PERIODIC TABLE OF THE ELEMENTS

Table of Selected Radioactive Isotopes

$_0$n	1	(15.3 min) β^-		67	(61.98 h) β^-		124	(60.20 d) β^+		178	(1.40 d) EC		231	(3.28 × 10^4 y) α
$_1$H	3	(12.26 y) β^-	$_{30}$Zn	65	(244.1 d) β^+, EC		125	(2.7 y) β^+		185	(75.1 d) β^-		233	(1.59 × 10^5 y) α
$_4$Be	7	(53.3 d) EC	$_{31}$Ga	67	(78.2 h) EC	$_{52}$Te	121 m	(154 d) IT		188	(69 d) β^-		234	(2.44 × 10^5 y) α
	10	(1.6 × 10^6 y) β^-		72	(14.10 h) β^-		123 m	(119.7 d) IT	$_{75}$Re	187	(5 × 10^{10} y) β^-		235	(7.04 × 10^8 y) α
$_6$C	11	(20.40 min) β^+	$_{32}$Ge	68	(275 d) EC		127 m	(109 d) IT	$_{76}$Os	194	(6.0 y) β^-		236	(2.34 × 10^7 y) α
	14	(5730 y) β^-	$_{33}$As	73	(80.3 d) EC	$_{53}$I	129	(1.6 × 10^7 y) β^-	$_{77}$Ir	192	(74.2 d) β^-, β^+, EC		238	(4.47 × 10^9 y) α
$_9$F	18	(109.8 min) β^+		74	(17.9 d) β^-, β^+, EC		131	(8.040 d) β^-	$_{78}$Au	195	(183 d) EC	$_{93}$Np	236	(1.1 × 10^5 y) EC, β^-
$_{11}$Na	22	(2.602 y) β^+, EC	$_{34}$Se	75	(118.5 d) β^-	$_{54}$Xe	133	(5.25 d) β^-		196	(6.18 d) β^-, EC, β^+		237	(2.14 × 10^6 y) α
	24	(15.02 h) β^-		79	(6.5 × 10^4 y) β^-		135	(9.10 h) β^-		198	(2.696 d) β^-		239	(2.346 d) β^-
$_{12}$Mg	28	(20.9 h) β^-	$_{35}$Br	82	(35.34 h) β^-	$_{55}$Cs	134	(2.06 y) β^-		199	(3.15 d) β^-	$_{94}$Pu	238	(87.75 y) α
$_{13}$Al	26	(7.2 × 10^5 y) β^+, EC	$_{36}$Kr	81	(2.1 × 10^5 y) EC		135	(2.9 × 10^6 y) β-	$_{80}$Hg	203	(46.6 d) β^-		239	(2.41 × 10^4 y) α
$_{15}$P	32	(14.26 d) β^-		85	(10.72 y) β^-		137	(30.17 y) β^-	$_{81}$Tl	204	(3.77 y) β^-		240	(6.54 × 10^3 y) α
$_{16}$S	35	(87.2 d) β^-	$_{37}$Rb	86	(18.7 d) β^-		140	(12.8 d) β^-	$_{82}$Pb	202	(3 × 10^5 y) EC		242	(3.8 × 10^5 y) α
$_{17}$Cl	36	(3.01 × 10^5 y) β^-		87	(4.8 × 10^{11} y) β^-	$_{56}$Ba	137	(6 × 10^4 y) EC		205	(3 × 10^7 y) EC		244	(8.3 × 10^7 y) α
	38	(37.2 min) β^-	$_{38}$Sr	90	(28.8 y) β^-		140	(40.3 h) β^-		210	(22.3 y) β^-, α	$_{95}$Am	241	(432 y) α
$_{18}$Ar	37	(35.02 d) EC	$_{39}$Y	88	(106.6 d) β^+, EC	$_{58}$Ce	144	(284 d) β^-	$_{83}$Bi	207	(38 y) EC		243	(7.37 × 10^3 y) α
	39	(265 y) β^-	$_{40}$Zr	93	(1.5 × 10^6 y) β^-	$_{59}$Pr	142	(19.1 h) β^-		208	(3.7 × 10^5 y) EC	$_{96}$Cm	242	(163.2 d) α
$_{19}$K	40	(1.28 × 10^9 y) EC		95	(64.0 d) β^-	$_{60}$Nd	147	(11.1 d) β^-		210	(5.01 d) β^-, α		244	(18.112 y) α
	42	(12.36 h) β^-	$_{41}$Nb	94	(2.0 × 10^4 y) β^-	$_{61}$Pm	145	(18 y) EC		210 m	(3 × 10^6 y) α		247	(1.55 × 10^7 y) α
$_{20}$Ca	45	(165 d) β^-		95	(35.15 d) β^-		147	(2.62 y) β^-	$_{84}$Po	208	(2.90 y) α		248	(3.5 × 10^5 y) α, SF
$_{21}$Sc	46	(83.80 d) β^-	$_{42}$Mo	99	(66.02 h) β^-		146	(7 × 10^7 y) α		209	(102 y) α	$_{97}$Bk	247	(1.4 × 10^3 y) α
$_{22}$Ti	51	(27.70 d) EC	$_{43}$Tc	97	(2.6 × 10^6 y) EC	$_{62}$Sm	151	(90 y) β^-		210	(138.38 d) α	$_{98}$Cf	249	(351 y) α
$_{23}$V	48	(15.97 d) EC		98	(4.2 × 10^6 y) β^-	$_{63}$Eu	147	(1.3 y) β^+, EC, β^-	$_{85}$At	209	(5.4 h) EC, α		251	(900 y) α
	49	(330.0 d) EC		99	(2.13 × 10^5 y) β^-		154	(8.5 y) β^-		210	(8.1 h) EC	$_{99}$Es	252	(472 d) α
	56	(2.578 h) β^-	$_{44}$Ru	106	(367 d) β^-	$_{64}$Gd	150	(2.1 × 10^6 y) α		211	(7.21 h) EC, α		253	(20.47 d) α
$_{26}$Fe	59	(44.6 d) β^-	$_{45}$Rh	101	(3.3 y) EC	$_{65}$Tb	158	(1.2 × 10^5 y) EC, β^-	$_{86}$Rn	222	(3.824 d) α		254	(276 d) α
$_{27}$Co	56	(78.8d) β^+, EC	$_{46}$Pd	103	(17.0 d) EC		160	(72.3 d) β^-	$_{87}$Fr	212	(19.3 min) EC, α	$_{100}$Fm	255	(20.1 h) α
	57	(270 d) EC		107	(7 × 10^6 y) β^-	$_{66}$Ho	166 m	(1.2 × 10^3 y) β^-		222	(15 min) β^-		257	(100.5 d) α
	58	(71.3 d) β^+, EC	$_{47}$Ag	108	(127 y) EC	$_{69}$Tm	170	(128.6 d) β^-		223	(21.8 min) β^-	$_{101}$Md	258	(55 d) α
	60	(5.272 y) β^-		110	(252 d) β^-		171	(1.92 y) β^-	$_{88}$Ra	226	(1.60 × 10^3 y) α	$_{102}$No	259	(58 min) α
$_{28}$Ni	57	(36.0 h) β^+, EC		111	(7.45 d) β^-	$_{70}$Yb	169	(32.0 d) EC	$_{89}$Ac	227	(21.77 y) β^-	$_{103}$Lr	260	(3.0 min) α
	59	(8 × 10^4 y) EC	$_{48}$Cd	109	(453 d) EC		175	(4.19 d) β^-	$_{90}$Th	228	(1.913 y) α	104	261	(65 s) α
	63	(92 y) β^-	$_{49}$In	114	(49.51 d) IT	$_{71}$Lu	176	(3.7 × 10^{10} y) β^-		230	(7.7 × 10^4 y) α	105	262	(40 s) α
$_{29}$Cu	64	(12.70 h) β^+, β^-, EC	$_{50}$Sn	121	(76 y) β^-	$_{72}$Ta	182	(115.0 d) β^-	$_{91}$Pa	232	(1.40 × 10^9 y) α	106	263	(0.9 d) α

Selected Radioactive Isotopes

Naturally occurring radioactive isotopes are designated by a mass number in blue (although some are also manufactured). Letter m indicates an isomer of another isotope of the same mass number. Half-lives follow in parentheses; where s, min, h, d, and y stand respectively for seconds, minutes, hours, days, and years. The table includes mainly the longer-lived radioactive isotopes; many others have been prepared. Isotopes known to be radioactive but with half-lives exceeding 10^{12} y have not been included. Symbols describing the principal mode (or modes) of decay are as follows (these processes are generally accompanied by gamma radiation):

- α alpha particle emission
- β^- beta particle (electron) emission
- β^+ positron emission
- EC orbital electron capture
- IT isomeric transition from upper to lower isomeric state
- SF spontaneous fission

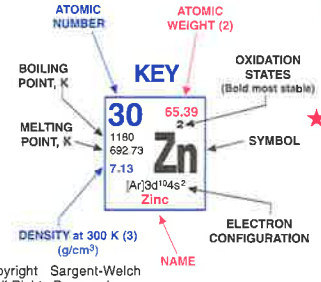
GROUP IA												IIIB	IVB	VB	VIB	VIIB	VIII	VIII	VIII	IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIII	VIII	VIII	IB	IIB							
1 1.00794 1 20.28 13.81 0.0899 † H 1s^1 Hydrogen	IIA																																					VIII
3 6.941 1 1615 453.7 0.53 Li 1s^{2}2s^1 Lithium	4 9.01218 2 3243 1560 1.85 Be 1s^{2}2s^2 Beryllium											5 10.811 3 4275 2365 2.34 B 1s^{2}2s^{2}p^1 Boron	6 12.011 ±4,2 5100* 3825* 2.26 C 1s^{2}2s^{2}p^2 Carbon	7 14.0067 ±3,5,4,2 77.344 63.15 1,251† N 1s^{2}2s^{2}p^3 Nitrogen	8 15.9994 -2 90.188 54.8 1,429† O 1s^{2}2s^{2}p^4 Oxygen	9 18.99840 -1 85.0 53.55 1,696† F 1s^{2}2s^{2}p^5 Fluorine	10 20.1797 27.10 24.55 0.900† Ne 1s^{2}2s^{2}p^6 Neon	2 4.00260 4.216 0.95 at 26 atm 0.1785† He 1s^2 Helium
11 22.98977 1 1156 371.0 0.97 Na [Ne]3s^1 Sodium	12 24.305 2 1360 922 1.74 Mg [Ne]3s^2 Magnesium											13 26.98154 3 2740 933.5 2.70 Al [Ne]3s^{2}p^1 Aluminum	14 28.0855 4,2 2630 1683 2.33 Si [Ne]3s^{2}p^2 Silicon	15 30.97376 ±3,5,4 553 317.3 1.82 P [Ne]3s^{2}p^3 Phosphorus	16 32.066 ±2,4,6 717.82 392.2 2.07 S [Ne]3s^{2}p^4 Sulfur	17 35.4527 ±1,3,5,7 239.18 172.17 3.214† Cl [Ne]3s^{2}p^5 Chlorine	18 39.948 87.45 83.95 1.784† Ar [Ne]3s^{2}p^6 Argon
19 39.0983 1 1033 336.8 0.86 K [Ar]4s^1 Potassium	20 40.078 2 1757 1112 1.55 Ca [Ar]4s^2 Calcium	21 44.9559 3 3109 1814 2.99 Sc [Ar]3d^{1}4s^2 Scandium	22 47.88 4,3 3560 1935 4.54 Ti [Ar]3d^{2}4s^2 Titanium	23 50.9415 5,4,3,2 3650 2163 6.11 V [Ar]3d^{3}4s^2 Vanadium	24 51,996 3,6,2 2945 2130 7.19 Cr [Ar]3d^{5}4s^1 Chromium	25 54.9380 2,3,4,6,7 2235 1518 7.44 Mn [Ar]3d^{5}4s^2 Manganese	26 55.847 3,2 3023 1808 7.874 Fe [Ar]3d^{6}4s^2 Iron	27 58.9332 2,3 3143 1768 8.90 Co [Ar]3d^{7}4s^2 Cobalt	28 58.6934 2,3 3005 1726 8.90 Ni [Ar]3d^{8}4s^2 Nickel	29 63.546 2,1 2840 1356.6 8.96 Cu [Ar]3d^{10}4s^1 Copper	30 65.39 2 1180 692.73 7.13 Zn [Ar]3d^{10}4s^2 Zinc	31 69.723 3 2478 302.92 5.91 Ga [Ar]3d^{10}4s^{2}p^1 Gallium	32 72.61 4 3107 1211.5 5.32 Ge [Ar]3d^{10}4s^{2}p^2 Germanium	33 74.9216 ±3,5 876 (sub) 1090 (29 atm) 5.78 As [Ar]3d^{10}4s^{2}p^3 Arsenic	34 78.96 -2,4,6 958 494 4.79 Se [Ar]3d^{10}4s^{2}p^4 Selenium	35 79.904 ±1,5,7 331.85 265.95 3.12 Br [Ar]3d^{10}4s^{2}p^5 Bromine	36 83.80 0,2 120.85 116 3.75† Kr [Ar]3d^{10}4s^{2}p^6 Krypton
37 85.4678 1 961 312.63 1.532 Rb [Kr]5s^1 Rubidium	38 87.62 2 1655 1042 2.54 Sr [Kr]5s^2 Strontium	39 88.9059 3 3611 1795 4.47 Y [Kr]4d^{1}5s^2 Yttrium	40 91.224 4 4682 2128 6.51 Zr [Kr]4d^{2}5s^2 Zirconium	41 92.9064 5,3 5015 2742 8.57 Nb [Kr]4d^{4}5s^1 Niobium	42 95.94 6,5,4,3,2 4912 2896 10.22 Mo [Kr]4d^{5}5s^1 Molybdenum	43 (98) 7 4538 2477 11.5 Tc [Kr]4d^{5}5s^2 Technetium	44 101.07 2,3,4,6,8 4425 2610 12.37 Ru [Kr]4d^{7}5s^1 Ruthenium	45 102.9055 2,3,4 3970 2236 12.41 Rh [Kr]4d^{8}5s^1 Rhodium	46 106.42 2,4 3240 1825 12.0 Pd [Kr]4d^{10} Palladium	47 107.868 1 2436 1235.08 10.50 Ag [Kr]4d^{10}5s^1 Silver	48 112.41 2 1040 594.26 8.65 Cd [Kr]4d^{10}5s^2 Cadmium	49 114.82 3 2350 429.78 7.31 In [Kr]4d^{10}5s^{2}p^1 Indium	50 118.710 4,2 2876 505.12 7.31 Sn [Kr]4d^{10}5s^{2}p^2 Tin	51 121.757 ±3,5 1650 903.91 6.69 Sb [Kr]4d^{10}5s^{2}p^3 Antimony	52 127.60 -2,4,6 1261 722.72 6.24 Te [Kr]4d^{10}5s^{2}p^4 Tellurium	53 126.9045 ±1,5,7 457.5 386.7 4.93 I [Kr]4d^{10}5s^{2}p^5 Iodine	54 131.29 0,2,4,6 165.1 161.39 5.90† Xe [Kr]4d^{10}5s^{2}p^6 Xenon
55 132.9054 1 944 301.54 1.87 Cs [Xe]6s^1 Cesium	56 137.33 2 2078 1002 3.59 Ba [Xe]6s^2 Barium	57 138.9055 3 ★ 3737 1191 6.15 La [Xe]5d^{1}6s^2 Lanthanum	72 178.49 4 4875 2504 13.31 Hf [Xe]4f^{14}5d^{2}6s^2 Hafnium	73 180.9479 5 5730 3293 16.65 Ta [Xe]4f^{14}5d^{3}6s^2 Tantalum	74 183.85 6,5,4,3,2 5825 3695 19.3 W [Xe]4f^{14}5d^{4}6s^2 Tungsten	75 186.207 7,6,4,2 5870 3455 21.0 Re [Xe]4f^{14}5d^{5}6s^2 Rhenium	76 190.2 2,3,4,6,8 5300 3300 22.6 Os [Xe]4f^{14}5d^{6}6s^2 Osmium	77 192.22 2,3,4,6 4700 2720 22.6 Ir [Xe]4f^{14}5d^{7}6s^2 Iridium	78 195.08 2,4 4100 2042.1 21.45 Pt [Xe]4f^{14}5d^{9}6s^1 Platinum	79 196.9665 3,1 3130 1337.58 19.3 Au [Xe]4f^{14}5d^{10}6s^1 Gold	80 200.59 2,1 629.88 234.31 13.55 Hg [Xe]4f^{14}5d^{10}6s^2 Mercury	81 204.383 3,1 1746 577 11.85 Tl [Xe]4f^{14}5d^{10}6s^{2}p^1 Thallium	82 207.2 4,2 2023 600.65 11.35 Pb [Xe]4f^{14}5d^{10}6s^{2}p^2 Lead	83 208.9804 3,5 1837 544.59 9.75 Bi [Xe]4f^{14}5d^{10}6s^{2}p^3 Bismuth	84 (209) 4,2,6 — 527 9.3 Po [Xe]4f^{14}5d^{10}6s^{2}p^4 Polonium	85 (210) ±1,3,5,7 610* 575 — At [Xe]4f^{14}5d^{10}6s^{2}p^5 Astatine	86 (222) 0,2 211.4 202 9.73 Rn [Xe]4f^{14}5d^{10}6s^{2}p^6 Radon
87 (223) 1 950 300 — Fr [Rn]7s^1 Francium	88 226.0254 2 1413 973 5.0 Ra [Rn]7s^2 Radium	89 (227) 3 ★★ 3470* 1324 10.07 Ac [Rn]6d^{1}7s^2 Actinium	104 (261) — — Rf [Rn]5f^{14}6d^{2}7s^2 (Rutherfordium)	105 (262) — — Ha [Rn]5f^{14}6d^{3}7s^2 (Hahnium)	106 (263) — — Sg [Rn]5f^{14}6d^{4}7s^2 (Seaborgium)	107 (262) — — Uns [Rn]5f^{14}6d^{5}7s^2 (Unnilseptium)	108 (265) — — Uno [Rn]5f^{14}6d^{6}7s^2 (Unniloctium)	109 (266) — — Une [Rn]5f^{14}6d^{7}7s^2 (Unilnonium)	110 (272) — — Uun [Rn]5f^{14}6d^{9}7s^2 (Ununnilium)																								

* Estimated Values

The A & B subgroup designations, applicable to elements in rows 4, 5, 6 and 7, are those recommended by the International Union of Pure and Applied Chemistry.

The names for elements 104-106 have been proposed, but not formally accepted by the IUPAC.

★ 58 140.12 3,4 3715 1071 6.77 Ce [Xe]4f^{1}5d^{1}6s^2 Cerium	59 140.9077 3,4 3785 1204 6.77 Pr [Xe]4f^{3}6s^2 Praseodymium	60 144.24 3 3347 1294 7.01 Nd [Xe]4f^{4}6s^2 Neodymium	61 (145) 3 3273 1315 7.22 Pm [Xe]4f^{5}6s^2 Promethium	62 150.36 3,2 2067 1347 7.52 Sm [Xe]4f^{6}6s^2 Samarium	63 151.965 3,2 1800 1095 5.24 Eu [Xe]4f^{7}6s^2 Europium	64 157.25 3 3545 1585 7.90 Gd [Xe]4f^{7}5d^{1}6s^2 Gadolinium	65 158.9253 3,4 3500 1629 8.23 Tb [Xe]4f^{9}6s^2 Terbium	66 162.50 3 2840 1685 8.55 Dy [Xe]4f^{10}6s^2 Dysprosium	67 164.9303 3 2968 1747 8.80 Ho [Xe]4f^{11}6s^2 Holmium	68 167.26 3 3140 1802 9.07 Er [Xe]4f^{12}6s^2 Erbium	69 168.9342 3,2 2223 1818 9.32 Tm [Xe]4f^{13}6s^2 Thulium	70 173.04 3,2 1469 1092 6.97 Yb [Xe]4f^{14}6s^2 Ytterbium	71 174.967 3 3668 1936 9.84 Lu [Xe]4f^{14}5d^{1}6s^2 Lutetium
★★ 90 232.0381 4 5060 2028 11.72 Th [Rn]6d^{2}7s^2 Thorium	91 231.0359 5,4 4300* 1845 15.4 Pa [Rn]5f^{2}6d^{1}7s^2 Protactinium	92 238.029 6,5,4,3 4407 1408 18.95 U [Rn]5f^{3}6d^{1}7s^2 Uranium	93 237.0482 6,5,4,3 4175* 912 20.2 Np [Rn]5f^{4}6d^{1}7s^2 Neptunium	94 (244) 6,5,4,3 3505 913 19.84 Pu [Rn]5f^{6}7s^2 Plutonium	95 (243) 6,5,4,3 2880 1449 13.7 Am [Rn]5f^{7}7s^2 Americium	96 (247) 3 — 1620 13.5 Cm [Rn]5f^{7}6d^{1}7s^2 Curium	97 (247) 4,3 — — 14* Bk [Rn]5f^{9}7s^2 Berkelium	98 (251) 3 — 1170* — Cf [Rn]5f^{10}7s^2 Californium	99 (252) 3 — 1130* — Es [Rn]5f^{11}7s^2 Einsteinium	100 (257) 3 — 1600* — Fm [Rn]5f^{12}7s^2 Fermium	101 (258) 3 — 1100* — Md [Rn]5f^{13}7s^2 Mendelevium	102 (259) 2,3 — 1100* — No [Rn]5f^{14}7s^2 Nobelium	103 (260) 3 — 1900* — Lr [Rn]5f^{14}6d^{1}7s^2 Lawrencium



NOTES:

(1) Black — solid. Red — gas. Blue — liquid. Outline — synthetically prepared.

(2) Based upon carbon-12. ( ) indicates most stable or best known isotope.

(3) Entries marked with daggers refer to the gaseous state at 273 K and 1 atm and are given in units of g/l.

Catalog Number S-18806

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Side 1