitals

Room-temperature α -Mn has a complex cubic structure with many atoms in the unit cell. The viewer intentionally shows a simplified multi-site cubic teaching motif rather than claiming a full crystallographic reconstruction.

The 3d models are representative probability distributions. They illustrate d-orbital angular shapes, not magnetic domains, chemical bonds or a metal band structure.

Phase behavior

On heating at approximately standard pressure, manganese passes through α , β , γ and δ solid allotropes before melting near 1519 K, then boiling near 2334 K. The explorer shows reviewed transition references rather than hiding solid-solid changes.

Five things to remember

- Atomic number 25 means 25 protons.
- Neutral manganese has [Ar] 3d⁵ 4s².
- Natural manganese is essentially monoisotopic ⁵⁵Mn.
- Manganese has several solid allotropes before melting, not one fixed crystal structure at all temperatures.
- Manganese compounds can have very different oxidation states and colors; metallic Mn is not permanganate or MnO₂.

Manganese: Real World & Signature Science

Big idea

Metallic Mn, Mn^{2+} , MnO_2 and permanganate are different chemical forms. Their colors, structures, reactivity and uses should not be blended into one generic “manganese” description.

Why this element is scientifically distinctive

Compare Mn with Mn^{2+} , inspect the 3d probability model and a simplified α -Mn structure, then use the phase explorer to follow $\alpha \rightarrow \beta \rightarrow \gamma \rightarrow \delta$ manganese before melting and connect those changes to alloys and battery chemistry.

Steel alloys	Most manganese demand is tied to iron and steel, where manganese improves processing and material performance.
Battery materials	MnO_2 and other manganese compounds are important in several battery chemistries; those compounds are not metallic Mn.
Oxidation-state chemistry	Mn^{2+} , MnO_2 and permanganate illustrate how oxidation state changes chemical identity and color.
Ore resources	Manganese is produced mainly from oxide/carbonate ores; selected major producing regions are shown as dated commodity context.
Biological trace role	Manganese is an essential trace nutrient in enzymes, but nutritional context is distinct from industrial metal/compound exposure.

From manganese ore to alloys and compounds: a high-level path

1. Manganese occurs in minerals and sedimentary/oxide deposits rather than as native metal.
2. Mining and beneficiation produce manganese ore/concentrates for metallurgical and chemical markets.
3. Most metallurgical manganese enters ferroalloys used in steelmaking; high-purity compounds feed batteries and chemicals.
4. Recycling occurs indirectly through steel scrap and, increasingly, battery-material recovery streams.

History checkpoints

1774	Johan Gottlieb Gahn isolated manganese metal from manganese dioxide-related material.
19th century	Manganese became increasingly important in steelmaking and alloy control.
20th century	Battery and chemical uses expanded alongside alloy production.
Today	Manganese is a major alloying commodity and a key component of several battery/material chemistries.

Manganese: Isotopes, Questions & Evidence

Isotope context

^{55}Mn	Stable · essentially all natural manganese	Reference teaching nucleus with 25 protons and 30 neutrons.
^{54}Mn	Radioactive tracer isotope	Used in controlled research/monitoring contexts.
Manganese isotope context	Naturally monoisotopic	The single stable natural isotope makes Mn a useful contrast to multi-isotope elements.

Common questions

What is manganese's atomic number?

25.

Is manganese a metal?

Yes. It is a transition metal, though much commercial manganese is used through alloys and compounds.

How many valence electrons does manganese have?

Simple valence counting depends on context; the ground state is $[\text{Ar}] 3d^5 4s^2$, and multiple d/s electrons can participate in transition-metal chemistry.

What is manganese used for?

Its largest role is steelmaking, with important battery and chemical uses as well.

Quick self-check

Q: What is manganese's atomic number? | Answer: 25. Atomic number equals proton count.

Q: What is the ground-state configuration? | Answer: $[\text{Ar}] 3d^5 4s^2$. Mn has a half-filled 3d subshell in its ground state.

Q: Does solid manganese have only one allotrope before melting? | Answer: No. α , β , γ and δ forms occur on heating.

Evidence & safety

Atomic/phase values are evaluated. Solid-solid transition temperatures are reviewed teaching references and may vary with conditions. The α -Mn viewer is deliberately schematic because the real unit cell is structurally complex.

Manganese is nutritionally essential at trace levels, but excessive occupational/environmental exposure can be harmful. This page is not medical or exposure-control guidance.

Core sources

Royal Society of Chemistry - Manganese

<https://periodic-table.rsc.org/element/25/manganese>

NIST - Atomic Data for Manganese

<https://physics.nist.gov/PhysRefData/Handbook/Tables/manganesetable1.htm>

USGS - Mineral Commodity Summaries 2026

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