

Protactinium (Pa) - Student Datasheet

Element 91 · Actinide · source-reviewed learning reference

Protactinium is element 91, a scarce radioactive actinide found only in trace amounts in uranium ores. ^{231}Pa is long-lived on human timescales, and the element's story links early actinide chemistry, tetragonal metal structure and decay-series geochemistry.

Quick reference

Atomic number	91
Relative atomic mass	231.036
Electron configuration	$[\text{Rn}] 5f^2 6d^1 7s^2$
Period / group / block	7 / Actinides / f
Ordinary state	Silvery radioactive solid
Density	15.4 g/cm ³
Melting point	1845 K
Boiling point	4273 K
Oxidation states	+5, +4
Electronegativity	1.5 (approx.)

Structure & orbitals

Protactinium is represented with a body-centred tetragonal teaching cell consistent with reported room-temperature metallic structure. The viewer is a simplified conventional cell.

The representative 6d and 5f clouds illustrate angular probability patterns for isolated-atom teaching. They are not direct maps of chemical bonds, radioactivity or the tetragonal metal band structure.

Phase behavior

At approximately standard pressure, protactinium is treated as a tetragonal solid below about 1845 K, liquid to about 4273 K and gaseous above the evaluated boiling reference.

Five things to remember

- Atomic number 91 means 91 protons.
- The ground-state reference is $[\text{Rn}] 5f^2 6d^1 7s^2$.
- ^{231}Pa is the key natural isotope and is radioactive.
- Protactinium metal has a tetragonal structure under ordinary conditions.
- Protactinium has little use outside research; no production or handling guidance is provided.

Protactinium: Real World & Signature Science

Big idea

Protactinium is scientifically important but has almost no everyday use. Its scarcity and radioactivity mean that evidence comes from specialized research, and operational nuclear-material information does not belong on this learning page.

Why this element is scientifically distinctive

Inspect a ^{231}Pa nucleus, representative 5f/6d/7s probability models and a tetragonal metal cell, then connect +5/+4 chemistry, uranium-decay occurrence, discovery history and isotope-geochemistry applications.

Trace natural occurrence	Small amounts of ^{231}Pa occur in uranium ores through decay-series processes.
Ocean/earth science	Pa isotopes, especially Pa/Th relationships, are used in specialized geochemical and paleoceanographic research.
Research chemistry	Protactinium's +5/+4 chemistry helps scientists understand early-actinide electronic trends.
Tetragonal metal	Bulk Pa metal has a reported body-centred tetragonal structure, distinct from neighboring actinides.
Safety boundary	All separation, source preparation and handling belong to licensed nuclear/radiochemical facilities and are excluded here.

Protactinium: trace decay-series occurrence to research measurement

1. Protactinium occurs naturally only in very small quantities within uranium decay systems.
2. Research measurements use specialized radiochemical separation and detection under licensed conditions; no separation method is provided here.
3. Geochemical studies can use Pa isotope ratios as tracers of processes such as particle transport and past ocean circulation.
4. The educational focus is identity, evidence and interpretation rather than acquisition or handling.

History checkpoints

1913	Kasimir Fajans and Oswald Göhring identified a short-lived isotope then called brevium.
1917-1918	Lise Meitner and Otto Hahn identified the much longer-lived ^{231}Pa , establishing protactinium more firmly.
1930s	Researchers isolated enough protactinium for more detailed chemical study.
Today	Protactinium remains a specialist research element and a useful isotope-system tracer in Earth science.

Protactinium: Isotopes, Questions & Evidence

Isotope context

²³¹Pa	Radioactive · key natural isotope	Reference teaching nucleus with 91 protons and 140 neutrons; long-lived compared with many radionuclides.
^{234m}Pa	Short-lived decay-series isotope	Historically linked to the early discovery of protactinium/brevium.
²³³Pa	Radioactive research isotope	Appears in nuclear-decay/transmutation studies under controlled conditions.

Common questions

What is protactinium's atomic number?

91.

Is protactinium a metal?

Yes. It is a radioactive actinide metal.

What is protactinium used for?

Mostly scientific research; Pa isotope systems also have geochemical/paleoceanographic uses.

Where is protactinium found?

In trace amounts in uranium ores and natural decay-series systems.

Quick self-check

Q: What is protactinium's atomic number? | Answer: 91. Atomic number equals proton count.

Q: Which isotope is the key natural reference? | Answer: ²³¹Pa. Pa-231 is the long-lived key natural isotope.

Q: What is the ordinary metal structure? | Answer: Tetragonal. Protactinium has a reported tetragonal metallic structure.

Evidence & safety

Atomic/phase values are evaluated. The tetragonal structure is a reviewed bulk-metal reference. Isotope-geochemistry is discussed conceptually; all radioactive-material operations remain out of scope.

Protactinium is radioactive and toxic. This page contains no production, separation, source fabrication, acquisition or handling instructions.

Core sources

Royal Society of Chemistry - Protactinium

<https://periodic-table.rsc.org/element/91/protactinium>

NIST - Atomic Data for Protactinium

<https://physics.nist.gov/PhysRefData/Handbook/Tables/protactiniumtable1.htm>

WebElements - Protactinium crystal structure

https://www.webelements.com/protactinium/crystal_structure.html