

Ruthenium (Ru) - Student Datasheet

Element 44 · Transition metal · source-reviewed learning reference

Ruthenium is element 44, a rare platinum-group transition metal. Its HCP metal, flexible oxidation chemistry and durable compounds connect the periodic table to chip resistors, electrical contacts, catalysis and electrochemical coatings.

Quick reference

Atomic number	44
Relative atomic mass	101.07
Electron configuration	[Kr] 4d ⁷ 5s ¹
Period / group / block	5 / 8 / d
State context	Shiny silvery platinum-group metal
Density	12.1 g/cm ³
Melting / transition	2606 K
Boiling / gas reference	4420 K
Oxidation states	+8, +6, +4, +3, +2, 0, −2
Electronegativity	2.20

Structure & orbitals

Ordinary ruthenium metal is HCP. The viewer is a conventional close-packed teaching cell and does not represent RuO₂, RuO₄ or coordination compounds.

The displayed d and s orbitals are isolated-atom probability teaching models. They are not metallic bands, bonding orbitals or measured electron-density maps of the bulk material.

Phase behavior

At approximately standard pressure, ruthenium is treated as a solid below 2606 K, liquid between melting and approximately 4420 K, and gas above the boiling reference. The ordinary crystal label applies to the stated material reference; unmodeled solid allotropy is not fabricated.

Five things to remember

- Atomic number 44 means every ruthenium nucleus has 44 protons.
- Neutral Ruthenium has the ground-state configuration [Kr] 4d⁷ 5s¹.
- The representative teaching isotope is ¹⁰²Ru.
- Ruthenium metal, ruthenium oxide and “ruthenium red” are not the same material.
- The ordinary material reference is Hexagonal close-packed (HCP).

Ruthenium: Real World & Signature Science

Element-specific science, uses and history

Big idea

Ruthenium metal, ruthenium oxide and “ruthenium red” are not the same material. Search results often mix the element with compounds and product names, so this guide keeps elemental Ru separate from RuO₂, RuO₄ and ruthenium-containing dyes or catalysts.

Why this element is scientifically distinctive

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

Chip resistors	Ruthenium-containing oxide materials are widely used in thick-film resistor systems; the functional material is not simply a block of Ru metal.
Electrical contacts	Ruthenium and ruthenium-containing alloys can provide hard, wear-resistant contact surfaces.
Catalysis	Ruthenium compounds and supported Ru catalysts enable selected hydrogenation, ammonia and metathesis-related chemistry.
Electrochemical anodes	RuO ₂ -containing coatings are used in selected electrochemical anodes; oxide properties differ from elemental Ru.
Compound boundary	Ruthenium red is a ruthenium-containing dye/complex name, while RuO ₄ is a volatile hazardous compound; neither is elemental ruthenium.

From source material to Ruthenium applications: high-level material path

1. Ruthenium is obtained from mineral or metallurgical feedstocks in which it is chemically associated with other elements rather than mined as abundant native metal.
2. Industrial separation and refining produce element-specific compounds or metal feedstock; this guide does not provide operational extraction recipes.
3. The refined material is converted into the particular alloy, compound, doped host or component required by the application.
4. Recycling and recovery depend on the host product, concentration and economics; application materials must not be confused with pure element.

History checkpoints

1820s	Gottfried Osann proposed the name ruthenium while studying platinum residues, but his claimed new substances were not fully verified.
1840s	Karl Ernst Claus isolated, purified and confirmed ruthenium as a new element in Kazan and retained the name derived from Ruthenia.
20th century	Ruthenium chemistry expanded into hard alloys, electrical contacts and catalytic/electrochemical materials.
Today	Ru is a low-abundance platinum-group element used mostly where a small amount provides high functional value.

Use contexts

- ['Electronics', 'Ruthenium-containing resistor materials and contacts exploit stability, conductivity and wear resistance.']
- ['Catalysis', 'Ru complexes and supported catalysts are important in selected industrial and synthetic reactions.']
- ['Electrochemistry', 'Conductive RuO₂-containing coatings are used in selected anode technologies.']
- ['Alloys', 'Small Ru additions can harden platinum-group alloys.']

Ruthenium: Isotopes, Questions & Evidence

Evidence status and learner self-check

Isotope context

^{102}Ru	Most abundant natural isotope	One of several naturally occurring ruthenium isotopes.
^{101}Ru / ^{104}Ru	Natural isotopes	Useful reference isotopes in spectroscopy and nuclear science.
Natural ruthenium	Multi-isotope element	Isotope-specific properties must not be confused with the relative atomic mass.

Common questions

What is ruthenium?

Ruthenium is chemical element 44, symbol Ru, a platinum-group transition metal.

What is ruthenium used for?

Important uses include resistor materials, wear-resistant electrical contacts, catalysts and ruthenium-oxide electrochemical coatings.

Where is ruthenium found?

It occurs with other platinum-group metals and can also be recovered from nickel/platinum-group processing streams.

Who discovered ruthenium?

Karl Ernst Claus confirmed and isolated ruthenium as a new element in the 1840s.

When was ruthenium discovered?

The accepted discovery/confirmation belongs to the 1840s, after earlier unconfirmed claims.

What color is ruthenium?

Elemental ruthenium is a shiny silvery metal.

Evidence & safety

Atomic identity and reference values are source-reviewed. Material viewers are teaching representations, not crystallographic refinements. Search demand shapes headings and FAQs but never overrides measured/evaluated evidence or element-versus-compound distinctions.

Ruthenium hazards are chemical-form specific. Do not generalize safety from elemental Ru to RuO_2 , volatile RuO_4 or coordination compounds; consult material-specific safety information.

Core sources

Royal Society of Chemistry - Ruthenium - <https://periodic-table.rsc.org/element/44/ruthenium>

NIST - Atomic Weights and Isotopic Compositions - https://physics.nist.gov/cgi-bin/Compositions/stand_alone.pl

IUPAC - Periodic Table of Elements - <https://iupac.org/what-we-do/periodic-table-of-elements/>