

This is "Appendix: Periodic Table of the Elements", appendix 1 from the book <u>Beginning Chemistry (index.html)</u> (v. 1.0).

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Appendix: Periodic Table of the Elements

In this chapter, we present some data on the chemical elements. The periodic table, introduced in <u>Chapter 3 "Atoms, Molecules, and Ions"</u>, lists all the known chemical elements, arranged by atomic number (that is, the number of protons in the nucleus). The periodic table is arguably the best tool in all of science; no other branch of science can summarize its fundamental constituents in such a concise and useful way. Many of the physical and chemical properties of the elements are either known or understood based on their positions on the periodic table. Periodic tables are available with a variety of chemical and physical properties listed in each element's box. What follows here is a more complex version of the periodic table than what was presented in <u>Chapter 3 "Atoms, Molecules, and Ions"</u>. The Internet is a great place to find periodic tables that contain additional information.

One item on most periodic tables is the atomic mass of each element. For many applications, only one or two decimal places are necessary for the atomic mass. However, some applications (especially nuclear chemistry; see <u>Chapter 15 "Nuclear Chemistry"</u>) require more decimal places. The atomic masses in <u>Table 17.1 "The Basics of the Elements of the Periodic Table"</u> represent the number of decimal places recognized by the International Union of Pure and Applied Chemistry, the worldwide body that develops standards for chemistry. The atomic masses of some elements are known very precisely, to a large number of decimal places. The atomic masses of other elements, especially radioactive elements, are not known as precisely. Some elements, such as lithium, can have varying atomic masses depending on how their isotopes are isolated.

The web offers many interactive periodic table resources. For example, see <u>http://www.ptable.com</u>.

			or most st 1st ioniza	atomic mas: able mass number tion energy in kJ/mo	55.8 762.5	45 <u>2</u>	6 ato +6 +5 ele	omic numbe ctronegativi	r ity
	group 1		cher	nical symbo	┉┤┢€	2	+4 +3 +2		
	1.00794 1			name	Iron	<u> </u>	-1 oxi	dation state	s
period 1	H		electron o	onfiguration	n — [Ar] 3d	⁶ 4s ²			
	Hydrogen 15'	2	_	ماليمان سيمغما		مارمام			
	6.941 3	9.012182 4	📕	alkalino mo	tala no	nmotals			
2	li ³	Re		other metal	s ha	logens			
	Lithium	Beryllium 15 ¹ 25 ²		transition m	netals no	ble gases			
	22.98976 11	24.3050 12		lanthanoids	un 🗌 un	known elem	ents		
3	Na	Ma		actinoids	👥 radi	oactive elements l	nave		
	Sodium	Magnesium	3	4	mas 5	ses in parenthesis 6	7	8	9
	39.0983 19	40.078 20	44.95591 21	47.867 22	50.9415 23	51.9962 24	54.93804 25	55.845 26	58.93319 2
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co
	Potassium (Ar) 45 ⁴	Calcium (Ar) 45 ²	Scandium (Ar) 3d ¹ 4s ²	Titanium (Ae) 3d ³ 4s ²	Vanadium Ar 3d ⁴ 4s ⁴	Chromium	Manganese (Ar) 3d ⁶ 4s ³	Iron -1 (Ae) 3d ⁴ 4s ²	Cobalt (Ar) 3d ² 4s ²
	85.4678 37	87.62 38	88.90585 39	91.224 40	92.90638 41	95.96 42	(98) 43	101.07 44	102.9055 4
5	Rubidium Rubidium	Sr Strontium	Yttrium	Zirconium	Nb Niobium	Mo	Tc Technetium	Ruthenium	Rhodium
	132.9054 55	137.327 56	174.9668 71	178.49 72	180.9478 73	183.84 74	186.207 75	190.23 76	192.217 7
6	Caesium taitei	Barium Barium	Lutetium	Hafnium Date: Sef or	Tantalum Det 41" set set	Tungsten	Re	Osmium Desting set of	Iridium
	(223) 87	(226) 88	(262) 103	(261) 104	(262) 105	(266) 106	(264) 107	(277) 108	(268) 109
7	Francium Bei 25	Radium (Pa) 25	Lawrencium (h) 5f ⁴ 75 ² 7p ²	Rutherfordium	Dubnium **	Seattorgium	Bh	Hs	Mt
			138.9054 57 S383 1.00 57 Lanthanum	140.116 5344 1.12 58 Cerium Det 41 56 64	140.9076 59 5270 1.13 59 Praseodymium Det 41°34"	144.242 533.1 1.14 60 Neodynium Det 41"44"	(145) 61 5410 61 Promethium Ixet eff ce ¹	150.36 5445 1.17 62 5 Samarium Samarium	151.964 63 547.1 63 Europium
			(227) 89	232.0380 90	231.0358 91	238.0289 92	(237) 93	(244) 94	(243) 94
			Actinium (http://bit/bit/	Thorium	Pa Protactinium Brej St ⁴ ed 73 ²	Uranium	Np	Plutonium	Americium (Rr) St ⁷ 73 ²

The properties listed in each box are introduced throughout the text. Atomic masses may vary by source.

L	electron co	nfiguration blocks							4.002602	2
									He	
s c	a 🛛	P		13	14	15	16	17	15 ²	
f				10.811 5 800.6 2.04 5	12.0107 6 10865 2.55 6	14.0067 7 1402.3 3.04 4	15.9994 8 1313.9 3.44 8		20.1797 2080.7	10
note	es			B	C	N	0	F	Ne	
 as of offici 	yet, element: ial name desi	s 112-118 have no onated by the IUP	AC	Boron 1s' 2s' 2p'	Carbon 3	Nitrogen	Oxygen Ist 2st 2pt	Fluorine 1st 2st 2pt	Neon 15 ² 25 ¹ 2p ⁴	
• 1 kJ/r	mol = 96.485	eV.		26.98153 13	28.0855 14	30.97696 15	32.065 16	35.453 17	39.948	18
 all ele oxida 	ements are in ation state of	rplied to have an zero.		577.5 1.41	7865 1.90	1011.8 2.19	C 1	C 314	1520.6	
	10	11	12	Aluminium (Ne) 33 ^r 5p ¹	Silicon 1	Phosphorus	Sulfer	Chlorine 3	Argon	
58.6	⁹³⁴ 28	63.546 29	65.38 30	69.723 31	72.64 32	74.92160 33	78.96 34		83.798 1550.8 3.00	36
N	1	Cu	Zn	Ga	Ge	As 👘	Se	Br	Kr	
Nick Mi3d	tel ई.क	Copper (A) 3d ⁶ 4s ¹	Zinc (Ar) 3d ^m 4s ²	Gallium (M)3d [®] 4s ¹ 4g ¹	Germanium Ar 3d ¹⁰ 45 ³ 46 ²	Arsenic [Ar] 3d ¹⁰ 4s ² 4p ¹	Selenium (Ar) 3d ⁴⁴ 45 ³ 40 ⁴	Bromine (Ar) 3d ¹¹ 45 ⁴ 49 ⁴	Krypton [Ar] 3d ¹⁰ 45 ¹ 4p ⁴	
106. 804.4	42 ₂₂₀ 46	107.8682 47	112.441 48 867.8 1.69	114.818 49	118.710 50 7086 1.96		127.60 52	126.9044 53	131.293 1170.4 2.60	54
P	d	Aa	Cd	In [®]	Sn [®]	Sb	Те	12025	Xe	2,2,3,2
Palla [67]-46	dium "	Silver poped" set	Cadmium pop 4d ¹⁹ Sa ¹	Indium (10) 4d° 5s² 5p²	Tin (k) 4d ^e ss ² Sp ³	Antimony ptrj4d" st ¹ sp ¹	Tellurium DV:4d ^m Sr ¹ Sp ⁴	lodine (x) 4d° se' sp'	Xenon (Kr) 4d ¹⁰ 5s ² 5p ⁴	
195.	.084 78	196.9665 79	200.59 80	204.3833 81 589.4 1.62	207.2 82	208.9804 83	(210) 84		(220) 1037.0	86
P	t	Au	Ha	TI	Pb 3	Bi	Po	At	Rn	
Plati [Xe] 4	inum Modites'	Gold (Xe) 4f" 5d" 6s'	Mercory (Xe) 41" 54" 56"	Thallium (Xe) 4 ^{er} 5d ^{er} 6e ² 6p ²	Lead (Xe) 4(" 5d" de' 6p"	Bismuth (Ke) 4f" 5d" 6s' 6p'	Polonium (Xe) 4f" 5d" fo' 6p"	Astatine (Xe) 4° sdite' op'	Radon (Xe) 46" 5d" 6e	'op*
(271) 110	(272) 111	(285) 112	(284) 113	(289) 114	(288) 115	(292) 116	117	(294) 1	18
Darr	S	Rg	Copernicium	Ununtrium	Ununquadition	Ununpentium	Ununhexium	Ununseptium	Uununoctiu	C
-										
157.	²⁵ , 64	158.9253 65	162.500 573.0 1.22 66	164.9303 67 581.0 1.23	167.259 68 589.3 1.24	168.9342 69	173.054 70			
Gad	olinium	Tb Terbium	Dyspressium	Ho	Erbium	Tm	Yb			
(247	¹⁾ 96	(247) 97	(251) 98	(252) 99	(257) 100	(258) 101	(259) 102			
10	m 3	DL	Cf i	Ec.	Em	Md	No			
Curi Bol St	um 1° 6d 75 ²	DK Berkelium (Pa) 5f ² 75 ²	Californium (Pn) 5f° 7s ²	ES Einsteinium (Ph) St ^{er} (s ¹	Fermium IRel St ^{er} 7s ¹	Mendelevium Phil Sf ¹⁰ 7s ²	Nobelium (Phi) 5f*7s ³			

Name	Atomic Symbol	Atomic Number	Atomic Mass	Footnotes	
actinium*	Ac	89			
aluminum	Al	13	26.9815386(8)		
americium*	Am	95			
antimony	Sb	51	121.760(1)	g	
argon	Ar	18	39.948(1)	g, r	
arsenic	As	33	74.92160(2)		
astatine*	At	85			
barium	Ва	56	137.327(7)		
berkelium*	Bk	97			
beryllium	Ве	4	9.012182(3)		
bismuth	Bi	83	208.98040(1)		
bohrium*	Bh	107			
boron	В	5	10.811(7)	g, m, r	
bromine	Br	35	79.904(1)		
cadmium	Cd	48	112.411(8)	g	
*Element has no stable nuclides. However, three such elements (Th, Pa, and U) have a characteristic terrestrial isotopic composition, and for these an atomic mass is tabulated.					

Table 17.1 The Basics of the Elements of the Periodic Table

[†]Commercially available Li materials have atomic weights that range between 6.939 and 6.996; if a more accurate value is required, it must be determined for the specific material.

g Geological specimens are known in which the element has an isotopic composition outside the limits for normal material. The difference between the atomic mass of the element in such specimens and that given in the table may exceed the stated uncertainty.

m Modified isotopic compositions may be found in commercially available material because it has been subjected to an undisclosed or inadvertent isotopic fractionation. Substantial deviations in the atomic mass of the element from that given in the table can occur.

Name	Atomic Symbol	Atomic Number	Atomic Mass	Footnotes
caesium (cesium)	Cs	55	132.9054519(2)	
calcium	Са	20	40.078(4)	g
californium*	Cf	98		
carbon	С	6	12.0107(8)	g, r
cerium	Ce	58	140.116(1)	g
chlorine	Cl	17	35.453(2)	g, m, r
chromium	Cr	24	51.9961(6)	
cobalt	Со	27	58.933195(5)	
copernicium*	Cn	112		
copper	Cu	29	63.546(3)	r
curium*	Cm	96		
darmstadtium*	Ds	110		
dubnium*	Db	105		
dysprosium	Dy	66	162.500(1)	g
einsteinium*	Es	99		
erbium	Er	68	167.259(3)	g
europium	Eu	63	151.964(1)	g

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Name	Atomic Symbol	Atomic Number	Atomic Mass	Footnotes
fermium*	Fm	100		
fluorine	F	9	18.9984032(5)	
francium*	Fr	87		
gadolinium	Gd	64	157.25(3)	g
gallium	Ga	31	69.723(1)	
germanium	Ge	32	72.64(1)	
gold	Au	79	196.966569(4)	
hafnium	Hf	72	178.49(2)	
hassium*	Hs	108		
helium	Не	2	4.002602(2)	g, r
holmium	Но	67	164.93032(2)	
hydrogen	Н	1	1.00794(7)	g, m, r
indium	In	49	114.818(3)	
iodine	Ι	53	126.90447(3)	
iridium	Ir	77	192.217(3)	
iron	Fe	26	55.845(2)	
krypton	Kr	36	83.798(2)	g, m

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Name	Atomic Symbol	Atomic Number	Atomic Mass	Footnotes
lanthanum	La	57	138.90547(7)	g
lawrencium*	Lr	103		
lead	Рb	82	207.2(1)	g, r
lithium	Li	3	[6.941(2)]†	g, m, r
lutetium	Lu	71	174.967(1)	g
magnesium	Mg	12	24.3050(6)	
manganese	Mn	25	54.938045(5)	
meitnerium*	Mt	109		
mendelevium*	Мd	101		
mercury	Нg	80	200.59(2)	
molybdenum	Мо	42	95.94(2)	g
neodymium	Nd	60	144.242(3)	g
neon	Ne	10	20.1797(6)	g, m
neptunium*	Np	93		
nickel	Ni	28	58.6934(2)	
niobium	Nb	41	92.90638(2)	
nitrogen	N	7	14.0067(2)	g, r

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Name	Atomic Symbol	Atomic Number	Atomic Mass	Footnotes
nobelium*	No	102		
osmium	Os	76	190.23(3)	g
oxygen	0	8	15.9994(3)	g, r
palladium	Pd	46	106.42(1)	g
phosphorus	Р	15	30.973762(2)	
platinum	Pt	78	195.084(9)	
plutonium*	Pu	94		
polonium*	Ро	84		
potassium	К	19	39.0983(1)	
praseodymium	Pr	59	140.90765(2)	
promethium*	Pm	61		
protactinium*	Ра	91	231.03588(2)	
radium*	Ra	88		
radon*	Rn	86		
roentgenium*	Rg	111		
rhenium	Re	75	186.207(1)	
rhodium	Rh	45	102.90550(2)	

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Name	Atomic Symbol	Atomic Number	Atomic Mass	Footnotes
rubidium	Rb	37	85.4678(3)	g
ruthenium	Ru	44	101.07(2)	g
rutherfordium*	Rf	104		
samarium	Sm	62	150.36(2)	g
scandium	Sc	21	44.955912(6)	
seaborgium*	Sg	106		
selenium	Se	34	78.96(3)	r
silicon	Si	14	28.0855(3)	r
silver	Ag	47	107.8682(2)	g
sodium	Na	11	22.98976928(2)	
strontium	Sr	38	87.62(1)	g, r
sulfur	S	16	32.065(5)	g, r
tantalum	Та	73	180.94788(2)	
technetium*	Тс	43		
tellurium	Те	52	127.60(3)	g
terbium	Тb	65	158.92535(2)	
thallium	Tl	81	204.3833(2)	

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Name	Atomic Symbol	Atomic Number	Atomic Mass	Footnotes
thorium*	Th	90	232.03806(2)	g
thulium	Tm	69	168.93421(2)	
tin	Sn	50	118.710(7)	g
titanium	Ti	22	47.867(1)	
tungsten	W	74	183.84(1)	
ununhexium*	Uuh	116		
ununoctium*	Uuo	118		
ununpentium*	Uup	115		
ununquadium*	Uuq	114		
ununtrium*	Uut	113		
uranium*	U	92	238.02891(3)	g, m
vanadium	V	23	50.9415(1)	
xenon	Хе	54	131.293(6)	g, m
ytterbium	Yb	70	173.04(3)	g
yttrium	Y	39	88.90585(2)	
zinc	Zn	30	65.409(4)	
zirconium	Zr	40	91.224(2)	g

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