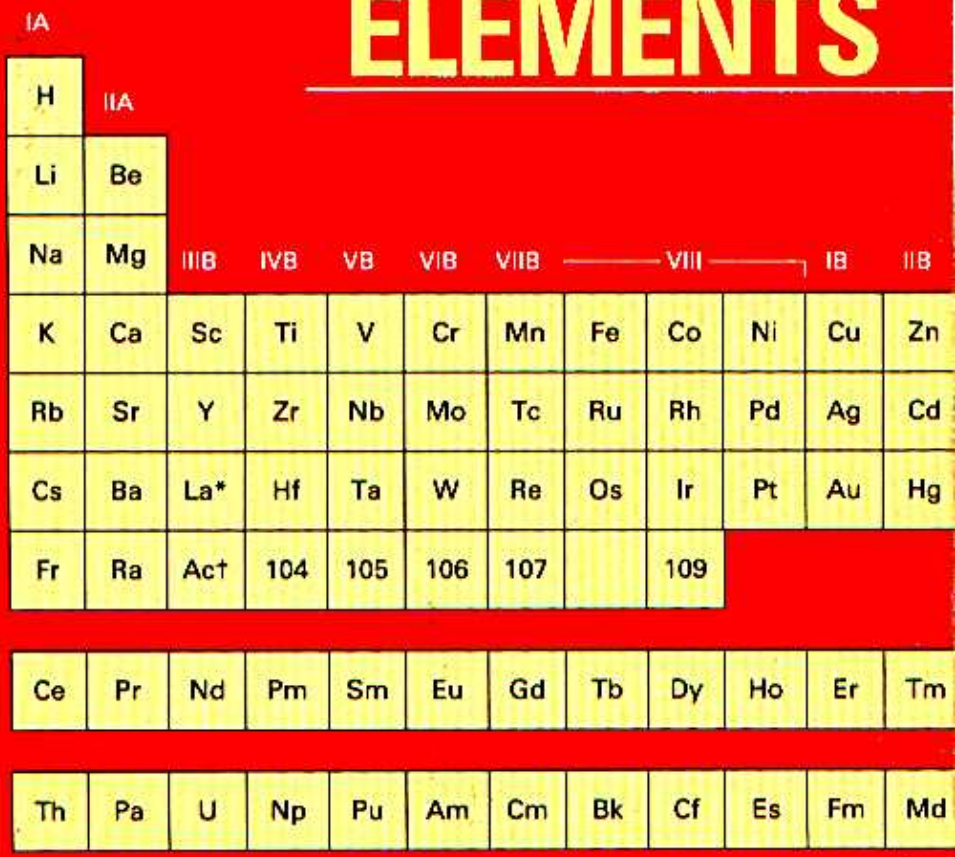
HANDBOOK OF THE ELEMENTS



SAMUEL RUBEN

											O
						IIIA	IVA	VA	VIA	VIIA	He
						B	C	N	O	F	Ne
VIIB		VIII		IB	IIB	Al	Si	P	S	Cl	Ar
Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
107		109									

Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu

Cm	Bk	Cf	Es	Fm	Md	No	Lr

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Handbook of the Elements

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Samuel Ruben

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Preface

Handbook of the Elements is a practical reference source that provides essential information on the 108 known chemical elements for students and working scientists alike.

Knowledge about the elements is critical to our understanding of science and the world around us. This edition represents the most up-to-date compilation of information on the elements currently available.

Data on the chemical elements have been the fundamentals of scientific work for years, yet new research is continually revising previously published material about them. Even physical "constants" are subject to change in the light of additional research.

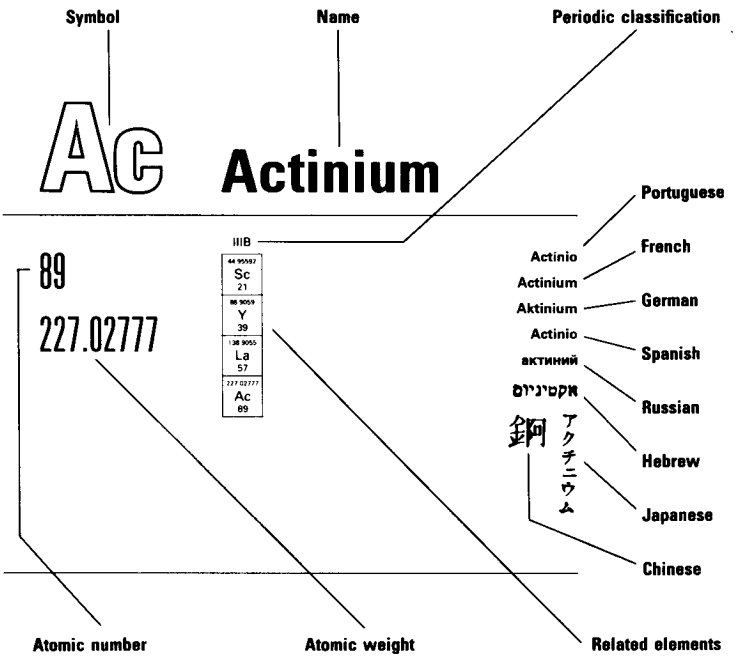
The information contained in this the third edition reflects state-of-the-art values on the most frequently required constants. The material in this current edition was compiled, corrected, and updated over a period of several years, utilizing hundreds of sources. Each value was checked in a minimum of 10 sources to ensure accuracy. A partial listing of the primary reference sources consulted is given at the end of the monographs.

I wish to acknowledge the significant assistance of Wayne Hruden for updating the reported values of the constants and the support given by the Duracell International Inc.

SAMUEL RUBEN
December 1984

Introduction

This handbook contains monographs for each of the 108 known chemical elements, arranged in alphabetical order for rapid reference.



Except where unavailable, values for the following twenty-five different elemental constants are given:

Periodic classification The group, family name, and/or series of the element; this categorization reflects the position of the element in the periodic table.

Atomic number An element of atomic number Z occupies the Zth position in the periodic classification. Its neutral atom has a nucleus with a charge of $+Ze$ surrounded by Z electrons, each of charge $-e$.

Atomic weight The relative atomic mass (A_r) based on $^{12}C \equiv 12$; the value for the most stable isotope is given for synthetic elements.

Naturally occurring isotopes Mass numbers of the isotopes are listed in decreasing order of natural terrestrial abundance.

Density The weight per unit volume of the element; measurements of this constant are generally made at 25°C, but the temperature utilized is shown in parentheses. Units are grams per cubic centimeter (g/cm^3).

Melting point Units are degrees Celsius (°C); **Boiling point:** Units are degrees Celsius (°C).

Latent heat of fusion The quantity of heat required to change 1 g of the solid element into the liquid state at a constant temperature. Units are Joules per gram (J/g).

Specific heat The thermal capacity of an element; the specific heat capacity is the quantity of heat required to raise the temperature of a mass through a measured number of Celsius degrees. Units are Joules per gram per degree Celsius (J/g/°C).

Coefficient of lineal thermal expansion The ratio of the change in length per degree Celsius to the original length at zero degrees Celsius. Units are centimeter per centimeter per degree Celsius (cm/cm/°C).

Thermal conductivity Thermal energy transmitted through a unit cube per unit time when there exists unit temperature difference between opposite parallel faces. Units are watts (or milliwatts) per centimeter per degree Celsius [w (or mw)/cm/°C].

Electrical resistivity A proportionality factor (ρ) relating the resistance to current flow between parallel faces of a 1-cm cube of the element. This factor is also known as specific resistance. Because the resistance of semiconductor is substantially influenced by the presence of traces of impurities, the intrinsic resistivity is the parameter given for these ultrapure elements. Units are ohm-centimeters (ohm-cm).

Ionization potential (1st) The energy necessary to remove the least strongly bound electron from its orbit and place it at rest at an infinite distance. Units are electron volts (eV).

Electron work function (ϕ) The minimum photonic energy required to remove an electron from the boundary of an element; also known as photoelectric work function. Units are electron volts (eV).

Oxidation potential The difference in potential produced by a voltaic half-cell associated with the cited chemical reaction. By using the oxidation potential, the likelihood of various chemical reactions can be predicted. Oxidation of gaseous hydrogen (at 1 atmosphere pressure) to ionic hydrogen (in 1 molar acid solution at 25°C) defines the zero reference. Units are volts (V).

Chemical valence The number of hydrogen atoms (or their equivalent) with which an atom of an element can combine (if negative) or the number which it can displace in a reaction (if positive). The principal valence is set in italic type when more than one valence is possible.

Electrochemical equivalents The mass of an element displaced by the passage of unit quantity of electricity. The values provided are derived from:

$$\text{electrochemical equivalents} = \frac{kA}{n}$$

where k is a constant equal to 0.0373100, A is the gram-atomic weight, and n is the principal valence. Units are grams per ampere-hour (g/amp-hr).

Ionic radius The radius an ion exhibits in an ionic crystal in which the ions are packed together with their outermost electronic shells in contact with each other. Values are given for a coordination number of 6. Ionic radii for other coordination numbers can be obtained by multiplying by the following conversion factors:

Coordination Number	*Conversion Factor*
12	1.12
9	1.05
8	1.03
6	1.00
4	0.94

Units are Ångstroms (1Å = 10^{-8} cm).

Valence electron potential ($-\epsilon V$) A calculated value based on the charge of the valence electrons and the ionic radius. It provides a quantitative indication of the reactivity of an element and is determined by the equation:

$$(-\epsilon V) = \frac{kn}{r}$$

where $(-\epsilon V)$ is the valence electron potential, n is the valence, and k is a proportionality factor converting Ångstroms to centimeters and expressing the force exerted by the valence electrons in electron volts and is equal to 14.399; r is the ionic radius in Ångstroms. The principal valence has been used for the determination.

Electronic configuration A sequential listing of the orbiting electrons, indicating the principal shells and the number of electrons in each subshell. For example, $4d^{10}$ would indicate the presence of 10 electrons in the "d" subshell of the fourth (N) principal shell. Principal shells are assigned letters corresponding to their quantum numbers as follows: 1 = K, 2 = L, 3 = M, 4 = N, 5 = O, 6 = P, and 7 = Q. A maximum exists for the number of electrons in each subshell: 2 in s, 6 in p, 10 in d, and 14 in f.

Valence electrons A sequential listing of the electrons involved in the ionization of the element. They are indicated in the same manner as in the electronic configuration.

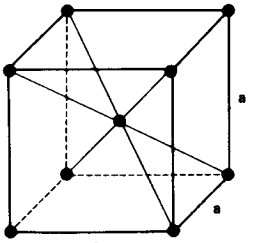
Crystal form A brief description of the atomic arrangement in the elemental solid state. (See accompanying figure for common Crystal Forms).

Half life The time required for one-half of an initial quantity of a radioactive isotope to be converted into its decay product. This entry is included only when all known isotopes of an element are unstable. The half life presented is that of the most stable isotope. Units are seconds, minutes, hours, days, or years.

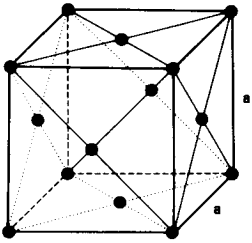
Cross section σ The effective size of a nucleus in capturing a thermal (slow) neutron. The larger the cross section the greater is the probability of neutron capture. Units are millibarns (mbarns) or barns (1 barn = 10^{-24} cm^2).

Vapor pressure The pressure exerted when a solid or liquid is in equilibrium with its vapor. Since this parameter is a function of temperature, the vapor pressure at the melting point is given. Units are Pascals (Pa).

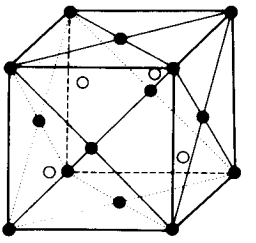
Crystal Forms



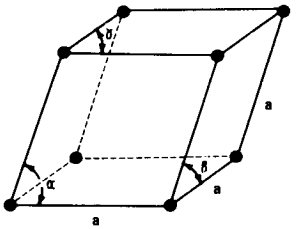
CUBIC, BODY CENTERED



CUBIC, FACE CENTERED

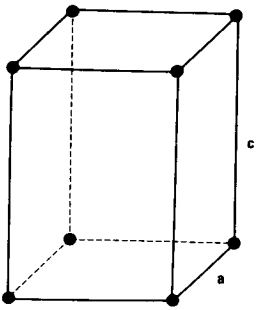


CUBIC, DIAMOND



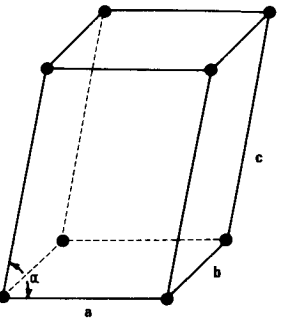
RHOMBOHEDRAL

$\alpha, \beta, \gamma, \neq 90°$



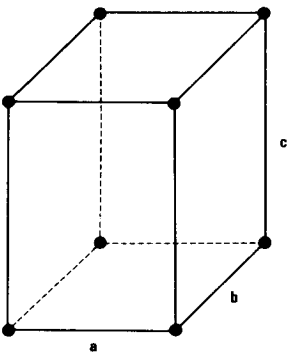
TETRAGONAL

$a \neq c$



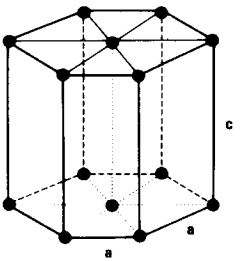
MONOCLINIC

$\alpha \neq 90°$



ORTHORHOMBIC

$a \neq b \neq c$



HEXAGONAL

$a \neq c$

Periodic Classification of the Elements

IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIII		
1.0079 H 1									
6.941 Li 3	9.01218 Be 4								
22.98977 Na 11	24.305 Mg 12								
39.098 K 19	40.08 Ca 20	44.95592 Sc 21	47.90 Ti 22	50.9415 V 23	51.996 Cr 24	54.9380 Mn 25	55.847 Fe 26	58.9332 Co 27	58.70 Ni 28
85.4678 Rb 37	87.62 Sr 38	88.9059 Y 39	91.22 Zr 40	92.9064 Nb 41	95.94 Mo 42	96.906 Tc 43	101.07 Ru 44	102.9055 Rh 45	106.4 Pd 46
132.9054 Cs 55	137.34 Ba 56	138.9055 La* 57	178.49 Hf 72	180.9479 Ta 73	183.85 W 74	186.2 Re 75	190.2 Os 76	192.22 Ir 77	195.09 Pt 78
223.01976 Fr 87	226.02544 Ra 88	227.02777 Act† 89	104	105	106	107		109	

*Lanthanide Series

140.12 Ce 58	140.9077 Pr 59	144.24 Nd 60	144.913 Pm 61	150.4 Sm 62	151.96 Eu 63	157.25 Gd 64	158.9254 Tb 65	162.50 Dy 66	164.9304 Ho 67

†Actinide Series

232.03807 Th 90	231.0359 Pa 91	238.029 U 92	237.0482 Np 93	244.06423 Pu 94	243.0614 Am 95	247.07038 Cm 96	247.07032 Bk 97	251.07961 Cf 98	254.08805 Es 99

							O
		IIIA	IVA	VA	VIA	VIIA	4.00260 He 2
		10.81 B 5	12.011 C 6	14.0067 N 7	15.9994 O 8	18.998403 F 9	20.179 Ne 10
		26.98154 Al 13	28.0855 Si 14	30.97376 P 15	32.06 S 16	35.453 Cl 17	39.948 Ar 18
IB	IIB						
63.546 Cu 29	65.38 Zn 30	69.72 Ga 31	72.59 Ge 32	74.9216 As 33	78.96 Se 34	79.904 Br 35	83.80 Kr 36
107.868 Ag 47	112.41 Cd 48	114.82 In 49	118.69 Sn 50	121.75 Sb 51	127.60 Te 52	126.9045 I 53	131.30 Xe 54
196.9665 Au 79	200.59 Hg 80	204.37 Tl 81	207.2 Pb 82	208.9804 Bi 83	208.98243 Po 84	209.987 At 85	222.01761 Rn 86

167.26 Er 68	168.9342 Tm 69	173.04 Yb 70	174.97 Lu 71

257.09515 Fm 100	258 Md 101	259 No 102	260 Lr 103

Ac Actinium

89

227.02777

IIIB

44.95592 Sc 21
88.9059 Y 39
138.9055 La 57
227.02777 Ac 89

Actínio
Actinium
Aktinium
Actinio
актиний
אקטיניום
錒 アクチニウム

Naturally occurring isotope: 227 (minute quantities only)
Density: 10.07 g/cm^3 (25°C)
Melting point: 1100 ± 50°C **Boiling point**: 3200 ± 300°C (est)
Latent heat of fusion: 62 J/g
Specific heat: 0.12 J/g/°C
Thermal conductivity: 0.12 w/cm/°C (25°C)
Ionization potential (1st): 5.17 eV
Oxidation potential: $Ac \rightarrow Ac^{3+} + 3\epsilon = 2.2$ V
Chemical valence: 3
Electrochemical equivalents: 2.82347 g/amp-hr
Ionic radius: 1.119 Å (Ac^{3+})
Valence electron potential ($-\epsilon V$): 38.60 (Ac^{3+})
Principal quantum number: 7
Principal electron shells: K L M N O P Q
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^{10}\ 6s^2\ 6p^6\ 6d^1\ 7s^2$
Valence electrons: $6d^1\ 7s^2$
Crystal form: Cubic, face centered
Half life: 21.77 years
Cross section σ: 810 ± 20 barns

Al Aluminum

13

26.98154

IIIA

10.81 B 5
26.98154 Al 13
69.72 Ga 31
114.82 In 49
204.37 Tl 81

Alumínio
Aluminium
Aluminium
Aluminio
алюминий
אלומין
鉛 アルミニウム

Naturally occurring isotope: 27
Density: 2.6984 g/cm^3 (20°C)
Melting point: 660.37°C **Boiling point:** 2467°C
Latent heat of fusion: 395.7 J/g
Specific heat: 0.903 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 23.9 × 10^{6}cm/cm/°C (20°C)
Thermal conductivity: 2.37 w/cm/°C (25°C)
Electrical resistivity: 2.6548 × 10^{-6} ohm-cm (20°C)
Ionization potential (1st): 5.986 eV
Electron work function ϕ: 4.28 eV
Oxidation potential: $Al \rightarrow Al^{3+} + 3\epsilon = 1.662$ V
Chemical valence: 3
Electrochemical equivalents: 0.33556 g/amp-hr
Ionic radius: 0.535 Å (Al^{3+})
Valence electron potential ($-\varepsilon$V): 80.7
Principal quantum number: 3
Principal electron shells: K L M
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$
Valence electrons: $3s^2\ 3p^1$
Crystal form: Cubic, face centered
Cross section σ: 232 ± 3 mbarns
Vapor pressure: 2.42 × 10^{-6} Pa (at melting point)

Am Americium

95

243.0614

Actinide Series

232.03807 Th 90	231.0359 Pa 91	238.029 U 92	237.0482 Np 93	244.06423 Pu 94	243.0614 Am 95	247.07038 Cm 96	247.07032 Bk 97	251.07961 Cf 98	254.08805 Es 99
257.09515 Fm 100	258 Md 101	259 No 102	260 Lr 103						

Amerício
Américium
Amerizium
Americio
америций
אמריציום
鋂 アメリシウム

Naturally occurring isotopes: None
Density: 13.67 g/cm^3 (20°C)
Melting point: 1176°C **Boiling point:** 2011°C
Ionization potential (1st): 5.99 eV
Oxidation potential: $Am \rightarrow Am^{3+} + 3\epsilon = 2.32$ V
Chemical valence: 2, *3*, 4, 5, 6
Electrochemical equivalents: 3.0229 g/amp-hr
Ionic radius: 0.982 Å (Am^{3+})
Valence electron potential ($-\varepsilon$V): 44.0
Principal quantum number: 7
Principal electron shells: K L M N O P Q
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^{10}\ 5f^7\ 6s^2\ 6p^6\ 7s^2$
Valence electrons: $5f^7\ 7s^2$
Crystal form: Hexagonal
Half life: 7.32×10^3 years
Cross section σ: 180 ± 20 barns

Sb Antimony

51

121.75

VA

14.0067 N 7
30.97376 P 15
74.9216 As 33
121.75 Sb 51
208.9804 Bi 83

Antimônio
Antimoine
Antimon
Antimonio
сурьма
אנטימון
銻 アンチモン

Naturally occurring isotopes: 121, 123
Density: 6.691 g/cm^3 (20°C)
Melting point: 630.74°C **Boiling point:** 1750°C
Latent heat of fusion: 165.0 J/g
Specific heat: 0.207 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 9.2×10^{-6} cm/cm/°C (0°C)
Thermal conductivity: 0.244 w/cm/°C (25°C)
Electrical resistivity: 39×10^{-6} ohm-cm (0°C)
Ionization potential (1st): 8.641 eV
Electron work function ϕ: 4.55 eV
Oxidation potential: $2Sb + 3H_2O \rightarrow Sb_2O_3 + 6H^+ + 6\epsilon = -0.152$ V
Chemical valence: −3, 0, *3*, 5
Electrochemical equivalents: 1.5142 g/amp-hr
Ionic radius: 0.76 Å (Sb^{3+})
Valence electron potential ($-\varepsilon$V): 57
Principal quantum number: 5
Principal electron shells: K L M N O
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 5s^2\ 5p^3$
Valence electrons: $5s^2\ 5p^3$
Crystal form: Rhombohedral
Cross section σ: 5 ± 1 barns
Vapor pressure: 2.49×10^{-9} Pa (at melting point)

Ar Argon

18

39.948

O

4.00260 He 2
20.179 Ne 10
39.948 Ar 18
83.80 Kr 36
131.30 Xe 54
222.01761 Rn 86

Argônio
Argon
Argon
Argón
аргон
ארגון
氩 アルゴン

Naturally occurring isotopes: 40, 36, 38
Density: 1.65 g/cm^3 (−233°C), 1.784 × 10^{-3} g/cm^3 (0°C)
Melting point: −189.2°C **Boiling point:** −185.7°C
Latent heat of fusion: 29.45 J/g
Specific heat: 0.52032 J/g/°C (25°C)
Thermal conductivity: 0.1772 mw/cm/°C (27°C at 1 atm)
Ionization potential (1st): 15.759 eV
Chemical valence: 0
Principal quantum number: 3
Principal electron shells: K L M
Electronic configuration: 1s^2 2s^2 2p^6 3s^2 3p^6
Valence electrons: (3s^2 3p^6)
Crystal form: Cubic, face centered
Cross section σ: 0.66 barns

As Arsenic

33

74.9216

VA

14.0067 N 7
30.97376 P 15
74.9216 As 33
121.75 Sb 51
208.9804 Bi 83

Arsênio
Arsenic
Arsen
Arsénico
мышьяк
ארסן
砷 砒素

Naturally occurring isotope: 75
Density: 5.73 g/cm^3 (gray) (20°C)
Melting point: 817°C (at 28 atm) **Boiling point:** 613°C (sublimes)
Latent heat of fusion: 369.9 J/g
Specific heat: 0.329 J/g/°C (gray) (25°C)
Coefficient of lineal thermal expansion: 6.02×10^{-6} cm/cm/°C (25°C)
Thermal conductivity: 0.502 w/cm/°C (gray) (25°C)
Electrical resistivity: 35×10^{-6} ohm-cm (0°C)
Ionization potential (1st): 9.81 eV
Electron work function ϕ: 3.75 eV
Oxidation potential: $As + 2H_2O \rightarrow HAsO_2 + 3H^+ + 3\epsilon = -0.2476$ V
Chemical valence: −3, 0, *3*, 5
Electrochemical equivalents: 0.93177 g/amp-hr
Ionic radius: 0.58 Å (As^{3+})
Valence electron potential ($-\varepsilon$V): 74
Principal quantum number: 4
Principal electron shells: K L M N
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^3$
Valence electrons: $4s^2\ 4p^3$
Crystal form: Rhombohedral
Cross section σ: 4.30 ± 0.10 barns

At Astatine

85

209.987

VIIA

18.998403 F 9
35.453 Cl 17
79.904 Br 35
126.9045 I 53
209.987 At 85

Astato
Astatine
Astat
Astatino
астатин
אסטטין
砹 アスタチン

Naturally occurring isotopes: None
Melting point: 302°C (est) **Boiling point:** 337°C (est)
Latent heat of fusion: 114 J/g (est)
Ionization potential (1st): 9.65 eV
Oxidation potential: $2At^- \rightarrow At_2 + 2\epsilon = -0.2$ V
Chemical valence: *1,* 3, 5, 7
Electrochemical equivalents: 7.8346 g/amp-hr
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^{10}\ 6s^2\ 6p^5$
Valence electrons: $6s^2\ 6p^5$
Half life: 8.1 hr

Ba Barium

56

137.34

IIA

9.01218 Be 4
24.305 Mg 12
40.08 Ca 20
87.62 Sr 38
137.34 Ba 56
226.02544 Ra 88

Bário
Barium
Barium
Bario
барий
בריום
銀 バリウム

Naturally occurring isotopes: 138, 137, 136, 135, 134, 130, 132
Density: 3.59 g/cm^3 (20°C)
Melting point: 725°C **Boiling point:** 1640°C
Latent heat of fusion: 55.79 J/g
Specific heat: 0.204 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 19.0 × 10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 0.184 w/cm/°C (22°C)
Ionization potential (1st): 5.212 eV
Electron work function ϕ: 2.7 eV
Oxidation potential: $Ba \rightarrow Ba^{2+} + 2\epsilon = 2.906$ V
Chemical valence: 2
Electrochemical equivalents: 2.5621 g/amp-hr
Ionic radius: 1.35 Å (Ba^{2+})
Valence electron potential ($-\varepsilon V$): 21.3
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 5s^2\ 5p^6\ 6s^2$
Valence electrons: $6s^2$
Crystal form: Cubic, body centered
Cross section σ: 1.2 ± 0.1 barns
Vapor pressure: 9.80 × 10 Pa (at melting point)

Bk Berkelium

97

247.07032

Actinide Series

232.03807 Th 90	231.0359 Pa 91	238.029 U 92	237.0482 Np 93	244.06423 Pu 94	243.0614 Am 95	247.07038 Cm 96	247.07032 Bk 97	251.07961 Cf 98	254.08805 Es 99
257.09515 Fm 100	258 Md 101	259 No 102	260 Lr 103						

Berquélio
Berkelium
Berkelium
Berkelio
беркелий
ברקליום
錁 バークリウム

Naturally occurring isotopes: None
Density: 14.78 g/cm^3 (25°C)
Melting point: 986 ± 25°C
Ionization potential (1st): 6.23 eV
Oxidation potential: $Bk \rightarrow Bk^{3+} + 3\epsilon = 1.97$ V
Chemical valence: *3,* 4
Electrochemical equivalents: 3.0727 g/amp-hr
Ionic radius: 0.949 Å (Bk^{3+})
Valence electron potential (−εV): 45.5
Principal quantum number: 7
Principal electron shells: K L M N O P Q
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^{10}\ 5f^8\ 6s^2\ 6p^6\ 6d^1\ 7s^2$
Valence electrons: $5f^8\ 6d^1\ 7s^2$
Crystal form: Hexagonal
Half life: 1.4×10^3 years

Be Beryllium

4

9.01218

IIA

9.01218 Be 4
24.305 Mg 12
40.08 Ca 20
87.62 Sr 38
137.34 Ba 56
226.02544 Ra 88

Berílio
Beryllium
Beryllium
Berilio
бериллий
בריליום
鈹 ベリリウム

Naturally occurring isotope: 9
Density: 1.848 g/cm^3 (20°C)
Melting point: 1278 ± 5°C **Boiling point:** 2970°C
Latent heat of fusion: 1301 J/g
Specific heat: 1.82 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 11.6 × 10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 2.01 w/cm/°C (25°C)
Electrical resistivity: 4.0 × 10^{-6} ohm-cm (20°C)
Ionization potential (1st): 9.322 eV
Electron work function ϕ: 4.98 eV
Oxidation potential: $Be \rightarrow Be^{2+} + 2\epsilon = 1.85$ V
Chemical valence: 2
Electrochemical equivalents: 0.16812 g/amp-hr
Ionic radius: 0.35 Å (Be^{2+})
Valence electron potential ($-\varepsilon$V): 82
Principal quantum number: 2
Principal electron shells: K L
Electronic configuration: $1s^2\ 2s^2$
Valence electrons: $2s^2$
Crystal form: Hexagonal, close packed
Cross section σ: 9.2 ± 0.5 mbarns
Vapor pressure: 4.18 Pa (at melting point)

Bi Bismuth

83

208.9804

VA

14.0067 N 7
30.97376 P 15
74.9216 As 33
121.75 Sb 51
208.9804 Bi 83

Bismuto
Bismuth
Wismut
Bismuto
ВИСМУТ
ביומוט
鉍 ビスマス

Naturally occurring isotope: 209
Density: 9.78 g/cm^3 (20°C)
Melting point: 271.3°C **Boiling point:** 1560 ± 5°C
Latent heat of fusion: 52.09 J/g
Specific heat: 0.122 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 13.3 × 10^{-6} cm/cm/°C
Thermal conductivity: 0.0792 w/cm/°C (25°C)
Electrical resistivity: 106.8 × 10^{-6} ohm-cm (0°C)
Ionization potential (1st): 7.289 eV
Electron work function ϕ**:** 4.22 eV
Oxidation potential: $Bi + H_2O \rightarrow BiO^+ + 2H^+ + 3\epsilon = -0.320$ V
Chemical valence: *3,* 5
Electrochemical equivalents: 2.5990 g/amp-hr
Ionic radius: 1.03 Å (Bi^{3+})
Valence electron potential ($-\varepsilon$**V):** 41.9
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^{10}\ 6s^2\ 6p^3$
Valence electrons: $6s^2\ 6p^3$
Crystal form: Rhombohedral
Cross section σ**:** 19 ± 2 mbarns
Vapor pressure: 6.27 × 10^{-4} Pa (at melting point)

Boron

5

10.81

IIIA

10.81
B
5
26.98154
Al
13
69.72
Ga
31
114.82
In
49
204.37
Tl
81

Bóro
Bore
Bor
Boro
бор
בור
硼 素

Naturally occurring isotopes: 11, 10
Density: 2.34 g/cm^3 (crystalline), 2.37 g/cm^3 (amorphous) (both at 20°C)
Melting point: 2300°C **Boiling point:** 2550°C (sublimes)
Latent heat of fusion: 890.8 J/g
Specific heat: 1.03 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 8.3×10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 0.274 w/cm/°C (25°C)
Electrical resistivity: 1.8×10^6 ohm-cm (0°C)
Ionization potential (1st): 8.298 eV
Electron work function ϕ: 4.45 eV
Oxidation potential: $B + 3H_2O \rightarrow H_3BO_3 + 3H^+ + 3\epsilon = -0.8698$ V
Chemical valence: 3
Electrochemical equivalents: 0.1344 g/amp-hr
Ionic radius: 0.23 Å (B^{3+})
Valence electron potential ($-\varepsilon$V): 190
Principal quantum number: 2
Principal electron shells: K L
Electronic configuration: $1s^2\ 2s^2\ 2p^1$
Valence electrons: $2s^2\ 2p^1$
Crystal form: Hexagonal, close packed
Cross section σ: 759 barns
Vapor pressure: 3.48×10^{-1} Pa (at melting point)

Br Bromine

35

79.904

VIIA

18.998403 F 9
35.453 Cl 17
79.904 Br 35
126.9045 I 53
209.987 At 85

Bromo
Brome
Brom
Bromo
бром
ברום
溴 臭素

Naturally occurring isotopes: 79, 81
Density: 3.1028 g/cm^3 (20°C)
Melting point: −7.2°C **Boiling point:** 58.78°C
Latent heat of fusion: 132.0 J/g (Br_2)
Specific heat: 0.47362 J/g/°C (Br_2) (25°C)
Thermal conductivity: 1.22 mw/cm/°C (27°C)
Electrical resistivity: 7.8 × 10^{12} ohm-cm (0°C)
Ionization potential (1st): 11.814 eV
Oxidation potential: $2Br^- \rightarrow Br_2 + 2\epsilon = -1.0652$ V
Chemical valence: *−1*, 3, 5, 7
Electrochemical equivalents: 2.9812 g/amp-hr
Ionic radius: 1.96 Å (Br^-)
Valence electron potential (−εV): −7.35
Principal quantum number: 4
Principal electron shells: K L M N
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^5$
Valence electrons: $4s^2\ 4p^5$
Crystal form: Orthorhombic, rhombic
Cross section σ: 6.8 ± 0.1 barns
Vapor pressure: 5.80 × 10^3 Pa (at melting point)

Cd Cadmium

48

112.41

IIB

65.38
Zn
30
112.41
Cd
48
200.59
Hg
80

Cádmio
Cadmium
Cadmium
Cadmio
кадмий
קדמיום
カドミウム

Naturally occurring isotopes: 114, 112, 111, 110, 113, 116, 106, 108
Density: 8.65 g/cm^3 (20°C)
Melting point: 320.9°C **Boiling point:** 765°C
Latent heat of fusion: 54.01 J/g
Specific heat: 0.231 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 29.8 $\times$ 10^{-6} cm/cm/°C (25°C)
Thermal conductivity: 0.969 w/cm/°C (25°C)
Electrical resistivity: 6.83 $\times$ 10^{-6} ohm-cm (0°C)
Ionization potential (1st): 8.993 eV
Electron work function ϕ: 4.22 eV
Oxidation potential: $Cd \rightarrow Cd^{2+} + 2\epsilon = 0.4029$ V
Chemical valence: 2
Electrochemical equivalents: 2.0970 g/amp-hr
Ionic radius: 0.97 Å (Cd^{2+})
Valence electron potential ($-\varepsilon$V): 30
Principal quantum number: 5
Principal electron shells: K L M N O
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 5s^2$
Valence electrons: $5s^2$
Crystal form: Hexagonal, close packed
Cross section σ: 2450 $\pm$ 20 barns
Vapor pressure: 1.48 $\times$ 10 Pa (at melting point)

Ca Calcium

20

40.08

IIA

9.01218 Be 4
24.305 Mg 12
40.08 Ca 20
87.62 Sr 38
137.34 Ba 56
226.02544 Ra 88

Cálcio
Calcium
Kalzium
Calcio
кальций
סידן
鈣 カルシウム

Naturally occurring isotopes: 40, 44, 42, 48, 43, 46
Density: 1.55 g/cm^3 (20°C)
Melting point: 839 ± 2°C **Boiling point:** 1484°C
Latent heat of fusion: 216.2 J/g
Specific heat: 0.632 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 22.3 × 10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 2.01 w/cm/°C (25°C)
Electrical resistivity: 3.91 × 10^{-6} ohm-cm (0°C)
Ionization potential (1st): 6.113 eV
Electron work function ϕ: 2.87 eV
Oxidation potential: $Ca \rightarrow Ca^{2+} + 2\epsilon = 2.866$ V
Chemical valence: 2
Electrochemical equivalents: 0.7477 g/amp-hr
Ionic radius: 0.99 Å (Ca^{2+})
Valence electron potential ($-\varepsilon$V): 29
Principal quantum number: 4
Principal electron shells: K L M N
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$
Valence electrons: $4s^2$
Crystal form: Cubic, face centered
Cross section σ: 0.44 ± 0.02 barns
Vapor pressure: 2.54 × 10^2 Pa (at melting point)

Cf Californium

98

251.07961

Actinide Series

232.03807 Th 90	231.0359 Pa 91	238.029 U 92	237.0482 Np 93	244.06423 Pu 94	243.0614 Am 95	247.07038 Cm 96	247.07032 Bk 97	251.07961 Cf 98	254.08805 Es 99
257.09515 Fm 100	258 Md 101	259 No 102	260 Lr 103						

Califórnio
Californium
Californium
Californio
калифорний
קליפורניום
鉲 カリフォルニウム

Naturally occurring isotopes: None
Density: 15.1 g/cm^3 (25°C)
Melting point: 900 ± 30°C
Ionization potential (1st): 6.30 eV
Oxidation potential: $Cf \rightarrow Cf^{3+} + 3\epsilon = 2.0$ V
Chemical valence: 2, *3*, 4
Electrochemical equivalents: 3.1226 g/amp-hr
Ionic radius: 0.934 Å (Cf^{3+})
Valence electron potential (−εV): 44.5
Principal quantum number: 7
Principal electron shells: K L M N O P Q
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^{10}\ 5f^{10}\ 6s^2\ 6p^6\ 7s^2$
Valence electrons: $5f^{10}\ 7s^2$
Crystal form: Hexagonal
Half life: 900 years
Cross section σ: 2100 ± 1000 barns

C Carbon

6

12.011

IVA

12.011 C 6
28.0855 Si 14
72.59 Ge 32
118.69 Sn 50
207.2 Pb 82

Carbono
Carbone
Kohlenstoff
Carbono
углерод
פחמן
碳 炭素

Naturally occurring isotopes: 12, 13, 14
Density: 3.52 g/cm^3 (diamond), 1.9–2.3 g/cm^3 (graphite), 1.8–2.1 g/cm^3 (amorphous) (all at 20°C)
Melting point: 3550°C **Boiling point:** 4827°C
Specific heat: 0.7099 J/g/°C (graphite) (25°C)
Coefficient of lineal thermal expansion: 2.10×10^{-6} cm/cm/°C (graphite) (30°C)
Thermal conductivity: 0.8–2.2 w/cm/°C (graphite) (25°C)
Electrical resistivity: 1375×10^{-6} ohm-cm (graphite) (0°C)
Ionization potential (1st): 11.260 eV
Electron work function ϕ: 5.0 eV
Oxidation potential: $CH_4 \rightarrow C + 4H^+ + 4\epsilon = -0.1316$ V
Chemical valence: 2, 3, *4*
Electrochemical equivalents: 0.11203 g/amp-hr
Ionic radius: 0.16 Å (C^{4+})
Valence electron potential ($-\varepsilon$V): 360
Principal quantum number: 2
Principal electron shells: K L
Electronic configuration: $1s^2\ 2s^2\ 2p^2$
Valence electrons: $2s^2\ 2p^2$
Crystal form: Hexagonal (graphite), cubic (diamond)
Cross section σ: 3.4 ± 0.2 mbarns

Ce Cerium

58

140.12

Lanthanide Series

140.12 Ce 58	140.9077 Pr 59	144.24 Nd 60	144.913 Pm 61	150.4 Sm 62	151.96 Eu 63	157.25 Gd 64	158.9254 Tb 65	162.50 Dy 66	164.9304 Ho 67
167.26 Er 68	168.9342 Tm 69	173.04 Yb 70	174.97 Lu 71						

Cério
Cérium
Zerium
Cerio
церий
צריום
铈 セリウム

Naturally occurring isotopes: 140, 142, 138, 136
Density: 6.657 g/cm^3 (25°C)
Melting point: 799°C **Boiling point:** 3426°C
Latent heat of fusion: 65.7 J/g
Specific heat: 0.192 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 7.1 $\times$ 10^{-6} cm/cm/°C (25°C)
Thermal conductivity: 0.113 w/cm/°C (25°C)
Electrical resistivity: 77 $\times$ 10^{-6} ohm-cm (25°C)
Ionization potential (1st): 5.47 eV
Electron work function ϕ: 2.84 eV
Oxidation potential: Ce $\rightarrow$ Ce^{3+} + 3ϵ = 2.483 V
Chemical valence: *3,* 4
Electrochemical equivalents: 1.7426 g/amp-hr
Ionic radius: 1.034 Å (Ce^{3+})
Valence electron potential (−εV): 41.78
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 4f^2 5s^2 5p^6 6s^2
Valence electrons: 4f^2 6s^2
Crystal form: Cubic, face centered
Cross section σ: 0.73 $\pm$ 0.08 barns

Cs Cesium

55

132.9054

IA

1.0079 H 1
6.941 Li 3
22.98977 Na 11
39.098 K 19
85.4678 Rb 37
132.9054 Cs 55
223.0197/6 Fr 87

Césio
Césium
Caesium
Ceslo
цезий
צזיום
銫 セシウム

Naturally occurring isotope: 133
Density: 1.873 g/cm^3 (20°C)
Melting point: 28.40 ± 0.01°C **Boiling point:** 669.3°C
Latent heat of fusion: 16.372 J/g
Specific heat: 0.241 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 97 × 10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 0.359 w/cm/°C (solid at melting point)
Electrical resistivity: 20.46 × 10^{-6} ohm-cm (20°C)
Ionization potential (1st): 3.894 eV
Electron work function ϕ: 2.14 eV
Oxidation potential: $Cs \rightarrow Cs^+ + \epsilon = 2.923$ V
Chemical valence: 1
Electrochemical equivalents: 4.95870 g/amp-hr
Ionic radius: 1.67 Å (Cs^+)
Valence electron potential ($-\varepsilon$V): 8.62
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 5s^2\ 5p^6\ 6s^1$
Valence electrons: $6s^1$
Crystal form: Cubic, body centered
Cross section σ: 30.0 ± 1.5 barns
Vapor pressure: 2.50 × 10^{-5} Pa (at melting point)

Cl Chlorine

17

35.453

VIIA

18.998403 F 9
35.453 Cl 17
79.904 Br 35
126.9045 I 53
209.987 At 85

Clóro
Chlore
Chlor
Cloro
хлор
כלור
氯 塩素

Naturally occurring isotopes: 35, 37
Density: 1.56 g/cm^3 (−33.6°C), 3.214 × 10^{-3} g/cm^3 (0°C)
Melting point: −100.98°C **Boiling point:** −34.6°C
Latent heat of fusion: 180.8 J/g (Cl_2)
Specific heat: 0.4782 J/g/°C (Cl_2) (25°C)
Thermal conductivity: 0.089 mw/cm/°C (27°C at 1 atm)
Ionization potential (1st): 12.967 eV
Oxidation potential: $2Cl^- \rightarrow Cl_2 + 2\epsilon = -1.3595$ V
Chemical valence: −*I*, 3, 5, 7
Electrochemical equivalents: 1.3228 g/amp-hr
Ionic radius: 1.81 Å (Cl^-)
Valence electron potential (−εV): −7.96
Principal quantum number: 3
Principal electron shells: K L M
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$
Valence electrons: $3s^2\ 3p^5$
Crystal form: Tetragonal
Cross section σ: 33 barns
Vapor pressure: 1.30 × 10^3 Pa (at melting point)

Cr Chromium

24

51.996

VIB

51.996 Cr 24
95.94 Mo 42
183.85 W 74
106

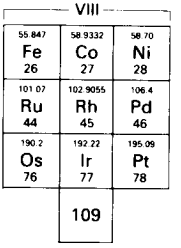
Crômio
Chrom
Chrom
Cromo
хром
כרום
鉻 クロム

Naturally occurring isotopes: 52, 53, 50, 54
Density: 7.20 g/cm^3 (20°C)
Melting point: 1857 ± 20°C **Boiling point:** 2672°C
Latent heat of fusion: 265.7 J/g
Specific heat: 0.449 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 6.2 × 10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 0.939 w/cm/°C (25°C)
Electrical resistivity: 12.9 × 10^{-6} ohm-cm (20°C)
Ionization potential (1st): 6.766 eV
Electron work function ϕ: 4.5 eV
Oxidation potential: $Cr \rightarrow Cr^{3+} + 3\epsilon = 0.744$ V
Chemical valence: 1, 2, 3, 4, 5, *6*
Electrochemical equivalents: 0.32333 g/amp-hr
Ionic radius: 0.52 Å (Cr^{6+})
Valence electron potential (−ϵ**V):** 170
Principal quantum number: 4
Principal electron shells: K L M N
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^1$
Valence electrons: $3d^5\ 4s^1$
Crystal form: Cubic, body centered
Cross section σ: 3.1 ± 0.2 barns
Vapor pressure: 9.90 × 10^2 Pa (at melting point)

Co Cobalt

27

58.9332



Cobalto
Cobalt
Kobalt
Cobalto
кобальт
קובלט
鈷 コバルト

Naturally occurring isotope: 59
Density: 8.71 g/cm^3 (21°C)
Melting point: 1495°C **Boiling point:** 2870°C
Latent heat of fusion: 258.6 J/g
Specific heat: 4.21 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 13.80 × 10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 1.00 w/cm/°C (25°C)
Electrical resistivity: 6.24 × 10^{-6} ohm-cm (20°C)
Ionization potential (1st): 7.86 eV
Electron work function ϕ: 5.0 eV
Oxidation potential: $Co \rightarrow Co^{2+} + 2\epsilon = 0.277$ V
Chemical valence: *2,* 3, 4
Electrochemical equivalents: 1.0994 g/amp-hr
Ionic radius: 0.745 Å (Co^{3+})
Valence electron potential ($-\varepsilon$V): 38.7
Principal quantum number: 4
Principal electron shells: K L M N
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^7\ 4s^2$
Valence electrons: $3d^7\ 4s^2$
Crystal form: Hexagonal, close packed
Cross section σ: 37.5 ± 0.2 barns
Vapor pressure: 1.75 × 10^2 Pa (at melting point)

Cu Copper

29

63.546

IB

63.546
Cu
29
107.868
Ag
47
196.9665
Au
79

Cobre
Cuivre
Kupfer
Cobre
медь
נחושת
銅 铜

Naturally occurring isotopes: 63, 65
Density: 8.96 g/cm^3 (25°C)
Melting point: 1083.4 ± 0.2°C **Boiling point:** 2567°C
Latent heat of fusion: 205.6 J/g
Specific heat: 0.3845 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 16.6 × 10^{-6} cm/cm/°C (25°C)
Thermal conductivity: 4.01 w/cm/°C (25°C)
Electrical resistivity: 1.678 × 10^{-6} ohm-cm (20°C)
Ionization potential (1st): 7.726 eV
Electron work function ϕ**:** 4.65 eV
Oxidation potentials: $Cu \rightarrow Cu^+ + \epsilon = -0.521$ V
$Cu \rightarrow Cu^{2+} + 2\epsilon = -0.3419$ V
Chemical valence: 1, *2*
Electrochemical equivalents: 1.1855 g/amp-hr
Ionic radius: 0.73 Å (Cu^{2+})
Valence electron potential ($-\varepsilon$**V):** 34
Principal quantum number: 4
Principal electron shells: K L M N
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^1$
Valence electrons: $3d^{10}\ 4s^1$
Crystal form: Cubic, face centered
Cross section σ**:** 3.8 ± 0.1 barns
Vapor pressure: 5.05 × 10^{-2} Pa (at melting point)

Cm Curium

96

247.07038

Actinide Series

232.03807 Th 90	231.0359 Pa 91	238.029 U 92	237.0482 Np 93	244.06423 Pu 94	243.0614 Am 95	247.07038 Cm 96	247.07032 Bk 97	251.07961 Cf 98	254.08805 Es 99
257.09515 Fm 100	258 Md 101	259 No 102	260 Lr 103						

Cúrio
Curium
Curium
Curio
кюрий
קיוריום
鋦 キュリウム

Naturally occurring isotopes: None
Density: 13.51 g/cm^3 (25°C)
Melting point: 1340 ± 40°C **Boiling point:** 3110°C
Ionization potential (1st): 6.02 eV
Oxidation potential: $Cm \rightarrow Cm^{3+} + 3\epsilon = 2.07$ V
Chemical valence: *3,* 4
Electrochemical equivalents: 3.0727 g/amp-hr
Ionic radius: 0.970 Å (Cm^{3+})
Valence electron potential (−εV): 44.5
Principal quantum number: 7
Principal electron shells: K L M N O P Q
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^{10}\ 5f^7\ 6s^2\ 6p^6\ 6d^1\ 7s^2$
Valence electrons: $5f^7\ 6d^1\ 7s^2$
Crystal form: Hexagonal
Half life: 1.6×10^7 years
Cross section σ: 180 barns

Dy Dysprosium

66

162.50

Lanthanide Series

140.12 Ce 58	140.9077 Pr 59	144.24 Nd 60	144.913 Pm 61	150.4 Sm 62	151.96 Eu 63	157.25 Gd 64	158.9254 Tb 65	162.50 Dy 66	164.9304 Ho 67
167.26 Er 68	168.9342 Tm 69	173.04 Yb 70	174.97 Lu 71						

Disprósio
Dysprosium
Dysprosium
Disprosio
диспрозий
דיספּרוזיום
鏑 ジスプロシウム

Naturally occurring isotopes: 164, 162, 163, 161, 160, 158, 156
Density: 8.550 g/cm^3 (25°C)
Melting point: 1412°C **Boiling point:** 2562°C
Latent heat of fusion: 105.6 J/g
Specific heat: 173 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 8.6 $\times$ 10^{-6} cm/cm/°C (25°C)
Thermal conductivity: 0.107 w/cm/°C (25°C)
Electrical resistivity: 90 $\times$ 10^{-6} ohm-cm (25°C)
Ionization potential (1st): 5.928 eV
Oxidation potential: Dy $\rightarrow$ Dy^{3+} + 3ϵ = 2.353 V
Chemical valence: 3
Electrochemical equivalents: 2.0210 g/amp-hr
Ionic radius: 0.912 Å (Dy^{3+})
Valence electron potential (−εV): 47.4
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 4f^{10} 5s^2 5p^6 6s^2
Valence electrons: 4f^{10} 6s^2
Crystal form: Hexagonal, close packed
Cross section σ: 930 $\pm$ 20 barns

Es Einsteinium

99

254.08805

Actinide Series

232.03807 Th 90	231.0359 Pa 91	238.029 U 92	237.0482 Np 93	244.06423 Pu 94	243.0614 Am 95	247.07038 Cm 96	247.07032 Bk 97	251.07961 Cf 98	254.08805 Es 99
257.09515 Fm 100	258 Md 101	259 No 102	260 Lr 103						

Einstênio
Einsteinium
Einsteinium
Einstenio
эйнштейний
אינשטיינים
爱因斯坦元素

Naturally occurring isotopes: None
Melting point: 860 ± 30°C
Ionization potential (1st): 6.42 eV
Oxidation potential: $Es \rightarrow Es^{2+} + 2\epsilon = 2.3$ V
Chemical valence: *2,* 3
Electrochemical equivalents: 4.7400 g/amp-hr
Ionic radius: 0.925 Å (Es^{3+})
Principal quantum number: 7
Principal electron shells: K L M N O P Q
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^{10}\ 5f^{11}\ 6s^2\ 6p^6\ 7s^2$
Valence electrons: $5f^{11}\ 7s^2$
Crystal form: Cubic, face centered
Half life: 276 days
Cross section σ: < 40 barns

Er Erbium

68

167.26

Érbio
Erbium
Erbium
Erbio
эрбий
ארביום
鉺 エルビウム

Lanthanide Series

140.12 Ce 58	140.9077 Pr 59	144.24 Nd 60	144.913 Pm 61	150.4 Sm 62	151.96 Eu 63	157.25 Gd 64	158.9254 Tb 65	162.50 Dy 66	164.9304 Ho 67
167.26 Er 68	168.9342 Tm 69	173.04 Yb 70	174.97 Lu 71						

Naturally occurring isotopes: 166, 168, 167, 170, 164, 162
Density: 9.066 g/cm^3 (25°C)
Melting point: 1529°C **Boiling point:** 2863°C
Latent heat of fusion: 102.6 J/g
Specific heat: 0.168 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 9.2 × 10^{-6} cm/cm/°C (25°C)
Thermal conductivity: 0.145 w/cm/°C (25°C)
Electrical resistivity: 107.0 × 10^{-6} ohm-cm (25°C)
Ionization potential (1st): 6.10 eV
Oxidation potential: Er → Er^{3+} + 3ϵ = 2.296 V
Chemical valence: 3
Electrochemical equivalents: 2.0802 g/amp-hr
Ionic radius: 0.881 Å (Er^{3+})
Valence electron potential (−εV): 49.0
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 4f^{12} 5s^2 5p^6 6s^2
Valence electrons: 4f^{12} 6s^2
Crystal form: Hexagonal, close packed
Cross section σ: 160 ± 30 barns

Eu Europium

63

151.96

Lanthanide Series

140.12 Ce 58	140.9077 Pr 59	144.24 Nd 60	144.913 Pm 61	150.4 Sm 62	151.96 Eu 63	157.25 Gd 64	158.9254 Tb 65	162.50 Dy 66	164.9304 Ho 67
167.26 Er 68	168.9342 Tm 69	173.04 Yb 70	174.97 Lu 71						

Európio
Europium
Europium
Europio
европий
אירופיום
銪 ユーロピウム

Naturally occurring isotopes: 153, 151
Density: 5.243 g/cm^3 (25°C)
Melting point: 822°C **Boiling point:** 1597°C
Latent heat of fusion: 68.9 J/g
Specific heat: 0.182 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 26 × 10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 0.139 w/cm/°C (25°C)
Electrical resistivity: 81 × 10^{-6} ohm-cm (25°C)
Ionization potential (1st): 5.666 eV
Electron work function ϕ**:** 2.5 eV
Oxidation potential: $Eu \rightarrow Eu^{3+} + 3\epsilon = 2.407$ V
Chemical valence: 2, *3*
Electrochemical equivalents: 1.8899 g/amp-hr
Ionic radius: 0.947 Å (Eu^{3+})
Valence electron potential ($-\varepsilon$**V):** 45.6
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^7\ 5s^2\ 5p^6\ 6s^2$
Valence electrons: $4f^7\ 6s^2$
Crystal form: Cubic, body centered
Cross section σ**:** 4100 ± 100 barns
Vapor pressure: 1.44 × 10^2 Pa (at melting point)

Fm Fermium

100

257.09515

Actinide Series

232.03807 Th 90	231.0359 Pa 91	238.029 U 92	237.0482 Np 93	244.06423 Pu 94	243.0614 Am 95	247.07038 Cm 96	247.07032 Bk 97	251.07961 Cf 98	254.08805 Es 99
257.09515 Fm 100	258 Md 101	259 No 102	260 Lr 103						

Fermium
Fermium
Fermium
Fermio
фермий
פרמיום
鐨 フェリミウム

Naturally occurring isotopes: None
Ionization potential (1st): 6.50 eV
Oxidation potential: $Fm \rightarrow Fm^{3+} + 3\epsilon = 2.0$ V
Chemical valence: 2, *3*
Electrochemical equivalents: 3.1974 g/amp-hr
Principal quantum number: 7
Principal electron shells: K L M N O P Q
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^{10}\ 5f^{12}\ 6s^2\ 6p^6\ 7s^2$
Valence electrons: $5f^{12}\ 7s^2$
Half life: 80 days

Fluorine

9

18.998403

VIIA

18.998403 F 9
35.453 Cl 17
79.904 Br 35
126.9045 I 53
209.987 At 85

Flúor
Fluor
Fluor
Flúor
фтор
פלואור
氟 弗素

Naturally occurring isotope: 19
Density: 1.696×10^{-3} g/cm^3 (0°C)
Melting point: −219.62°C **Boiling point:** −188.14°C
Latent heat of fusion: 26.89 J/g (F_2)
Specific heat: 0.824 J/g/°C (F_2) (25°C)
Thermal conductivity: 0.279 mw/cm/°C (27°C at 1 atm)
Ionization potential (1st): 17.422 eV
Oxidation potential: $F^- \rightarrow \frac{1}{2}F_2 + \epsilon = -2.87$ V
Chemical valence: −1
Electrochemical equivalents: 0.70883 g/amp-hr
Ionic radius: 1.33 Å (F^-)
Valence electron potential (−εV): −10.1
Principal quantum number: 2
Principal electron shells: K L
Electronic configuration: $1s^2\ 2s^2\ 2p^5$
Valence electrons: $2s^2\ 2p^5$
Cross section σ: 9.8 ± 0.7 mbarns
Vapor pressure: 4.90×10^2 Pa (at melting point)

Fr Francium

87

223.01976

IA

1.0079 H 1
6.941 Li 3
22.98977 Na 11
39.098 K 19
85.4678 Rb 37
132.9054 Cs 55
223.01976 Fr 87

Frâncio
Francium
Franzium
Francio
франций
פרנציום
鈁 ワランシウム

Naturally occurring isotopes: None (actinium decay product)
Melting point: 27°C (est) **Boiling point:** 677°C (est)
Latent heat of fusion: 9.39 J/g (est)
Ionization potential (1st): 3.83 eV
Chemical valence: 1
Electrochemical equivalents: 8.3209 g/amp-hr
Ionic radius: 1.80 Å (Fr^+)
Valence electron potential ($-\varepsilon V$): 8.00
Principal quantum number: 7
Principal electron shells: K L M N O P Q
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^{10}\ 6s^2\ 6p^6\ 7s^1$
Valence electrons: ($7s^1$)
Half life: 22 minutes
Crystal form: Cubic, body centered

Gd Gadolinium

64

157.25

Gadolínio
Gadolinium
Gadolinium
Gadolinio
гадолиний
גדוליניום
釓 ガドリニウム

Lanthanide Series

140.12 Ce 58	140.9077 Pr 59	144.24 Nd 60	144.913 Pm 61	150.4 Sm 62	151.96 Eu 63	157.25 Gd 64	158.9254 Tb 65	162.50 Dy 66	164.9304 Ho 67
167.26 Er 68	168.9342 Tm 69	173.04 Yb 70	174.97 Lu 71						

Naturally occurring isotopes: 158, 160, 156, 157, 155, 154, 152
Density: 7.900 g/cm^3 (25°C)
Melting point: 1313°C **Boiling point:** 3266°C
Latent heat of fusion: 98.51 J/g
Specific heat: 0.235 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 9.7 × 10^{-6} cm/cm/°C (25°C)
Thermal conductivity: 0.105 w/cm/°C (25°C)
Electrical resistivity: 140.5 × 10^{-6} ohm-cm (25°C)
Ionization potential (1st): 6.14 eV
Electron work function ϕ: 3.1 eV
Oxidation potential: Gd → Gd^{3+} + 3ϵ = 2.397 V
Chemical valence: 3
Electrochemical equivalents: 1.9557 g/amp-hr
Ionic radius: 0.938 Å (Gd^{3+})
Valence electron potential (−εV): 46.1
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 4f^7 5s^2 5p^6 5d^1 6s^2
Valence electrons: 4f^7 5d^1 6s^2
Crystal form: Hexagonal, close packed
Cross section σ: 46,000 ± 2000 barns
Vapor pressure: 2.44 × 10^4 Pa (at melting point)

Ga Gallium

31

69.72

IIIA

10.81 B 5
26.98154 Al 13
69.72 Ga 31
114.82 In 49
204.37 Tl 81

Gálio
Gallium
Gallium
Galio
галлий
גליום
鎵 ガリウム

Naturally occurring isotopes: 69, 71
Density: 5.906 g/cm^3 (25°C)
Melting point: 29.78°C **Boiling point:** 2403°C
Latent heat of fusion: 80.17 J/g
Specific heat: 0.371 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 18.1 $\times$ 10^{-6} cm/cm/°C (25°C)
Thermal conductivity: 0.281 w/cm/°C (liquid) (30°C)
Electrical resistivity: 17.4 $\times$ 10^{-6} ohm-cm (20°C)
Ionization potential (1st): 5.999 eV
Electron work function ϕ: 4.2 eV
Oxidation potential: Ga $\rightarrow$ Ga^{3+} + 3ϵ = $-$0.529 V
Chemical valence: 2, *3*
Electrochemical equivalents: 0.8671 g/amp-hr
Ionic radius: 0.620 Å (Ga^{3+})
Valence electron potential ($-\varepsilon$V): 69.7
Principal quantum number: 4
Principal electron shells: K L M N
Electronic configuration: 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^1
Valence electrons: 4s^2 4p^1
Crystal form: Orthorhombic, rhombic
Cross section σ: 3.1 $\pm$ 0.3 barns
Vapor pressure: 9.31 $\times$ 10^{-36} Pa (at melting point)

Ge Germanium

32

72.59

IVA

12.011 C 6
28.0855 Si 14
72.59 Ge 32
118.69 Sn 50
207.2 Pb 82

Germânio
Germanium
Germanium
Germanio
германий
גרמניום
鍺 ゲルマニウム

Naturally occurring isotopes: 74, 72, 70, 73, 76
Density: 5.323 g/cm^3 (25°C)
Melting point: 937.4°C **Boiling point:** 2830°C
Latent heat of fusion: 438.3 J/g
Specific heat: 0.3216 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 5.75 × 10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 0.667 w/cm/°C (25°C)
Electrical resistivity: 47 ohm-cm (intrinsic resistivity) (22°C)
Ionization potential (1st): 7.899 eV
Electron work function ϕ: 5.0 eV
Oxidation potential: $Ge + 2H_2O \rightarrow GeO_2 + 4H^+ + 4\epsilon = -0.15$ V
Chemical valence: −4, 2, *4*
Electrochemical equivalents: 0.6771 g/amp-hr
Ionic radius: 0.530 Å (Ge^{4+})
Valence electron potential (−εV): 109
Principal quantum number: 4
Principal electron shells: K L M N
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^2$
Valence electrons: $4s^2\ 4p^2$
Crystal form: Cubic, diamond
Cross section σ: 2.30 ± 0.26 barns
Vapor pressure: 7.46 × 10^{-5} Pa (at melting point)

Au Gold

79

196.9665

IB

63.546
Cu
29
107.868
Ag
47
196.9665
Au
79

Ouro
Or
Gold
Oro
золото
זהב
金 金

Naturally occurring isotope: 197
Density: 19.32 g/cm^3 (20°C)
Melting point: 1064.43°C **Boiling point:** 3080°C
Latent heat of fusion: 62.81 J/g
Specific heat: 0.1290 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 14.2 $\times$ 10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 3.19 w/cm/°C (25°C)
Electrical resistivity: 2.44 $\times$ 10^{-6} ohm-cm (20°C)
Ionization potential (1st): 9.225 eV
Electron work function ϕ: 5.1 eV
Oxidation potentials: $Au \rightarrow Au^+ + \epsilon = -1.691$ V
$Au \rightarrow Au^{3+} + 3\epsilon = -1.498$ V
Chemical valence: 1, *3*
Electrochemical equivalents: 2.4496 g/amp-hr
Ionic radius: 0.85 Å (Au^{3+})
Valence electron potential ($-\epsilon$V): 51
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^{10}\ 6s^1$
Valence electrons: $5d^{10}\ 6s^1$
Crystal form: Cubic, face centered
Cross section σ: 98.8 $\pm$ 0.3 barns
Vapor pressure: 2.37 $\times$ 10^{-4} Pa (at melting point)

Hf Hafnium

72

178.49

IVB

47.90
Ti
22
91.22
Zr
40
178.49
Hf
72
104

Háfnio
Hafnium
Hafnium
Hafnio
гафний
הפניום
鉿 ハフニウム

Naturally occurring isotopes: 180, 178, 177, 179, 176, 174
Density: 13.31 g/cm^3 (20°C)
Melting point: 2227 ± 20°C **Boiling point:** 4602°C
Latent heat of fusion: 122.0 J/g
Specific heat: 0.144 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 5.6 × 10^{-6} cm/cm/°C (25°C)
Thermal conductivity: 0.230 w/cm/°C (25°C)
Electrical resistivity: 35.1 × 10^{-6} ohm-cm (25°C)
Ionization potential (1st): 6.65 eV
Electron work function ϕ**:** 3.9 eV
Oxidation potential: $Hf \rightarrow Hf^{4+} + 4\epsilon = 1.70$ V
Chemical valence: 4
Electrochemical equivalents: 1.6649 g/amp-hr
Ionic radius: 0.71 Å (Hf^{4+})
Valence electron potential ($-\varepsilon$**V):** 81
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^2\ 6s^2$
Valence electrons: $5d^2\ 6s^2$
Crystal form: Hexagonal, close packed
Cross section σ**:** 103 ± 3 barns
Vapor pressure: 1.12 × 10^{-3} Pa (at melting point)

He Helium

2

4.00260

O

4.00260 He 2
20.179 Ne 10
39.948 Ar 18
83.80 Kr 36
131.30 Xe 54
222.01761 Rn 86

Hélio
Hélium
Helium
Helio
гелий
הליום
ヘリウム
氦

Naturally occurring isotopes: 4, 3
Density: 0.17847 × 10^{-3} g/cm^3 (0°C)
Melting point: −272.2°C (26 atm); I **Boiling point:** −268.934°C
Latent heat of fusion: 5.23 J/g
Specific heat: 5.1930 J/g/°C (25°C)
Thermal conductivity: 1.520 mw/cm/°C (25°C at 1 atm)
Ionization potential (1st): 24.58 eV
Chemical valence: 0
Principal quantum number: 1
Principal electron shells: K
Electronic configuration: $1s^2$
Valence electrons: ($1s^2$)
Crystal form: Hexagonal, close packed
Cross section σ: 0.007 barns

Ho Holmium

67

164.9304

Lanthanide Series

140.12 Ce 58	140.9077 Pr 59	144.24 Nd 60	144.913 Pm 61	150.4 Sm 62	151.96 Eu 63	157.25 Gd 64	158.9254 Tb 65	162.50 Dy 66	164.9304 Ho 67
167.26 Er 68	168.9342 Tm 69	173.04 Yb 70	174.97 Lu 71						

Hólmio
Holmium
Holmium
Holmio
холмий
הולמיום
鈥 ホルミウム

Naturally occurring isotope: 165
Density: 8.795 g/cm^3 (25°C)
Melting point: 1474°C **Boiling point:** 2695°C
Latent heat of fusion: 104.1 J/g
Specific heat: 0.165 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 9.5 × 10^{-6} cm/cm/°C (400°C)
Thermal conductivity: 0.162 w/cm/°C (25°C)
Electrical resistivity: 87.0 × 10^{-6} ohm-cm (25°C)
Ionization potential (1st): 6.02 eV
Oxidation potential: Ho → Ho^{3+} + 3ε = 2.319 V
Chemical valence: 3
Electrochemical equivalents: 2.0512 g/amp-hr
Ionic radius: 0.901 Å (Ho^{3+})
Valence electron potential (−eV): 47.9
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{11}\ 5s^2\ 5p^6\ 6s^2$
Valence electrons: $4f^{11}\ 6s^2$
Crystal form: Hexagonal, close packed
Cross section σ: 65 ± 2 barns

H Hydrogen

1

1.0079

IA

1.0079 H 1
6.941 Li 3
22.98977 Na 11
39.098 K 19
85.4678 Rb 37
132.9054 Cs 55
223.01976 Fr 87

Hidrogênio
Hydrogène
Wasserstoff
Hidrógeno
водород
מימן
水素 気

Naturally occurring isotopes: 1.007825 (protium), 2.01410 (deuterium), 3.01605 (tritium)
Density: 0.08988 × 10^{-3} g/cm^3 (0°C)
Melting point: −259.14°C **Boiling point:** −252.87°C
Latent heat of fusion: 116.3 J/g (H_2)
Specific heat: 14.30 J/g/°C (H_2) (25°C)
Thermal conductivity: 1.815 mw/cm/°C (27°C at 1 atm)
Ionization potential (1st): 13.59765 eV
Oxidation potentials: $H_2 \rightarrow 2H^+ + \epsilon = 0.00000$ V
$H^- \rightarrow \frac{1}{2}H_2 + \epsilon = 2.25$ V
Chemical valence: 1
Electrochemical equivalents: 0.037605 g/amp-hr
Ionic radius: 0.012 Å (H^+)
Valence electron potential (−εV): 1200
Principal quantum number: 1
Principal electron shells: K
Electronic configuration: $1s^1$
Valence electrons: $1s^1$
Crystal form: Hexagonal, close packed
Cross section σ: 0.33 barns

In Indium

49

114.82

IIIA

10.81
B
5
26.98154
Al
13
69.72
Ga
31
114.82
In
49
204.37
Tl
81

Índio
Indium
Indium
Indio
индий
אינדיום
銦 インジウム

Naturally occurring isotopes: 115, 113
Density: 7.28 g/cm^3 (20°C)
Melting point: 156.61°C **Boiling point:** 2080°C
Latent heat of fusion: 28.44 J/g
Specific heat: 0.233 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 24.8 $\times$ 10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 0.818 w/cm/°C (25°C)
Electrical resistivity: 8.37 $\times$ 10^{-6} ohm-cm (0°C)
Ionization potential (1st): 5.786 eV
Electron work function ϕ: 4.12 eV
Oxidation potential: In $\rightarrow$ In^{3+} + 3ϵ = 0.343 V
Chemical valence: 1, 2, *3*
Electrochemical equivalents: 1.4280 g/amp-hr
Ionic radius: 0.800 Å (In^{3+})
Valence electron potential ($-\varepsilon$V): 54.0
Principal quantum number: 5
Principal electron shells: K L M N O
Electronic configuration: 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 5s^2 5p^1
Valence electrons: 5s^2 5p^1
Crystal form: Tetragonal
Cross section σ: 194 $\pm$ 2 barns
Vapor pressure: 1.42 $\times$ 10^{17} Pa (at melting point)

Iodine

53

126.9045

VIIA

18.998403 F 9
35.453 Cl 17
79.904 Br 35
126.9045 I 53
209.987 At 85

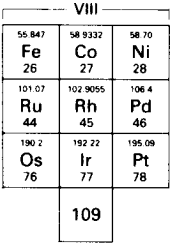
Iôdo
Iode
Iod
Yodo
иод
יוד
碘 沃素

Naturally occurring isotope: 127
Density: 4.93 g/cm^3 (20°C)
Melting point: 113.5°C **Boiling point:** 184.35°C
Latent heat of fusion: 124.4 J/g (I_2)
Specific heat: 0.21448 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 93×10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 4.49 mw/cm/°C (27°C)
Electrical resistivity: 1.3×10^9 ohm-cm (20°C)
Ionization potential (1st): 10.451 eV
Oxidation potential: $I^- \rightarrow \frac{1}{2}I_2 + \epsilon = -0.5355$ V
Chemical valence: *−1*, 3, 5, 7
Electrochemical equivalents: 4.7348 g/amp-hr
Ionic radius: 2.20 Å (I^-)
Valence electron potential (−εV): −6.55
Principal quantum number: 5
Principal electron shells: K L M N O
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 5s^2\ 5p^5$
Valence electrons: $5s^2\ 5p^5$
Crystal form: Orthorhombic
Cross section σ: 6.2 ± 0.2 barns

Ir Iridium

77

192.22



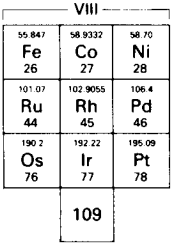
Irídio
Iridium
Iridium
Iridio
иридий
אירידיום
銥 イリジウム

Naturally occurring isotopes: 193, 191
Density: 22.42 g/cm^3 (17°C)
Melting point: 2410°C **Boiling point:** 4130°C
Latent heat of fusion: 137.2 J/g
Specific heat: 0.131 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 6.6 × 10^{-6} cm/cm/°C (25°C)
Thermal conductivity: 1.47 w/cm/°C (25°C)
Electrical resistivity: 4.71 × 10^{-6} ohm-cm (20°C)
Ionization potential (1st): 9.1 eV
Electron work function ϕ: 5.27 eV
Oxidation potential: $Ir + 6Cl^- \rightarrow IrCl_6^{3-} + 3\epsilon = -0.77$ V
Chemical valence: 2, 3, *4*, 6
Electrochemical equivalents: 1.793 g/amp-hr
Ionic radius: 0.625 Å (Ir^{4+})
Valence electron potential ($-\varepsilon$V): 92.2
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^7\ 6s^2$
Valence electrons: $5d^7\ 6s^2$
Crystal form: Cubic, face centered
Cross section σ: 425 ± 15 barns
Vapor pressure: 1.47 Pa (at melting point)

Fe Iron

26

55.847



Ferro
Fer
Eisen
Hierro
железо
ברזל
鉄 鉄

Naturally occurring isotopes: 56, 54, 57, 58
Density: 7.874 g/cm^3 (20°C)
Melting point: 1535°C **Boiling point:** 2750°C
Latent heat of fusion: 275.1 J/g
Specific heat: 0.450 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 11.76 $\times$ 10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 0.804 w/cm/°C (25°C)
Electrical resistivity: 9.71 $\times$ 10^{-6} ohm-cm (20°C)
Ionization potential (1st): 7.870 eV
Electron work function ϕ: 4.70 eV
Oxidation potential: $Fe \rightarrow Fe^{2+} + 2\epsilon = 0.4402$ V
Chemical valence: 2, *3*, 4, 6
Electrochemical equivalents: 0.69455 g/amp-hr
Ionic radius: 0.645 Å (Fe^{3+})
Valence electron potential ($-\varepsilon$V): 67.0
Principal quantum number: 4
Principal electron shells: K L M N
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6\ 4s^2$
Valence electrons: $3d^6\ 4s^2$
Crystal form: Cubic, body centered
Cross section σ: 2.56 $\pm$ 0.05 barns
Vapor pressure: 7.05 Pa (at melting point)

Kr Krypton

36

83.80

O

4.00260
He
2
20.179
Ne
10
39.948
Ar
18
83.80
Kr
36
131.30
Xe
54
222.01761
Rn
86

Criptônio
Krypton
Krypton
Criptón
криптон
קריפטון
氪 クリプトン

Naturally occurring isotopes: 84, 86, 82, 83, 80, 78
Density: 3.733 × 10^{-3} g/cm^3 (20°C)
Melting point: −156.6°C **Boiling point:** −152.30 ± 0.10°C
Latent heat of fusion: 19.54 J/g
Specific heat: 0.24804 J/g/°C (25°C)
Thermal conductivity: 0.0949 mw/cm/°C (27°C)
Ionization potential (1st): 13.999 eV
Chemical valence: 0
Principal quantum number: 4
Principal electron shells: K L M N
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6$
Valence electrons: ($4s^2\ 4p^6$)
Crystal form: Cubic, face centered (solid)
Cross section σ: 24.5 ± 1.0 barns

La Lanthanum

57

138.9055

IIIB

44.95592 Sc 21
88.9059 Y 39
138.9055 La 57
227.02777 Ac 89

Lantânio
Lanthane
Lanthan
Lantano
лантан
לנתן
鑭 ランタン

Naturally occurring isotopes: 139, 138
Density: 6.145 g/cm^3 (25°C)
Melting point: 921°C **Boiling point:** 3457°C
Latent heat of fusion: 81.4 J/g
Specific heat: 0.195 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 5.2 × 10^{-6} cm/cm/°C (25°C)
Thermal conductivity: 0.134 w/cm/°C (25°C)
Electrical resistivity: 56 × 10^{-6} ohm-cm (25°C)
Ionization potential (1st): 5.577 eV
Electron work function ϕ: 3.5 eV
Oxidation potential: La → La^{3+} + 3ϵ = 2.522 V
Chemical valence: 3
Electrochemical equivalents: 1.7275 g/amp-hr
Ionic radius: 1.061 Å (La^{3+})
Valence electron potential (−εV): 40.71
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 5s^2 5p^6 5d^1 6s^2
Valence electrons: 5d^1 6s^2
Crystal form: Hexagonal, close packed
Cross section σ: 8.9 ± 0.2 barns
Vapor pressure: 1.33 × 10^{-7} Pa (at melting point)

Lr Lawrencium

103

260

Laurêncio
Lawrencium
Lawrenzium
Lawrencio
лавренций

テーレンチウム

Actinide Series

232.03807 Th 90	231.0358 Pa 91	238.029 U 92	237.0482 Np 93	244.06423 Pu 94	243.0614 Am 95	247.07038 Cm 96	247.07032 Bk 97	251.07961 Cf 98	254.08805 Es 99
257.09515 Fm 100	258 Md 101	259 No 102	260 Lr 103						

Naturally occurring isotopes: None
Oxidation potential: $Lr \rightarrow Lr^{3+} + 3\epsilon = 2.0\ V$
Chemical valence: 3
Electrochemical equivalents: 3.23 g/amp-hr
Principal quantum number: 7
Principal electron shells: K L M N O P Q
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^{10}\ 5f^{14}\ 6s^2\ 6p^6\ 6d^1\ 7s^2$
Valence electrons: $5f^{14}\ 6d^1\ 7s^2$
Half life: 3 minutes

Pb Lead

82

207.2

IVA

12.011 C 6
28.0855 Si 14
72.59 Ge 32
118.69 Sn 50
207.2 Pb 82

Chumbo
Plomb
Blei
Plomo
свинец
עופרת
鉛 鉛

Naturally occurring isotopes: 208, 206, 207, 204
Density: 11.342 g/cm^3 (20°C)
Melting point: 327.502°C **Boiling point:** 1740°C
Latent heat of fusion: 23.06 J/g
Specific heat: 0.128 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 28.3 $\times$ 10^{-6} cm/cm/°C (25°C)
Thermal conductivity: 0.353 w/cm/°C (25°C)
Electrical resistivity: 20.65 $\times$ 10^{-6} ohm-cm (20°C)
Ionization potential (1st): 7.416 eV
Electron work function ϕ: 4.25 eV
Oxidation potential: Pb $\rightarrow$ Pb^{2+} + 2ϵ = 0.126 V
Chemical valence: *2*, 4
Electrochemical equivalents: 3.865 g/amp-hr (Pb^{2+})
Ionic radius: 1.19 Å (Pb^{2+})
Valence electron potential ($-\varepsilon$V): 24.2
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 4f^{14} 5s^2 5p^6 5d^{10} 6s^2 6p^2
Valence electrons: 6s^2 6p^2
Crystal form: Cubic, face centered
Cross section σ: 180 $\pm$ 10 mbarns
Vapor pressure: 4.21 $\times$ 10^{-7} Pa (at melting point)

Li Lithium

3

6.941

IA

1.0079 H 1
6.941 Li 3
22.98977 Na 11
39.098 K 19
85.4678 Rb 37
132.9054 Cs 55
223.01976 Fr 87

Litio
Lithium
Lithium
Litio
литий
ליתיום
鋰 リチウム

Naturally occurring isotopes: 7, 6
Density: 0.534 g/cm^3 (20°C)
Melting point: 180.54°C **Boiling point:** 1342°C
Latent heat of fusion: 430.1 J/g
Specific heat: 3.57 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 60×10^{-6} cm/cm/°C (25°C)
Thermal conductivity: 0.848 w/cm/°C (25°C)
Electrical resistivity: 8.55×10^{-6} ohm-cm (0°C)
Ionization potential (1st): 5.392 eV
Electron work function ϕ: 2.9 eV
Oxidation potential: $Li \rightarrow Li^+ + \epsilon = 3.045$ V
Chemical valence: 1
Electrochemical equivalents: 0.2590 g/amp-hr
Ionic radius: 0.76 Å (Li^+)
Valence electron potential ($-\varepsilon V$): 19
Principal quantum number: 2
Principal electron shells: K L
Electronic configuration: $1s^2\ 2s^1$
Valence electrons: $2s^1$
Crystal form: Cubic, body centered
Cross section σ: 71 barns
Vapor pressure: 1.63×10^{-8} Pa (at melting point)

Lu Lutetium

71

174.97

Lutécio
Lutetium
Lutetium
Lutecio
лютеций
לוטציום
鑥 ルテチウム

Lanthanide Series

140.12 Ce 58	140.9077 Pr 59	144.24 Nd 60	144.913 Pm 61	150.4 Sm 62	151.96 Eu 63	157.25 Gd 64	158.9254 Tb 65	162.50 Dy 66	164.9304 Ho 67
167.26 Er 68	168.9342 Tm 69	173.04 Yb 70	174.97 Lu 71						

Naturally occurring isotopes: 175, 176
Density: 9.840 g/cm^3 (25°C)
Melting point: 1663°C **Boiling point:** 3395°C
Latent heat of fusion: 110.1 J/g
Specific heat: 0.154 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 12.5 $\times$ 10^{-6} cm/cm/°C (400°C)
Thermal conductivity: 0.164 w/cm/°C (25°C)
Electrical resistivity: 79.0 $\times$ 10^{-6} ohm-cm (25°C)
Ionization potential (1st): 5.4259 eV
Electron work function ϕ: 3.3 eV
Oxidation potential: Lu $\rightarrow$ Lu^{3+} + 3ϵ = 2.255 V
Chemical valence: 3
Electrochemical equivalents: 2.1760 g/amp-hr
Ionic radius: 0.848 Å (Lu^{3+})
Valence electron potential ($-\varepsilon$V): 50.9
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 4f^{14} 5s^2 5p^6 5d^1 6s^2
Valence electrons: 5d^1 6s^2
Crystal form: Hexagonal, close packed
Cross section σ: 75 $\pm$ 2 barns
Vapor pressure: 2.46 $\times$ 10^3 Pa (at melting point)

Mg Magnesium

12

24.305

IIA

9.01218 Be 4
24.305 Mg 12
40.08 Ca 20
87.62 Sr 38
137.34 Ba 56
226.02544 Ra 88

Magnésio
Magnésium
Magnesium
Magnesio
магний
מגנזיום
鎂 マグネシウム

Naturally occurring isotopes: 24, 26, 25
Density: 1.738 g/cm^3 (20°C)
Melting point: 648.8 ± 0.5°C **Boiling point:** 1090°C
Latent heat of fusion: 368.6 J/g
Specific heat: 102 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 27.1 × 10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 1.56 w/cm/°C (20°C)
Electrical resistivity: 4.45 × 10^{-6} ohm-cm (20°C)
Ionization potential (1st): 7.646 eV
Electron work function ϕ: 3.66 eV
Oxidation potential: $Mg \rightarrow Mg^{2+} + 2\epsilon = 2.363$ V
Chemical valence: 2
Electrochemical equivalents: 0.45341 g/amp-hr
Ionic radius: 0.72 Å (Mg^{2+})
Valence electron potential ($-\varepsilon$V): 40
Principal quantum number: 3
Principal electron shells: K L M
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2$
Valence electrons: $3s^2$
Crystal form: Hexagonal, close packed
Cross section σ: 64 ± 2 mbarns
Vapor pressure: 3.61 × 10^2 (at melting point)

Mn Manganese

25

54.9380

VIIB

54.9380
Mn
25
96.906
Tc
43
186.2
Re
75
107

Manganês
Manganese
Mangan
Manganeso
марганец
מנגן
錳 マンガン

Naturally occurring isotope: 55
Density: 7.44 g/cm^3 (20°C)
Melting point: 1244 ± 3°C **Boiling point:** 1962°C
Latent heat of fusion: 266.7 J/g
Specific heat: 0.479 J/g/°C (20°C)
Coefficient of lineal thermal expansion: 22 × 10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 78.1 mw/cm/°C (25°C)
Electrical resistivity: 185 × 10^{-6} ohm-cm (20°C)
Ionization potential (1st): 7.435 eV
Electron work function ϕ: 4.1 eV
Oxidation potential: $Mn \rightarrow Mn^{2+} + 2\epsilon = 1.18$ V
Chemical valence: −2, −1, 0, 1, 2, 3, 4, 5, 6, 7
Electrochemical equivalents: 0.29282 g/amp-hr
Ionic radius: 0.46 Å (Mn^{7+})
Valence electron potential (−εV): 220
Principal quantum number: 4
Principal electron shells: K L M N
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^2$
Valence electrons: $3d^5\ 4s^2$
Crystal form: Cubic, face centered
Cross section σ: 13.3 ± 0.1 barns
Vapor pressure: 1.21 × 10^2 Pa (at melting point)

Md Mendelevium

101

258

Mendelévio
Mendelevium
Mendelevium
Mendelevio
менделевий
מנדלביום
鍆 メンデルビウム

Actinide Series

232.03807 Th 90	231.0359 Pa 91	238.029 U 92	237.0482 Np 93	244.06423 Pu 94	243.0614 Am 95	247.07038 Cm 96	247.07032 Bk 97	251.07961 Cf 98	254.08805 Es 99
257.09515 Fm 100	258 Md 101	259 No 102	260 Lr 103						

Naturally occurring isotopes: None
Ionization potential (1st): 6.58 eV
Oxidation potential: $Md \rightarrow Md^{3+} + 3\epsilon = 1.6$ V
Chemical valence: 1, 2, *3*
Electrochemical equivalents: 3.21 g/amp-hr
Principal quantum number: 7
Principal electron shells: K L M N O P Q
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^{10}\ 5f^{13}\ 6s^2\ 6p^6\ 7s^2$
Valence electrons: $5f^{13}\ 7s^2$
Half life: 55 days

Hg Mercury

80

200.59

IIB

65.38
Zn
30
112.41
Cd
48
200.59
Hg
80

Mercúrio
Mercure
Quecksilber
Mercurio
ртуть
כספית
汞 水銀

Naturally occurring isotopes: 202, 200, 199, 201, 198, 204, 196
Density: 13.534 g/cm^3 (25°C)
Melting point: −38.87°C **Boiling point:** 356.58°C
Latent heat of fusion: 11.46 J/g
Specific heat: 0.1395 J/g/°C (liquid) (25°C)
Thermal conductivity: 0.0830 w/cm/°C (25°C)
Electrical resistivity: 95.78 × 10^{-6} ohm-cm (20°C)
Ionization potential (1st): 10.437 eV
Electron work function ϕ: 4.49 eV
Oxidation potential: $Hg \rightarrow Hg^{2+} + 2\epsilon = -0.788$ V
Chemical valence: 1, *2*
Electrochemical equivalents: 3.7420 g/amp-hr
Ionic radius: 1.02 Å (Hg^{2+})
Valence electron potential ($-\varepsilon V$): 28.2
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^{10}\ 6s^2$
Valence electrons: $6s^2$
Crystal form: Rhombohedral
Cross section σ: 375 ± 5 barns
Vapor pressure: 2.00 × 10^{-4} Pa (at melting point)

Mo Molybdenum

42

95.94

VIB

51.996 Cr 24
95.94 Mo 42
183.85 W 74
106

Molibdênio
Molybdène
Molybdän
Molibdeno
молибден
מוליבדן
鉬 モリブデン

Naturally occurring isotopes: 98, 96, 95, 92, 100, 97, 94
Density: 10.22 g/cm^3 (20°C)
Melting point: 2617°C **Boiling point:** 4612°C
Latent heat of fusion: 288.0 J/g
Specific heat: 0.251 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 6.6 × 10^{-6} cm/cm/°C (25°C)
Thermal conductivity: 1.38 w/cm/°C (25°C)
Electrical resistivity: 5.2 × 10^{-6} ohm-cm (0°C)
Ionization potential (1st): 7.099 eV
Electron work function ϕ: 4.6 eV
Oxidation potential: Mo → Mo^{3+} + 3ϵ = 0.2 V
Chemical valence: 2, 3, *4,* 5, 6
Electrochemical equivalents: 0.8949 g/amp-hr
Ionic radius: 0.650 Å (Mo^{4+})
Valence electron potential (−εV): 88.6
Principal quantum number: 5
Principal electron shells: K L M N O
Electronic configuration: 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^5 5s^1
Valence electrons: 4d^5 5s^1
Crystal form: Cubic, body centered
Cross section σ: 2.65 ± 0.05 barns
Vapor pressure: 3.47 Pa (at melting point)

Nd Neodymium

60

144.24

Neodímio
Neodymium
Neodym
Neodimio
неодимий
ניאודימיום
钕 ネオジム

Lanthanide Series

140.12 Ce 58	140.9077 Pr 59	144.24 Nd 60	144.913 Pm 61	150.4 Sm 62	151.96 Eu 63	157.25 Gd 64	158.9254 Tb 65	162.50 Dy 66	164.9304 Ho 67
167.26 Er 68	168.9342 Tm 69	173.04 Yb 70	174.97 Lu 71						

Naturally occurring isotopes: 142, 144, 146, 143, 145, 148, 150
Density: 7.007 g/cm^3 (25°C)
Melting point: 1021°C **Boiling point:** 3068°C
Latent heat of fusion: 75.47 J/g
Specific heat: 0.190 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 8.6 × 10^6 cm/cm/°C (25°C)
Thermal conductivity: 0.165 w/cm/°C (25°C)
Electrical resistivity: 64.0 × 10^{-6} ohm-cm (25°C)
Ionization potential (1st): 5.49 eV
Electron work function ϕ**:** 3.2 eV
Oxidation potential: $Nd \rightarrow Nd^{3+} + 3\epsilon = 2.431$ V
Chemical valence: 2, *3*
Electrochemical equivalents: 1.7939 g/amp-hr
Ionic radius: 0.995 Å (Nd^{3+})
Valence electron potential ($-\varepsilon$V)**:** 43.4
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^4\ 5s^2\ 5p^6\ 6s^2$
Valence electrons: $4f^4\ 6s^2$
Crystal form: Hexagonal, close packed
Cross section σ**:** 49 ± 2 barns
Vapor pressure: 6.03 × 10^{-3} Pa (at melting point)

Ne Neon

10

20.179

O

4.00260
He
2
20.179
Ne
10
39.948
Ar
18
83.80
Kr
36
131.30
Xe
54
222.01761
Rn
86

Neônio
Neon
Neon
Neón
неон
ניאון
氖 ネオン

Naturally occurring isotopes: 20, 22, 21
Density: 0.8999 × 10^{-3} g/cm^3 (20°C)
Melting point: −248.67°C **Boiling point:** −246.048°C
Latent heat of fusion: 16.6 J/g
Specific heat: 1.0301 J/g/°C (25°C)
Thermal conductivity: 0.493 mw/cm/°C (27°C)
Ionization potential (1st): 21.564 eV
Chemical valence: 0
Principal quantum number: 2
Principal electron shells: K L
Electronic configuration: $1s^2\ 2s^2\ 2p^6$
Valence electrons: ($2s^2\ 2p^6$)
Crystal form: Cubic, face centered
Cross section σ: 38 ± 10 mbarns

Np Neptunium

93

237.0482

Neptúnio
Neptunium
Neptunium
Neptunio
нептуний
נפטוניום
錼 ネプツニウム

Actinide Series

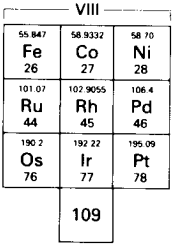
232.03807 Th 90	231.0359 Pa 91	238.029 U 92	237.0482 Np 93	244.06423 Pu 94	243.0614 Am 95	247.07038 Cm 96	247.07032 Bk 97	251.07961 Cf 98	254.08805 Es 99
257.09515 Fm 100	258 Md 101	259 No 102	260 Lr 103						

Naturally occurring isotopes: None
Density: 20.45 g/cm^3 (25°C)
Melting point: 640 ± 1°C **Boiling point:** 3902°C
Latent heat of fusion: 46 J/g
Thermal conductivity: 63 mw/cm/°C (27°C)
Electrical resistivity: 119 × 10^{-6} ohm-cm (100°C)
Ionization potential (1st): 6.19 eV
Oxidation potential: Np → Np^{3+} + 3ϵ = 1.856 V
Chemical valence: 3, 4, *5*, 6, 7
Electrochemical equivalents: 1.7689 g/amp-hr
Ionic radius: 0.75 Å (Np^{5+})
Valence electron potential (−εV): 96
Principal quantum number: 7
Principal electron shells: K L M N O P Q
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^{10}\ 5f^4\ 6s^2\ 6p^6\ 6d^1\ 7s^2$
Valence electrons: $5f^4\ 6d^1\ 7s^2$
Crystal form: Orthorhombic
Half life: 2.14 × 10^4 years
Cross section σ: 170 ± 5 barns

Ni Nickel

28

58.70



Niquel
Nickel
Nickel
Niquel
никель
ניקל
鎳 ニッケル

Naturally occurring isotopes: 58, 60, 62, 61, 64
Density: 8.902 g/cm^3 (25°C)
Melting point: 1453°C **Boiling point:** 2732°C
Latent heat of fusion: 300.3 J/g
Specific heat: 0.444 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 13.3 × 10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 0.909 w/cm/°C (25°C)
Electrical resistivity: 6.84 × 10^{-6} ohm-cm (20°C)
Ionization potential (1st): 7.635 eV
Electron work function ϕ: 5.15 eV
Oxidation potential: $Ni \rightarrow Ni^{2+} + 2\epsilon = 0.250$ V
Chemical valence: 0, 1, *2*, 3
Electrochemical equivalents: 1.095 g/amp-hr
Ionic radius: 0.69 Å (Ni^{2+})
Valence electron potential ($-\varepsilon$V): 42
Principal quantum number: 4
Principal electron shells: K L M N
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^8\ 4s^2$
Valence electrons: $3d^8\ 4s^2$
Crystal form: Cubic, face centered
Cross section σ: 4.54 ± 0.10 barns
Vapor pressure: 2.37 × 10^2 Pa (at melting point)

Nb Niobium

41

92.9064

VB

50.9415 V 23
92.9064 Nb 41
180.9479 Ta 73
105

Nióbio
Niobium
Niob
Niobio
ниобий
ניוביום
鈮 ニオブ

Naturally occurring isotope: 93
Density: 8.57 g/cm^3 (20°C)
Melting point: 2468 ± 10°C **Boiling point:** 4742°C
Latent heat of fusion: 288.4 J/g
Specific heat: 0.265 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 7.31 × 10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 0.537 w/cm/°C (25°C)
Electrical resistivity: 14.6 × 10^{-6} ohm-cm (20°C)
Ionization potential (1st): 6.88 eV
Electron work function ϕ: 4.3 eV
Oxidation potential: $Nb \rightarrow Nb^{3+} + 3\epsilon = 1.099$ V
Chemical valence: 2, 3, 4, *5*
Electrochemical equivalents: 0.69327 g/amp-hr
Ionic radius: 0.69 Å (Nb^{5+})
Valence electron potential ($-\varepsilon V$): 104
Principal quantum number: 5
Principal electron shells: K L M N O
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^4\ 5s^1$
Valence electrons: $4d^4\ 5s^1$
Crystal form: Cubic, face centered
Cross section σ: 1.15 ± 0.05 barns
Vapor pressure: 7.55 × 10^{-2} Pa (at melting point)

N Nitrogen

7

14.0067

VA

14.0067 N 7
30.97376 P 15
74.9216 As 33
121.75 Sb 51
208.9804 Bi 83

Nitrogênio
Azote
Stickstoff
Nitrógeno
азот
חנקן
氮 窒素

Naturally occurring isotopes: 14, 15
Density: 1.165 × 10^{-3} g/cm^3 (20°C)
Melting point: −209.86°C **Boiling point:** −195.8°C
Latent heat of fusion: 51.41 J/g (N_2)
Specific heat: 1.040 J/g/°C (N_2) (25°C)
Thermal conductivity: 0.2598 mw/cm/°C (27°C at 1 atm)
Ionization potential (1st): 14.534 eV
Oxidation potential: $N_2 + 2H_2O \rightarrow H_2N_2O_2 + 2H^+ + 2\epsilon = -2.65$ V
Chemical valence: −3, 3, *5*
Electrochemical equivalents: 0.10452 g/amp-hr
Ionic radius: 0.13 Å (N^{5+})
Valence electron potential (−εV): 550
Principal quantum number: 2
Principal electron shells: K L
Electronic configuration: $1s^2\ 2s^2\ 2p^3$
Valence electrons: $2s^2\ 2p^3$
Crystal form: Hexagonal, close packed
Cross section σ: 1.9 barns

No Nobelium

102

259

Nobélio
Nobelium
Nobelium
Nobelio
нобелий
נובליום
ノーベリウム

Actinide Series

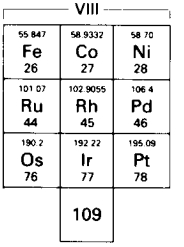
232.03807 Th 90	231.0359 Pa 91	238.029 U 92	237.0482 Np 93	244.06423 Pu 94	243.0614 Am 95	247.07038 Cm 96	247.07032 Bk 97	251.07961 Cf 98	254.08805 Es 99
257.09515 Fm 100	258 Md 101	259 No 102	260 Lr 103						

Naturally occurring isotopes: None
Ionization potential (1st): 6.65 eV
Oxidation potential: $No \rightarrow No^{2+} + 2\epsilon = 2.5$ V
Chemical valence: *2*, 3
Electrochemical equivalents: 4.83 g/amp-hr
Ionic radius: 1.1 Å (est) (No^{2+})
Valence electron potential (−εV): (26)
Principal quantum number: 7
Principal electron shells: K L M N O P Q
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^{10}\ 5f^{14}\ 6s^2\ 6p^6\ 7s^2$
Valence electrons: $5f^{14}\ 7s^2$
Half life: ~59 minutes

Os Osmium

76

190.2



Osmio
Osmium
Osmium
Osmio
осмий
אוסמיום
鋨 オスミウム

Naturally occurring isotopes: 192, 190, 189, 188, 187, 186, 184
Density: 22.61 g/cm^3 (20°C)
Melting point: 3045 ± 30°C **Boiling point:** 5027 ± 100°C
Latent heat of fusion: 154.1 J/g
Specific heat: 0.13 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 6.3 × 10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 0.876 w/cm/°C (25°C)
Electrical resistivity: 9.5 × 10^{-6} ohm-cm (20°C)
Ionization potential (1st): 8.7 eV
Electron work function ϕ: 4.83 eV
Oxidation potential: $Os + 4H_2O \rightarrow OsO_4 + 8H^+ + 8\epsilon = -0.85$ V
Chemical valence: 0, 1, 2, 3, *4*, 5, 6, 7, 8
Electrochemical equivalents: 1.774 g/amp-hr
Ionic radius: 0.630 Å (Os^{4+})
Valence electron potential ($-\varepsilon$V): 91.4
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^6\ 6s^2$
Valence electrons: $5d^6\ 6s^2$
Crystal form: Hexagonal, close packed
Cross section σ: 15.3 ± 0.7 barns
Vapor pressure: 2.52 Pa (at melting point)

O Oxygen

8

15.9994

VIA

15.9994 O 8
32.06 S 16
78.96 Se 34
127.60 Te 52
208.98243 Po 84

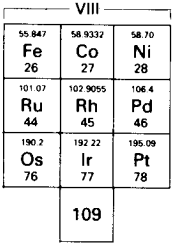
Oxigênio
Oxygène
Sauerstoff
Oxigeno
кислород
חמצן
氧 酸 素

Naturally occurring isotopes: 16, 18, 17
Density: 1.429 $\times$ 10^{-3} g/cm^3 (0°C)
Melting point: −218.4°C **Boiling point:** −182.962°C
Latent heat of fusion: 26.17 J/g (O_2)
Specific heat: 0.9174 J/g/°C (O_2) (25°C)
Thermal conductivity: 0.2674 w/cm/°C (25°C at 1 atm)
Ionization potential (1st): 13.618 eV
Oxidation potential: $2H_2O$ (liquid) $\rightarrow O_2 + 4H^+ + 4\epsilon = -1.229$ V
Chemical valence: −2
Electrochemical equivalents: 0.29847 g/amp-hr
Ionic radius: 1.40 Å (O^{2-})
Valence electron potential (−εV): −20.6
Principal quantum number: 2
Principal electron shells: K L
Electronic configuration: $1s^2\ 2s^2\ 2p^4$
Valence electrons: $2s^2\ 2p^4$
Crystal form: Cubic
Cross section σ: 0.27 mbarns

Pd Palladium

46

106.4



Paládio
Palladium
Palladium
Paladio
палладий
פלדיום
鈀 パラジウム

Naturally occurring isotopes: 106, 108, 105, 110, 104, 102
Density: 12.023 g/cm^3 (20°C)
Melting point: 1554°C **Boiling point:** 3140°C
Latent heat of fusion: 157.4 J/g
Specific heat: 0.244 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 11.67 $\times$ 10^{-6} cm/cm/°C (0°C)
Thermal conductivity: 0.718 w/cm/°C (25°C)
Electrical resistivity: 10.54 $\times$ 10^{-6} ohm-cm (20°C)
Ionization potential (1st): 8.34 eV
Electron work function ϕ: 5.12 eV
Oxidation potential: $Pd \rightarrow Pd^{2+} + 2\epsilon = -0.987$ V
Chemical valence: *2*, 3, 4
Electrochemical equivalents: 1.985 g/amp-hr
Ionic radius: 0.86 Å (Pd^{2+})
Valence electron potential ($-\varepsilon$V): 33
Principal quantum number: 5
Principal electron shells: K L M N O
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}$
Valence electrons: $4d^{10}$
Crystal form: Cubic, face centered
Cross section σ: 6.0 $\pm$ 1.0 barns
Vapor pressure: 1.33 Pa (at melting point)

P Phosphorus

15

30.97376

VA

14.0067 N 7
30.97376 P 15
74.9216 As 33
121.75 Sb 51
208.9804 Bi 83

Fósforo
Phosphore
Phosphor
Fósforo
фосфор
זרחן
磷 燐

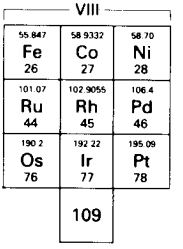
Naturally occurring isotope: 31
Density: 1.828 g/cm^3 (white), 2.34 g/cm^3 (red), 2.699 g/cm^3 (black) (all at 20°C)
Melting point: 44.1°C (white) **Boiling point:** 280.3°C (white)
Latent heat of fusion: 20.28 J/g (white)
Specific heat: 0.7697 J/g/°C (white) (25°C)
Coefficient of lineal thermal expansion: 125 × 10^{-6} cm/cm/°C (25°C)
Thermal conductivity: 2.36 mw/cm/°C (white) (25°C)
Electrical resistivity: 10^{11} ohm-cm (white) (20°C)
Ionization potential (1st): 10.486 eV
Oxidation potential: $P + 2H_2O \rightarrow H_3PO_2 + H^+ + \epsilon = 0.508$ V
Chemical valence: −3, 3, *5*
Electrochemical equivalents: 0.23113 g/amp-hr
Ionic radius: 0.38 Å (P^{5+})
Valence electron potential (−εV): 190
Principal quantum number: 3
Principal electron shells: K L M
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$
Valence electrons: $3s^2\ 3p^3$
Crystal form: Cubic
Cross section σ: 0.19 barns
Vapor pressure: 20.8 Pa (at melting point)

Four allotropes of phosphorus have different melting points, crystal forms, colors, and electrical conductivities. The black variety has the highest electrical conductivity.

Pt Platinum

78

195.09



Platina
Platine
Plátin
Platino
платина
פלטין
鉑 **白金[プラチナ]**

Naturally occurring isotopes: 195, 194, 196, 198, 192, 190
Density: 21.45 g/cm^3 (20°C)
Melting point: 1773.5°C **Boiling point:** 3827 ± 100°C
Latent heat of fusion: 100.9 J/g
Specific heat: 0.133 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 9.5 × 10^{-6} cm/cm/°C (25°C)
Thermal conductivity: 0.716 w/cm/°C (25°C)
Electrical resistivity: 9.85 × 10^{-6} ohm-cm (0°C)
Ionization potential (1st): 8.96 eV
Electron work function ϕ: 5.65 eV
Oxidation potential: $Pt \rightarrow Pt^{2+} + 2\epsilon = -1.2$ V
Chemical valence: 2, 3, *4*
Electrochemical equivalents: 1.8197 g/amp-hr
Ionic radius: 0.625 Å (Pt^{4+})
Valence electron potential (−εV): 92.2
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^9\ 6s^1$
Valence electrons: $5d^9\ 6s^1$
Crystal form: Cubic, face centered
Cross section σ: 9 ± 1 barns
Vapor pressure: 3.12 × 10^{-2} Pa (at melting point)

Pu Plutonium

94

244.06423

Actinide Series

232.03807 Th 90	231.0359 Pa 91	238.029 U 92	237.0482 Np 93	244.06423 Pu 94	243.0614 Am 95	247.07038 Cm 96	247.07032 Bk 97	251.07961 Cf 98	254.08805 Es 99
257.09515 Fm 100	258 Md 101	259 No 102	260 Lr 103						

Plutônio
Plutonium
Plutonium
Plutonio
плутоний
פלוטוניום
钚 プリトニウム

Naturally occurring isotope: 242 (trace)
Density: 19.737 g/cm^3 (25°C)
Melting point: 639.5°C **Boiling point:** 3232°C
Latent heat of fusion: 11 J/g
Specific heat: 0.14 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 42.3 $\times$ 10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 0.0670 w/cm/°C (25°C)
Electrical resistivity: 146.45 $\times$ 10^{-6} ohm-cm (0°C)
Ionization potential (1st): 6.06 eV
Oxidation potential: Pu $\rightarrow$ Pu^{3+} + 3ϵ = 2.031 V
Chemical valence: 3, *4*, 5, 6, 7
Electrochemical equivalents: 2.2765 g/amp-hr
Ionic radius: 0.887 Å (Pu^{4+})
Valence electron potential (−ϵV): 64.9
Principal quantum number: 7
Principal electron shells: K L M N O P Q
Electronic configuration: 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 4f^{14} 5s^2 5p^6 5d^{10} 5f^6 6s^2 6p^6 7s^2
Valence electrons: 5f^6 7s^2
Crystal form: Monoclinic
Half life: 8.3 $\times$ 10^7 years
Cross section σ: 1.8 $\pm$ 0.3 barns

Po Polonium

84

208.98243

VIA

15.9994 O 8
32.06 S 16
78.96 Se 34
127.60 Te 52
208.98243 Po 84

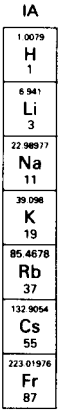
Polônio
Polonium
Polonium
Polonio
полоний
פולוניום
钋 ポロニウム

Naturally occurring isotopes: None
Density: 9.20 g/cm^3 (20°C)
Melting point: 254°C **Boiling point:** 962°C
Latent heat of fusion: 60.1 J/g
Specific heat: 0.13 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 23.5 $\times$ 10^{-6} cm/cm/°C (20°C)
Electrical resistivity: 42 $\times$ 10^{-6} ohm-cm (0°C)
Ionization potential (1st): 8.42 eV
Oxidation potential: $Po \rightarrow Po^{2+} + 2\epsilon = -0.65$ V
Chemical valence: *−2*, 0, 2, 4, 6
Electrochemical equivalents: 3.8986 g/amp-hr
Ionic radius: 2.30 Å (Po^{2-})
Valence electron potential (−εV): −12.5
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^{10}\ 6s^2\ 6p^4$
Valence electrons: $6s^2\ 6p^4$
Crystal form: Cubic, body centered
Half life: 103 years
Vapor pressure: 1.76 $\times$ 10^{-2} Pa (at melting point)

K Potassium

19

39.098



Potássio
Potassium
Kalium
Potasio
калий
אשלגן
鉀 カリウム

Naturally occurring isotopes: 39, 41, 40
Density: 0.862 g/cm^3 (20°C)
Melting point: 63.25°C **Boiling point:** 759.9°C
Latent heat of fusion: 59.33 J/g
Specific heat: 0.757 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 83×10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 1.025 w/cm/°C (25°C)
Electrical resistivity: 7.20×10^{-6} ohm-cm (20°C)
Ionization potential (1st): 4.341 eV
Electron work function ϕ: 2.30 eV
Oxidation potential: $K \rightarrow K^+ + \epsilon = 2.925$ V
Chemical valence: 1
Electrochemical equivalents: 1.4587 g/amp-hr
Ionic radius: 1.38 Å (K^+)
Valence electron potential ($-\varepsilon V$): 10.4
Principal quantum number: 4
Principal electron shells: K L M N
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1$
Valence electrons: $4s^1$
Crystal form: Cubic, body centered
Cross section σ: 2.1 barns
Vapor pressure: 1.06×10^{-4} Pa (at melting point)

Pr Praseodymium

59

140.9077

Lanthanide Series

140.12 Ce 58	140.9077 Pr 59	144.24 Nd 60	144.913 Pm 61	150.4 Sm 62	151.96 Eu 63	157.25 Gd 64	158.9254 Tb 65	162.50 Dy 66	164.9304 Ho 67
167.26 Er 68	168.9342 Tm 69	173.04 Yb 70	174.97 Lu 71						

Praséodímio
Praseodyne
Praseodym
Praseodimio
празеодимий
פרסיאודים
鐠 プラセオジム

Naturally occurring isotope: 141
Density: 6.773 g/cm^3 (25°C)
Melting point: 931°C **Boiling point:** 3512°C
Latent heat of fusion: 71.3 J/g
Specific heat: 0.193 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 6.5 $\times$ 10^{-6} cm/cm/°C (25°C)
Thermal conductivity: 0.125 w/cm/°C (25°C)
Electrical resistivity: 68 $\times$ 10^{-6} ohm-cm (25°C)
Ionization potential (1st): 5.42 eV
Electron work function ϕ: 2.7 eV
Oxidation potential: $Pr \rightarrow Pr^{3+} + 3\epsilon = 2.462$ V
Chemical valence: *3,* 4
Electrochemical equivalents: 1.7524 g/amp-hr
Ionic radius: 1.013 Å (Pr^{3+})
Valence electron potential ($-\varepsilon$V): 42.64
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^3\ 5s^2\ 5p^6\ 6s^2$
Valence electrons: $4f^3\ 6s^2$
Crystal form: Hexagonal, close packed
Cross section σ: 3.9 $\pm$ 0.5 barns

Pm Promethium

61

144.913

Promécio
Prometheum
Prometheum
Promecio
прометий
פרומתיום
鉕 プロメチウム

Lanthanide Series

140.12 Ce 58	140.9077 Pr 59	144.24 Nd 60	144.913 Pm 61	150.4 Sm 62	151.96 Eu 63	157.25 Gd 64	158.9254 Tb 65	162.50 Dy 66	164.9304 Ho 67
167.26 Er 68	168.9342 Tm 69	173.04 Yb 70	174.97 Lu 71						

Naturally occurring isotopes: None
Density: 7.22 ± 0.02 g/cm^3 (25°C)
Melting point: 1168 ± 6°C **Boiling point:** 2460°C
Latent heat of fusion: 86.7 J/g
Specific heat: 0.185 J/g/°C (25°C)
Thermal conductivity: 0.179 w/cm/°C (25°C)
Ionization potential (1st): 5.55 eV
Oxidation potential: $Pm \rightarrow Pm^{3+} + 3\epsilon = 2.423$ V
Chemical valence: 3
Electrochemical equivalents: 1.8022 g/amp-hr
Ionic radius: 0.979 Å (Pm^{3+})
Valence electron potential ($-\varepsilon$V): 44.1
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^5\ 5s^2\ 5p^6\ 6s^2$
Valence electrons: $4f^5\ 6s^2$
Crystal form: Hexagonal
Half life: 17.7 years

Pa Protactinium

91

231.0359

Actinide Series

232.03807 Th 90	231.0359 Pa 91	238.029 U 92	237.0482 Np 93	244.06423 Pu 94	243.0614 Am 95	247.07038 Cm 96	247.07032 Bk 97	251.07961 Cf 98	254.08805 Es 99
257.09515 Fm 100	258 Md 101	259 No 102	260 Lr 103						

Protactínio
Protactinium
Protactinium
Protactinio
протактиний
פרוטאקטיניום
鏷 プロトアクチニウム

Naturally occurring isotope: 231 (minute quantities only)
Density: 15.37 g/cm^3 (25°C)
Melting point: 1575°C
Latent heat of fusion: 65 J/g
Specific heat: 0.12 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 11.2 × 10^{-6} cm/cm/°C (25°C)
Ionization potential (1st): 5.89 eV
Chemical valence: 3, 4, *5*
Electrochemical equivalents: 1.7240 g/amp-hr
Oxidation potential: $Pa \rightarrow Pa^{3+} + 3\epsilon = 1.6$ V
Ionic radius: 0.78 Å (Pa^{5+})
Valence electron potential (−εV): 92
Principal quantum number: 7
Principal electron shells: K L M N O P Q
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^{10}\ 5f^2\ 6s^2\ 6p^6\ 6d^1\ 7s^2$
Valence electrons: $5f^2\ 6d^1\ 7s^2$
Crystal form: Tetragonal
Half life: 3.248 × 10^4 years
Cross section σ: 200 ± 10 barns

Ra Radium

88

226.02544

IIA

9.01218 Be 4
24.305 Mg 12
40.08 Ca 20
87.62 Sr 38
137.34 Ba 56
226.02544 Ra 88

Rádio
Radium
Radium
Radio
радий
רדיום
鐳 ラジウム

Naturally occurring isotope: 226 (minute quantities only)
Density: 5.5 g/cm^3 (extrapolated) (20°C)
Melting point: 700°C **Boiling point:** 1140°C
Latent heat of fusion: 37 J/g (est)
Specific heat: 0.120 J/g/°C (25°C)
Thermal conductivity: 0.186 w/cm/°C (20°C)
Ionization potential (1st): 5.279 eV
Oxidation potential: $Ra \rightarrow Ra^{2+} + 2\epsilon = 2.916$ V
Chemical valence: 2
Electrochemical equivalents: 4.2165 g/amp-hr
Ionic radius: 1.43 Å (Ra^{2+})
Valence electron potential ($-\varepsilon$V): 20.1
Principal quantum number: 7
Principal electron shells: K L M N O P Q
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^{10}\ 6s^2\ 6p^6\ 7s^2$
Valence electrons: $7s^2$
Half life: 1622 years
Cross section σ: 20 ± 3 barns
Vapor pressure: 3.27×10^2 Pa (at melting point)

Rn Radon

86

222.01761

O

4.00260 He 2
20.179 Ne 10
39.948 Ar 18
83.80 Kr 36
131.30 Xe 54
222.01761 Rn 86

Radônio
Radon
Radon
Radòn
радон
ראדון
氡 ラドン

Naturally occurring isotopes: None (radium decay product)
Density: 9.96×10^{-3} g/cm^3 (20°C)
Melting point: −71°C **Boiling point:** −61.8°C
Latent heat of fusion: 13.1 J/g
Specific heat: 0.09362 J/g/°C (25°C)
Thermal conductivity: 0.0364 mw/cm/°C (27°C)
Ionization potential (1st): 10.748 eV
Chemical valence: 0
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^{10}\ 6s^2\ 6p^6$
Valence electrons: ($6s^2\ 6p^6$)
Crystal form: Cubic, face centered
Half life: 3.824 days
Cross section σ: 0.72 ± 0.07 barns

Re Rhenium

75

186.2

VIIB

54.9380 Mn 25
96.906 Tc 43
186.2 Re 75
107

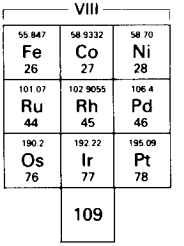
Rênio
Rhenium
Rhenium
Renio
рений
רניום
錸 レニウム

Naturally occurring isotopes: 187, 185
Density: 21.04 g/cm^3 (20°C)
Melting point: 3180°C **Boiling point:** 5627°C (est)
Latent heat of fusion: 177.6 J/g
Specific heat: 0.137 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 6.7 $\times$ 10^{-6} cm/cm/°C (25°C)
Thermal conductivity: 0.480 w/cm/°C (25°C)
Electrical resistivity: 19.3 $\times$ 10^{-6} ohm-cm (20°C)
Ionization potential (1st): 7.88 eV
Electron work function ϕ: 4.96 eV
Oxidation potential: $Re + 2H_2O \rightarrow ReO_2 + 4H^+ + 4\epsilon = -0.2513$ V
Chemical valence: 0, 1, 2, 3, 4, 5, 6, 7
Electrochemical equivalents: 0.9924 g/amp-hr
Ionic radius: 0.56 Å (Re^{7+})
Valence electron potential ($-\varepsilon$V): 180
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^5\ 6s^2$
Valence electrons: $5d^5\ 6s^2$
Crystal form: Hexagonal, close packed
Cross section σ: 85 $\pm$ 5 barns
Vapor pressure: 3.24 Pa (at melting point)

Rh Rhodium

45

102.9055



Ródio
Rhodium
Rhodium
Rodio
родий
רודיום
銠 ロジウム

Naturally occurring isotope: 103
Density: 12.41 g/cm^3 (20°C)
Melting point: 1966 ± 3°C **Boiling point:** 3727 ± 100°C
Latent heat of fusion: 211.6 J/g
Specific heat: 0.24 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 8.3 × 10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 1.50 w/cm/°C (25°C)
Electrical resistivity: 4.51 × 10^{-6} ohm-cm (20°C)
Ionization potential (1st): 7.46 eV
Electron work function ϕ: 4.98 eV
Oxidation potential: $Rh \rightarrow Rh^{3+} + 3\epsilon = -0.80$ V
Chemical valence: 2, *3,* 4, 5, 6
Electrochemical equivalents: 1.2798 g/amp-hr
Ionic radius: 0.68 Å (Rh^{3+})
Valence electron potential ($-\varepsilon$V): 64
Principal quantum number: 5
Principal electron shells: K L M N O
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^8\ 5s^1$
Valence electrons: $4d^8\ 5s^1$
Crystal form: Cubic, face centered
Cross section σ: 150 ± 5 barns
Vapor pressure: 6.33 × 10^{-1} Pa (at melting point)

Rb Rubidium

37

85.4678

IA

1.0079 H 1
6.941 Li 3
22.98977 Na 11
39.098 K 19
85.4678 Rb 37
132.9054 Cs 55
223.01976 Fr 87

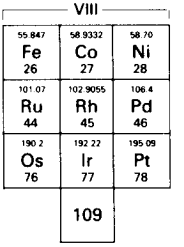
Rubidio
Rubidium
Rubidium
Rubidio
рубидий
רוביידיום
鈉 **ルビジウム**

Naturally occurring isotopes: 85, 87
Density: 1.532 g/cm^3 (20°C)
Melting point: 38.89°C **Boiling point:** 686°C
Latent heat of fusion: 27.43 J/g
Specific heat: 0.3634 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 90×10^{-6} cm/cm/°C (25°C)
Thermal conductivity: 0.582 w/cm/°C (25°C)
Electrical resistivity: 12.84×10^{-6} ohm-cm (20°C)
Ionization potential (1st): 4.177 eV
Electron work function ϕ: 2.16 eV
Oxidation potential: $Rb \rightarrow Rb^+ + \epsilon = 2.925$ V
Chemical valence: 1
Electrochemical equivalents: 3.1888 g/amp-hr
Ionic radius: 1.52 Å (Rb^+)
Valence electron potential ($-\varepsilon$V): 9.47
Principal quantum number: 5
Principal electron shells: K L M N O
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 5s^1$
Valence electrons: $5s^1$
Crystal form: Cubic, body centered
Cross section σ: 0.5 ± 0.1 barns
Vapor pressure: 1.56×10^{-4} Pa (at melting point)

Ru Ruthenium

44

101.07



Rutênio
Ruthénium
Ruthenium
Rutenio
рутений
רותניום
釘 ルテニウム

Naturally occurring isotopes: 102, 104, 101, 99, 100, 96, 98
Density: 12.45 g/cm^3 (20°C)
Melting point: 2310°C **Boiling point:** 3900°C
Latent heat of fusion: 252.7 J/g
Specific heat: 0.238 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 9.91 × 10^{-6} cm/cm/°C (50°C)
Thermal conductivity: 1.17 w/cm/°C (25°C)
Electrical resistivity: 6.80 × 10^{-6} ohm-cm (0°C)
Ionization potential (1st): 7.37 eV
Electron work function ϕ: 4.71 eV
Oxidation potential: $Ru + 5Cl^- \rightarrow RuCl_3^{2-} + 3\epsilon = -0.601$ V
Chemical valence: 1, 2, *3*, 4, 5, 6, 7, 8
Electrochemical equivalents: 1.2570 g/amp-hr
Ionic radius: 0.68 Å (Ru^{4+})
Valence electron potential ($-\varepsilon$V): 64
Principal quantum number: 5
Principal electron shells: K L M N O
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^7\ 5s^1$
Valence electrons: $4d^7\ 5s^1$
Crystal form: Hexagonal, close packed
Cross section σ: 3.0 ± 0.8 barns
Vapor pressure: 1.40 Pa (at melting point)

Sm Samarium

62

150.4

Lanthanide Series

140.12 Ce 58	140.9077 Pr 59	144.24 Nd 60	144.913 Pm 61	150.4 Sm 62	151.96 Eu 63	157.25 Gd 64	158.9254 Tb 65	162.50 Dy 66	164.9304 Ho 67
167.26 Er 68	168.9342 Tm 69	173.04 Yb 70	174.97 Lu 71						

Samário
Samarium
Samarium
Samario
самарий
סמריום
鉑 サマリウム

Naturally occurring isotopes: 152, 154, 147, 149, 148, 150, 144
Density: 7.520 g/cm^3 (25°C)
Melting point: 1077°C **Boiling point:** 1791°C
Latent heat of fusion: 73.8 J/g
Specific heat: 0.196 J/g/°C (25°C)
Thermal conductivity: 0.133 w/cm/°C (25°C)
Electrical resistivity: 88 × 10^{-6} ohm-cm (25°C)
Ionization potential (1st): 5.63 eV
Electron work function ϕ: 2.7 eV
Oxidation potential: $Sm \rightarrow Sm^{3+} + 3\epsilon = 2.414$ V
Chemical valence: 2, *3*
Electrochemical equivalents: 1.870 g/amp-hr
Ionic radius: 0.964 Å (Sm^{3+})
Valence electron potential ($-\varepsilon$V): 44.8
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^6\ 5s^2\ 5p^6\ 6s^2$
Valence electrons: $4f^6\ 6s^2$
Crystal form: Rhombohedral
Cross section σ: 5820 ± 100 barns
Vapor pressure: 5.63 × 10^2 Pa (at melting point)

Sc Scandium

21

44.95592

IIIB

44.95592 Sc 21
88.9059 Y 39
138.9055 La 57
227.02777 Ac 89

Escândio
Scandium
Scandium
Escandio
скандий
סקנדיום
鈧 スカンジウム

Naturally occurring isotope: 45
Density: 2.989 g/cm^3 (25°C)
Melting point: 1541°C **Boiling point:** 2831°C
Latent heat of fusion: 358.6 J/g
Specific heat: 0.568 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 12 × 10^{-6} cm/cm/°C (25°C)
Thermal conductivity: 0.158 w/cm/°C (25°C)
Electrical resistivity: 61.0 × 10^{-6} ohm-cm (20°C)
Ionization potential (1st): 6.54 eV
Electron work function ϕ: 3.5 eV
Oxidation potential: $Sc \rightarrow Sc^{3+} + 3\epsilon = 2.077$ V
Chemical valence: 3
Electrochemical equivalents: 0.55914 g/amp-hr
Ionic radius: 0.745 Å (Sc^{3+})
Valence electron potential ($-\varepsilon$V): 58.0
Principal quantum number: 4
Principal electron shells: K L M N
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^1\ 4s^2$
Valence electrons: $3d^1\ 4s^2$
Crystal form: Hexagonal, close packed
Cross section σ: 25 ± 2 barns
Vapor pressure: 2.21 × 10 Pa (at melting point)

Se Selenium

34

78.96

VIA

15.9994 O 8
32.06 S 16
78.96 Se 34
127.60 Te 52
208.98243 Po 84

Selênio
Sélénium
Selen
Selenio
селен
סלן
硒 セレン

Naturally occurring isotopes: 80, 78, 82, 76, 77, 74
Density: 4.792 g/cm^3 (gray) (20°C)
Melting point: 217°C (gray) **Boiling point:** 684.9 ± 1.0°C
Latent heat of fusion: 68.93 J/g
Specific heat: 0.1606 J/g/°C (Se_2) (25°C)
Coefficient of lineal thermal expansion: 36.8 cm/cm/°C (20°C)
Thermal conductivity: 0.0452 w/cm/°C (along C-axis at 25°C)
Electrical resistivity: 1 ohm-cm (20°C)
Ionization potential (1st): 9.752 eV
Electron work function ϕ: 5.9 eV
Oxidation potential: $Se + 3H_2O \rightarrow H_2SeO_3 + 4H^+ + 4\epsilon = -0.740$ V
Chemical valence: −2, *4*, 6
Electrochemical equivalents: 0.73650 g/amp-hr
Ionic radius: 0.50 Å (Se^{4+})
Valence electron potential (−εV): 120
Principal quantum number: 4
Principal electron shells: K L M N
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^4$
Valence electrons: $4s^2\ 4p^4$
Crystal forms: Hexagonal, monoclinic, amorphous
Cross section σ: 12.2 ± 0.6 barns
Vapor pressure: 6.95×10^{-1} Pa (at melting point)

Si Silicon

14

28.0855

IVA

12.011 C 6
28.0855 Si 14
72.59 Ge 32
118.69 Sn 50
207.2 Pb 82

Silício
Silicium
Silizium
Silicio
кремний
צורן
硅 珪素

Naturally occurring isotopes: 28, 29, 30
Density: 2.329 g/cm^3 (25°C)
Melting point: 1410°C **Boiling point:** 2355°C
Latent heat of fusion: 1.655 J/g
Specific heat: 0.712 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 4.2 × 10^{-6} cm/cm/°C (25°C)
Thermal conductivity: 1.49 w/cm/°C (25°C)
Electrical resistivity: 3.5 ohm-cm (20°C)
Ionization potential (1st): 8.151 eV
Electron work function ϕ: 4.52 eV
Oxidation potential: $Si + 2H_2O \rightarrow SiO_2 + 4H^+ + 4\epsilon = 0.857$ V
Chemical valence: $-4, -1, 1, \mathit{4}$
Electrochemical equivalents: 0.26197 g/amp-hr
Ionic radius: 0.400 Å (Si^{4+})
Valence electron potential ($-\varepsilon$V): 144
Principal quantum number: 3
Principal electron shells: K L M
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$
Valence electrons: $3s^2\ 3p^2$
Crystal form: Cubic, diamond
Cross section σ: 160 ± 20 mbarns
Vapor pressure: 4.77 Pa (at melting point)

Ag Silver

47

107.868

IB

63.546
Cu
29
107.868
Ag
47
196.9665
Au
79

Prata
Argent
Silber
Plata
серебро
כסף
銀 銀

Naturally occurring isotopes: 107, 109
Density: 10.50 g/cm^3 (20°C)
Melting point: 961.93°C **Boiling point:** 2212°C
Latent heat of fusion: 104.8 J/g
Specific heat: 0.2350 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 18.62 $\times$ 10^{-6} cm/cm/°C (17°C)
Thermal conductivity: 4.29 w/cm/°C (25°C)
Electrical resistivity: 1.586 $\times$ 10^{-6} ohm-cm (20°C)
Ionization potential (1st): 7.576 eV
Electron work function ϕ: 4.26 eV
Oxidation potentials: $Ag \rightarrow Ag^+ + \epsilon = -0.7991$ V
$Ag^+ \rightarrow Ag^{2+} + \epsilon = -1.980$ V
Chemical valence: *1*, 2, 3
Electrochemical equivalents: 4.0246 g/amp-hr
Ionic radius: 1.26 Å (Ag^+)
Valence electron potential ($-\varepsilon$V): 11.4
Principal quantum number: 5
Principal electron shells: K L M N O
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 5s^1$
Valence electrons: $(4d^{10})\ 5s^1$
Crystal form: Cubic, face centered
Cross section σ: 63.8 $\pm$ 0.6 barns
Vapor pressure: 3.42 $\times$ 10^{-1} Pa (at melting point)

Na Sodium

11

22.98977

IA

1.0079 H 1
6.941 Li 3
22.98977 Na 11
39.098 K 19
85.4678 Rb 37
132.9054 Cs 55
223.01976 Fr 87

Sódio
Sodium
Natrium
Sodio
натрий
נתרן
鈉 ナトリウム

Naturally occurring isotopes: 23
Density: 0.9712 g/cm^3 (20°C)
Melting point: 97.81 ± 0.03°C **Boiling point:** 882.9°C
Latent heat of fusion: 113 J/g
Specific heat: 1.23 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 72 × 10^{-6} cm/cm/°C (25°C)
Thermal conductivity: 1.42 w/cm/°C (25°C)
Electrical resistivity: 4.33 × 10^{-6} ohm-cm (0°C)
Ionization potential (1st): 5.139 eV
Electron work function ϕ: 2.75 eV
Oxidation potential: $Na \rightarrow Na^+ + \epsilon = 2.714$ V
Chemical valence: 1
Electrochemical equivalents: 0.85775 g/amp-hr
Ionic radius: 1.02 Å (Na^+)
Valence electron potential ($-\varepsilon$V): 14.1
Principal quantum number: 3
Principal electron shells: K L M
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^1$
Valence electrons: $3s^1$
Crystal form: Cubic, body centered
Cross section σ: 534 ± 5 mbarns
Vapor pressure: 1.43 × 10^{-5} Pa (at melting point)

Sr Strontium

38

87.62

IIA

9.01218 Be 4
24.305 Mg 12
40.08 Ca 20
87.62 Sr 38
137.34 Ba 56
226.02544 Ra 88

Estrôncio
Strontium
Strontium
Estroncio
стронций
סטרונציום
鍶 ストロンチウム

Naturally occurring isotopes: 88, 86, 87, 84
Density: 2.54 g/cm^3 (20°C)
Melting point: 769°C **Boiling point:** 1384°C
Latent heat of fusion: 105.1 J/g
Specific heat: 0.30 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 21 × 10^{-6} cm/cm/°C (25°C)
Thermal conductivity: 0.354 w/cm/°C (25°C)
Electrical resistivity: 23 × 10^{-6} ohm-cm (20°C)
Ionization potential (1st): 5.695 eV
Electron work function ϕ: 2.59 eV
Oxidation potential: $Sr \rightarrow Sr^{2+} + 2\epsilon = 2.888$ V
Chemical valence: 2
Electrochemical equivalents: 1.635 g/amp-hr
Ionic radius: 1.12 Å (Sr^{2+})
Valence electron potential ($-\epsilon V$): 25.7
Principal quantum number: 5
Principal electron shells: K L M N O
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 5s^2$
Valence electrons: $5s^2$
Crystal form: Cubic, face centered
Cross section σ: 1.21 ± 0.06 barns
Vapor pressure: 2.46 × 10^2 Pa (at melting point)

Sulfur

16

32.06

VIA

15.9994 O 8
32.06 S 16
78.96 Se 34
127.60 Te 52
208.98243 Po 84

Enxôfre

Soufre

Schwefel

Azufre

cepa

גפרית

硫 硫黄

Naturally occurring isotopes: 32, 34, 33, 36
Density: 2.07 g/cm^3 (rhombic form at 25°C)
Melting point: 112.8°C **Boiling point:** 444.674°C
Latent heat of fusion: 44.01 J/g
Specific heat: 0.706 J/g/°C (rhombic) (25°C)
Coefficient of lineal thermal expansion: 64.13 × 10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 2.70 mw/cm/°C (25°C)
Electrical resistivity: 2 × 10^{17} ohm-cm (20°C)
Ionization potential (1st): 10.360 eV
Oxidation potentials: $S + 3H_2O \rightarrow H_2SO_3 + 4H^+ + 4\epsilon = -0.45$ V
$S^{2-} \rightarrow S + 2\epsilon = 0.447$ V
Chemical valence: −2, *4*, 6
Electrochemical equivalents: 0.2990 g/amp-hr
Ionic radius: 0.37 Å (S^{4+})
Valence electron potential (−εV): 160
Principal quantum number: 3
Principal electron shells: K L M
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$
Valence electrons: $3s^2\ 3p^4$
Crystal form: Orthorhombic
Cross section σ: 0.51 barns
Vapor pressure: 2.65 × 10^{-20} Pa (at melting point)

Ta Tantalum

73

180.9479

VB

50.9415 V 23
92.9064 Nb 41
180.9479 Ta 73
105

Tantálio
Tantale
Tantal
Tántalo
тантал
טנטל
鉭 タンタル

Naturally occurring isotopes: 181, 180
Density: 16.60 g/cm^3 (20°C)
Melting point: 2996°C **Boiling point:** 5425 ± 100°C
Latent heat of fusion: 174 J/g
Specific heat: 0.140 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 6.5 × 10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 0.575 w/cm/°C (25°C)
Electrical resistivity: 12.45 × 10^{-6} ohm-cm (25°C)
Ionization potential (1st): 7.89 eV
Electron work function ϕ: 4.25 eV
Oxidation potential: $2Ta + 5H_2O \rightarrow Ta_2O_5 + 10H^+ + 10\epsilon = 0.812$ V
Chemical valence: 3, 4, *5*
Electrochemical equivalents: 1.3502 g/amp-hr
Ionic radius: 0.64 Å (Ta^{5+})
Valence electron potential (−εV): 110
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^3\ 6s^2$
Valence electrons: $5d^3\ 6s^2$
Crystal form: Cubic, body centered
Cross section σ: 22 ± 1 barns
Vapor pressure: 7.76 × 10^{-1} Pa (at melting point)

Tc Technetium

43

96.906

VIIB

54.9380 Mn 25
96.906 Tc 43
186.2 Re 75
107

Tecnécio
Technetium
Technetium
Tecnecio
технеций
טכנציום
鎝 テクネチウム

Naturally occurring isotopes: None
Density: 11.496 g/cm^3 (25°C)
Melting point: 2172°C **Boiling point:** 4877°C
Latent heat of fusion: 235 ± 5 J/g
Specific heat: 0.24 J/g/°C (25°C)
Thermal conductivity: 0.506 w/cm/°C (25°C)
Ionization potential (1st): 7.28 eV
Oxidation potential: $Tc \rightarrow Tc^{2+} + 2\epsilon = -0.4$ V
Chemical valence: 0, 1, 2, 3, 4, 5, 6, 7
Electrochemical equivalents: 0.51651 g/amp-hr
Ionic radius: 0.56 Å (Tc^{7+})
Valence electron potential (−εV): 180
Principal quantum number: 5
Principal electron shells: K L M N O
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^6\ 5s^1$
Valence electrons: $4d^6\ 5s^1$
Crystal form: Hexagonal, close packed
Half life: 2.6×10^6 years
Vapor pressure: 2.29×10^{-2} Pa (at melting point)

Te Tellurium

52

127.60

VIA

15.9994 O 8
32.06 S 16
78.96 Se 34
127.60 Te 52
208.98243 Po 84

Telúrio
Tellure
Tellur
Telurio
теллур
טלור
碲 テルル

Naturally occurring isotopes: 130, 128, 126, 125, 124, 122, 123
Density: 6.24 g/cm^3 (20°C)
Melting point: 449.5 ± 0.3°C **Boiling point:** 989.8 ± 3.8°C
Latent heat of fusion: 137.2 J/g
Specific heat: 0.202 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 16.75 × 10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 0.0338 w/cm/°C (along C-axis at 25°C)
Electrical resistivity: 4.36 ohm-cm (25°C)
Ionization potential (1st): 0.009 eV
Electron work function ϕ**:** 4.95 eV
Oxidation potential: $Te + 2H_2O \rightarrow TeO_2 + 4H^+ + 4\epsilon = -0.529$ V
Chemical valence: −2, 2, *4*, 6
Electrochemical equivalents: 1.1902 g/amp-hr
Ionic radius: 0.97 Å (Te^{4+})
Valence electron potential ($-\varepsilon$**V):** 59
Principal quantum number: 5
Principal electron shells: K L M N O
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 5s^2\ 5p^4$
Valence electrons: $5s^2\ 5p^4$
Crystal form: Hexagonal
Cross section σ**:** 4.7 ± 0.1 barns
Vapor pressure: 2.31 × 10 Pa (at melting point)

Tb Terbium

65

158.9254

Térbio
Terbium
Terbium
Terbio
тербий
טרביום
鉞 テルビウム

Lanthanide Series

140.12 Ce 58	140.9077 Pr 59	144.24 Nd 60	144.913 Pm 61	150.4 Sm 62	151.96 Eu 63	157.25 Gd 64	158.9254 Tb 65	162.50 Dy 66	164.9304 Ho 67
167.26 Er 68	168.9342 Tm 69	173.04 Yb 70	174.97 Lu 71						

Naturally occurring isotope: 159
Density: 8.229 g/cm^3 (25°C)
Melting point: 1356°C **Boiling point:** 3123°C
Latent heat of fusion: 102.7 J/g
Specific heat: 0.182 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 11.8 × 10^{-6} cm/cm/°C (25°C)
Thermal conductivity: 0.111 w/cm/°C (25°C)
Electrical resistivity: 116 × 10^{-6} ohm-cm (25°C)
Ionization potential (1st): 5.85 eV
Electron work function ϕ: 3.0 eV
Oxidation potential: Tb → Tb^{3+} + 3ϵ = 2.391 V
Chemical valence: *3*, 4
Electrochemical equivalents: 1.9765 g/amp-hr
Ionic radius: 0.923 Å (Tb^{3+})
Valence electron potential (−εV): 46.8
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^9\ 5s^2\ 5p^6\ 6s^2$
Valence electrons: $4f^9\ 6s^2$
Crystal form: Hexagonal, close packed
Cross section σ: 30 ± 10 barns

Tl Thallium

81

204.37

IIIA

10.81
B
5
26.98154
Al
13
69.72
Ga
31
114.82
In
49
204.37
Tl
81

Tálio
Thallium
Thallium
Talio
таллий
תליום
鉈 タリウム

Naturally occurring isotopes: 205, 203
Density: 11.85 g/cm^3 (20°C)
Melting point: 303.5°C **Boiling point:** 1457 ± 10°C
Latent heat of fusion: 20.90 J/g
Specific heat: 0.129 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 28 × 10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 0.461 w/cm/°C (25°C)
Electrical resistivity: 18.0 × 10^{-6} ohm-cm (0°C)
Ionization potential (1st): 6.108 eV
Electron work function ϕ: 3.84 eV
Oxidation potentials: $Tl \rightarrow Tl^+ + \epsilon = 0.3363$ V
$Tl^+ \rightarrow Tl^{3+} + 2\epsilon = -1.25$ V
Chemical valence: *1,* 3
Electrochemical equivalents: 7.6250 g/amp-hr
Ionic radius: 1.50 Å (Tl^+)
Valence electron potential (−εV): 9.60
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^{10}\ 6s^2\ 6p^1$
Valence electrons: $6s^2\ 6p^1$
Crystal form: Hexagonal, close packed
Cross section σ: 3.4 ± 0.5 barns
Vapor pressure: 5.33 × 10^{-6} Pa (at melting point)

Th Thorium

90

232.03807

Actinide Series

232.03807 Th 90	231.0359 Pa 91	238.029 U 92	237.0482 Np 93	244.06423 Pu 94	243.0614 Am 95	247.07038 Cm 96	247.07032 Bk 97	251.07981 Cf 98	254.08805 Es 99
257.09515 Fm 100	258 Md 101	259 No 102	260 Lr 103						

Tório
Thorium
Thorium
Torio
торий
תוריום
針 トリウム

Naturally occurring isotope: 232
Density: 11.724 g/cm^3 (25°C)
Melting point: 1750°C **Boiling point:** 4787°C
Latent heat of fusion: 82.93 J/g
Specific heat: 0.118 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 12.5 $\times$ 10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 0.540 w/cm/°C (25°C)
Electrical resistivity: 13.1 $\times$ 10^{-6} ohm-cm (25°C)
Ionization potential (1st): 6.08 eV
Electron work function ϕ: 3.41 eV
Oxidation potential: $Th \rightarrow Th^{4+} + 4\epsilon = 1.899$ V
Chemical valence: 3, *4*
Electrochemical equivalents: 2.1643 g/amp-hr
Ionic radius: 0.972 Å (Th^{4+})
Valence electron potential ($-\varepsilon$V): 59.3
Principal quantum number: 7
Principal electron shells: K L M N O P Q
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^{10}\ 6s^2\ 6p^6\ 6d^2\ 7s^2$
Valence electrons: $6d^2\ 7s^2$
Crystal form: Cubic, face centered
Half life: 1.40 $\times$ 10^{10} years
Cross section σ: 74 $\pm$ 0.1 barns

Tm Thulium

69

168.9342

Lanthanide Series

140.12 Ce 58	140.9077 Pr 59	144.24 Nd 60	144.913 Pm 61	150.4 Sm 62	151.96 Eu 63	157.25 Gd 64	158.9254 Tb 65	162.50 Dy 66	164.9304 Ho 67
167.26 Er 68	168.9342 Tm 69	173.04 Yb 70	174.97 Lu 71						

Túlio

Thulium

Thulium

Tulio

тулий

תוליום

銩 ツリウム

Naturally occurring isotope: 169
Density: 9.321 g/cm^3 (25°C)
Melting point: 1545 ± 15°C **Boiling point:** 1727°C
Latent heat of fusion: 109.0 J/g
Specific heat: 0.160 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 11.6 × 10^{-6} cm/cm/°C (400°C)
Thermal conductivity: 0.169 w/cm/°C (25°C)
Electrical resistivity: 79 × 10^{-6} ohm-cm (25°C)
Ionization potential (1st): 6.1844 eV
Oxidation potential: Tm → Tm^{3+} + 3ϵ = 2.278 V
Chemical valence: 2, *3*
Electrochemical equivalents: 2.1010 g/amp-hr
Ionic radius: 0.869 Å (Tm^{3+})
Valence electron potential (−εV): 49.7
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{13}\ 5s^2\ 5p^6\ 6s^2$
Valence electrons: $4f^{13}\ 6s^2$
Crystal form: Hexagonal, close packed
Cross section σ: 115 ± 15 barns
Vapor pressure: 4.90 × 10^{-3} Pa (at melting point)

Sn Tin

50

118.69

IVA

12.011
C
6
28.0855
Si
14
72.59
Ge
32
118.69
Sn
50
207.2
Pb
82

Estanho
Etain
Zinn
Estaño
олово
בדיל
錫 すず

Naturally occurring isotopes: 120, 118, 116, 119, 117, 124, 122, 112, 114, 115
Density: 7.298 g/cm^3 (25°C)
Melting point: 231.9681°C **Boiling point:** 2270°C
Latent heat of fusion: 60.67 J/g
Specific heat: 0.227 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 23×10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 0.668 w/cm/°C (25°C)
Electrical resistivity: 11.5×10^{-6} ohm-cm (20°C)
Ionization potential (1st): 7.334 eV
Electron work function ϕ: 4.42 eV
Oxidation potentials: $Sn \rightarrow Sn^{2+} + 2\epsilon = 0.136$ V
$Sn^{2+} \rightarrow Sn^{4+} + 2\epsilon = -0.15$ V
Chemical valence: $-4, -1, 2, \mathit{4}$
Electrochemical equivalents: 1.1071 g/amp-hr
Ionic radius: 0.690 Å (Sn^{4+})
Valence electron potential ($-\varepsilon$V): 83.5
Principal quantum number: 5
Principal electron shells: K L M N O
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 5s^2\ 5p^2$
Valence electrons: $5s^2\ 5p^2$
Crystal form: Tetragonal
Cross section σ: 0.63 ± 0.1 barns
Vapor pressure: 5.78×10^{-21} Pa (at melting point)

Ti Titanium

22

47.90

IVB

47.90
Ti
22
91.22
Zr
40
178.49
Hf
72
104

Titânio
Titane
Titan
Titanio
ТИТАН
טיטניום
鈦 チタン

Naturally occurring isotopes: 48, 46, 47, 49, 50
Density: 4.507 g/cm^3 (20°C)
Melting point: 1660 ± 10°C **Boiling point:** 3287°C
Latent heat of fusion: 323.4 J/g
Specific heat: 0.522 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 8.41 × 10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 0.219 w/cm/°C (25°C)
Electrical resistivity: 42 × 10^{-6} ohm-cm (20°C)
Ionization potential (1st): 6.82 eV
Electron work function ϕ**:** 4.33 eV
Oxidation potential: $Ti \rightarrow Ti^{2+} + 2\epsilon = 1.628$ V
Chemical valence: 1, 2, 3, *4*
Electrochemical equivalents: 0.4468 g/amp-hr
Ionic radius: 0.605 Å (Ti^{4+})
Valence electron potential ($-\varepsilon$**V):** 95.2
Principal quantum number: 4
Principal electron shells: K L M N
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^2\ 4s^2$
Valence electrons: $3d^2\ 4s^2$
Crystal form: Hexagonal, close packed
Cross section σ**:** 6.1 ± 0.2 barns
Vapor pressure: 4.90 × 10^{-1} Pa (at melting point)

W Tungsten

74

183.85

VIB

51.996
Cr
24
95.94
Mo
42
183.85
W
74
106

Tungstênio
Tungstène
Wolframz
Tungsteno
вольфрам
וולפרם
鎢 タングステン

Naturally occurring isotopes: 184, 186, 182, 183, 180
Density: 19.35 g/cm^3 (20°C)
Melting point: 3410 ± 20°C **Boiling point:** 5660°C
Latent heat of fusion: 191.7 J/g
Specific heat: 0.125 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 4.6 × 10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 1.73 w/cm/°C (25°C)
Electrical resistivity: 5.65 × 10^{-6} ohm-cm (27°C)
Ionization potential (1st): 7.98 eV
Electron work function ϕ: 4.55 eV
Oxidation potential: $W + 3H_2O \rightarrow WO_3 + 6H^+ + 6\epsilon = 0.09$ V
Chemical valence: 2, 3, 4, 5, *6*
Electrochemical equivalents: 1.1432 g/amp-hr
Ionic radius: 0.62 Å (W^{6+})
Valence electron potential ($-\varepsilon$V): 140
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^4\ 6s^2$
Valence electrons: $5d^4\ 6s^2$
Crystal form: Alpha—cubic, body centered; beta—cubic, face centered
Cross section σ: 18.5 ± 0.5 barns
Vapor pressure: 4.27 Pa (at melting point)

U Uranium

92

238.029

Actinide Series

232.03807 Th 90	231.0359 Pa 91	238.029 U 92	237.0482 Np 93	244.06423 Pu 94	243.0614 Am 95	247.07038 Cm 96	247.07032 Bk 97	251.07981 Cf 98	254.08805 Es 99
257.09515 Fm 100	258 Md 101	259 No 102	260 Lr 103						

Urânio
Uranium
Uran
Uranio
уран
אורניום
鈾 ウラニウム

Naturally occurring isotopes: 238, 235, 234
Density: 19.04 g/cm^3 (25°C)
Melting point: 1132.3 ± 0.8°C **Boiling point:** 3818°C
Latent heat of fusion: 65.08 J/g
Specific heat: 0.1162 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 13.4 × 10^{-6} cm/cm/°C (25°C)
Thermal conductivity: 0.275 w/cm/°C (25°C)
Electrical resistivity: 27 × 10^{-6} ohm-cm (25°C)
Ionization potential (1st): 6.05 eV
Electron work function ϕ**:** 3.63 eV
Oxidation potential: $U \rightarrow U^{3+} + 3\epsilon = 1.789$ V
Chemical valence: 3, 4, 5, *6*
Electrochemical equivalents: 1.4801 g/amp-hr
Ionic radius: 0.52 Å (U^{6+})
Valence electron potential ($-\varepsilon$**V):** 170
Principal quantum number: 7
Principal electron shells: K L M N O P Q
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^{10}\ 5f^3\ 6s^2\ 6p^6\ 6d^1\ 7s^2$
Valence electrons: $5f^3\ 6d^1\ 7s^2$
Crystal form: Orthorhombic
Half life: 4.51 × 10^9 years
Cross section σ**:** 7.595 ± 0.070 barns
Vapor pressure: 1.19 × 10^{-6} Pa (at melting point)

Vanadium

23

50.9415

VB

50.9415 V 23
92.9064 Nb 41
180.9479 Ta 73
105

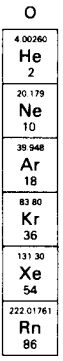
Vanádio
Vanadium
Vanadium
Vanadio
ванадий
ונדיום
釩 バナジウム

Naturally occurring isotopes: 51, 50
Density: 6.11 g/cm^3 (18.7°C)
Melting point: 1890 ± 10°C **Boiling point:** 3380°C
Latent heat of fusion: 345.2 J/g
Specific heat: 0.489 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 6.15 × 10^{-6} cm/cm/°C (25°C)
Thermal conductivity: 0.307 w/cm/°C (25°C)
Electrical resistivity: 24.8 × 10^{-6} ohm-cm (20°C)
Ionization potential (1st): 6.74 eV
Electron work function ϕ: 4.3 eV
Oxidation potential: $V \rightarrow V^{2+} + 2\epsilon = 1.186$ V
Chemical valence: 2, 3, 4, *5*
Electrochemical equivalents: 0.38013 g/amp-hr
Ionic radius: 0.59 Å (V^{5+})
Valence electron potential ($-\epsilon$V): 120
Principal quantum number: 4
Principal electron shells: K L M N
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3\ 4s^2$
Valence electrons: $3d^3\ 4s^2$
Crystal form: Cubic, body centered
Cross section σ: 5.06 ± 0.06 barns
Vapor pressure: 3.06 Pa (at melting point)

Xe Xenon

54

131.30



Xenônio
Xénon
Xenon
Xenón
КСЕНОН
כסנון
氙 キセノン

Naturally occurring isotopes: 132, 129, 131, 134, 136, 130, 128, 124, 126
Density: 5.895×10^{-3} g/cm^3 (20°C)
Melting point: −111.9°C **Boiling point:** −107.1 ± 3°C
Latent heat of fusion: 17.5 J/g
Specific heat: 0.15831 J/g/°C (25°C)
Thermal conductivity: 0.514 mw/cm/°C (0°C at 1 atm)
Ionization potential (1st): 12.130 eV
Chemical valence: 0
Principal quantum number: 5
Principal electron shells: K L M N O
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 5s^2\ 5p^6$
Valence electrons: ($5s^2\ 5p^6$)
Crystal form: Cubic, face centered
Cross section σ: 24.5 ± 1.0 barns

Yb Ytterbium

70

173.04

Lanthanide Series

140.12 Ce 58	140.9077 Pr 59	144.24 Nd 60	144.913 Pm 61	150.4 Sm 62	151.96 Eu 63	157.25 Gd 64	158.9254 Tb 65	162.50 Dy 66	164.9304 Ho 67
167.26 Er 68	168.9342 Tm 69	173.04 Yb 70	174.97 Lu 71						

Itérbio
Ytterbium
Ytterbium
Iterbio
иттербий
איטרביום
鐿 イッテルビウム

Naturally occurring isotopes: 174, 172, 173, 171, 176, 170, 168
Density: 6.965 g/cm^3 (25°C)
Melting point: 819°C **Boiling point:** 1194°C
Latent heat of fusion: 53.23 J/g
Specific heat: 0.155 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 29.9 × 10^6 cm/cm/°C (25°C)
Thermal conductivity: 0.349 w/cm/°C (25°C)
Electrical resistivity: 28 × 10^{-6} ohm-cm (25°C)
Ionization potential (1st): 6.2539 eV
Oxidation potential: Yb → Yb^{3+} + 3ϵ = 2.267 V
Chemical valence: 2, *3*
Electrochemical equivalents: 2.1520 g/amp-hr
Ionic radius: 0.858 Å (Yb^{3+})
Valence electron potential (−eV): 50.3
Principal quantum number: 6
Principal electron shells: K L M N O P
Electronic configuration: 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 4f^{14} 5s^2 5p^6 6s^2
Valence electrons: 4f^{14} 6s^2
Crystal form: Cubic, face centered
Cross section σ: 37 ± 3 barns
Vapor pressure: 3.95 × 10^2 Pa (at melting point)

Y Yttrium

39

88.9059

IIIB

44.95592 Sc 21
88.9059 Y 39
138.9055 La 57
227.02777 Ac 89

Itrio
Yttrium
Yttrium
Itrio
иттрий
איטריום
钇 イットリウム

Naturally occurring isotope: 89
Density: 4.469 g/cm^3 (25°C)
Melting point: 1522°C **Boiling point:** 3338°C
Latent heat of fusion: 193.1 J/g
Specific heat: 0.298 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 10.8×10^{-6} cm/cm/°C (400°C)
Thermal conductivity: 0.172 w/cm/°C (25°C)
Electrical resistivity: 57×10^{-6} ohm-cm (25°C)
Ionization potential (1st): 6.38 eV
Electron work function ϕ: 3.1 eV
Oxidation potential: $Y \rightarrow Y^{3+} + 3\epsilon = 2.372$ V
Chemical valence: 3
Electrochemical equivalents: 1.1057 g/amp-hr
Ionic radius: 0.900 Å (Y^{3+})
Valence electron potential ($-\varepsilon$V): 48.0
Principal quantum number: 5
Principal electron shells: K L M N O
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^1\ 5s^2$
Valence electrons: $4d^1\ 5s^2$
Crystal form: Hexagonal, close packed
Cross section σ: 1.3 ± 0.1 barns
Vapor pressure: 5.31 Pa (at melting point)

Zn Zinc

30

65.38

IIB

65.38 Zn 30
112.41 Cd 48
200.59 Hg 80

Zinco
Zinc
Zink
Zinc
цинк
אבץ
鋅 亜鉛

Naturally occurring isotopes: 64, 66, 68, 67, 70
Density: 7.133 g/cm^3 (25°C)
Melting point: 419.58°C **Boiling point:** 907°C
Latent heat of fusion: 113.0 J/g
Specific heat: 0.388 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 39.7 $\times$ 10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 1.16 w/cm/°C (25°C)
Electrical resistivity: 5.916 $\times$ 10^{-6} ohm-cm (20°C)
Ionization potential (1st): 9.394 eV
Electron work function ϕ: 4.33 eV
Oxidation potential: $Zn \rightarrow Zn^{2+} + 2\epsilon = 0.7628$ V
Chemical valence: 2
Electrochemical equivalents: 1.220 g/amp-hr
Ionic radius: 0.740 Å (Zn^{2+})
Valence electron potential ($-\varepsilon$V): 38.9
Principal quantum number: 4
Principal electron shells: K L M N
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2$
Valence electrons: $4s^2$
Crystal form: Hexagonal, close packed
Cross section σ: 1.10 $\pm$ 0.04 barns
Vapor pressure: 19.2 Pa (at melting point)

Zr Zirconium

40

91.22

IVB

47.90 Ti 22
91.22 Zr 40
178.49 Hf 72
104

Zircônio
Zirconium
Zirkonium
Zirconio
цирконий
צירקוניום
鋯 ジルコニウム

Naturally occurring isotopes: 90, 94, 92, 91, 96
Density: 6.506 g/cm^3 (20°C)
Melting point: 1852 ± 2°C **Boiling point:** 4377°C
Latent heat of fusion: 251.2 J/g
Specific heat: 0.278 J/g/°C (25°C)
Coefficient of lineal thermal expansion: 5.85 × 10^{-6} cm/cm/°C (20°C)
Thermal conductivity: 0.227 w/cm/°C (27°C)
Electrical resistivity: 40 × 10^{-6} ohm-cm (20°C)
Ionization potential (1st): 6.84 eV
Electron work function ϕ: 4.05 eV
Oxidation potential: $Zr \rightarrow Zr^{4+} + 4\epsilon = 1.529$ V
Chemical valence: 1, 2, 3, *4*
Electrochemical equivalents: 0.8509 g/amp-hr
Ionic radius: 0.72 Å (Zr^{4+})
Valence electron potential (−eV): 80
Principal quantum number: 5
Principal electron shells: K L M N O
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^2\ 5s^2$
Valence electrons: $4d^2\ 5s^2$
Crystal form: Hexagonal, close packed
Cross section σ: 0.182 ± 0.005 barns
Vapor pressure: 1.68 × 10^{-3} Pa (at melting point)

Element 104

Kurchatovium
Rutherfordium

104

261

IVB

47.90
Ti
22
91.22
Zr
40
178.49
Hf
72
104

Naturally occurring isotopes: None
Chemical valence: 4
Principal quantum number: 7
Principal electron shells: K L M N O P Q
Electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^{10}\ 5f^{14}\ 6s^2\ 6p^6\ 6d^2\ 7s^2$
Valence electrons: $6d^2\ 7s^2$
Half life: ~65 seconds

Element 105 Nielsbohrium Hahnium

105

(262)

VB

50.9415 V 23
92.9064 Nb 41
180.9479 Ta 73
105

Naturally occurring isotopes: None
Chemical valence: (5)
Principal quantum number: 7
Principal electron shells: K L M N O P Q
Half life: ~40 seconds

Element
106

106

(263)

VIB

51.996 Cr 24
95.94 Mo 42
183.85 W 74
106

Naturally occurring isotopes: None
Chemical valence: (6)
Principal quantum number: 7
Principal electron shells: K L M N O P Q
Half life: ~1 second

Element
107

107
(262)

VIIB

54.9380
Mn
25
96.906
Tc
43
186.2
Re
75
107

Naturally occurring isotopes: None
Chemical valence: (7)
Principal quantum number: 7
Principal electron shells: K L M N O P Q

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Canadian Journal of Chemistry
Canadian Journal of Physics
Chemical and Engineering News
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Chemische Berichte
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Helvetica Chimica Acta
Inorganic Chemistry
Journal of American Chemical Society
Journal of Applied Physics
Journal of Chemical and Engineering Data
Journal of Chemical Education
Journal of Chemical Physics
Journal of Inorganic and Nuclear Chemistry
Journal of Less-Common Metals
Journal of Physical and Chemical Reference Data
Journal of Physical Chemistry
Journal of Physics and Chemistry of Solids
Journal of Solid State Chemistry
Journal of the Chemical Society
Journal of the Electrochemical Society
Materials Research Bulletin
Nature
Physical Review
Proceedings of the Physical Society
Proceedings of the Royal Society
Progress in Inorganic Chemistry
Pure and Applied Chemistry
Science
Talanta
Transactions of the Faraday Society