Return to Table Introduction

Ground levels and ionization energies for the neutral atoms

Z	Element	Ground-state configuration	Ground level	Ionization energy (eV)	Reference for ionization energy
1 H	Hydrogen	$1s$	$^2S_{1/2}$	13.5984	(1983), (1985)
2 He	Helium	$1s^2$	$^1S_0$	24.5874	(1997), (1998)
3 Li	Lithium	$1s^2\ 2s$	$^2S_{1/2}$	5.3917	Lorenzen & Niemax (1982)
4 Be	Beryllium	$1s^2\ 2s^2$	$^1S_0$	9.3227	Beigang et al. (1983)
5 B	Boron	$1s^2\ 2s^2\ 2p$	$^2P^o_{1/2}$	8.2980	(1970), (1974)
6 C	Carbon	$1s^2\ 2s^2\ 2p^2$	$^3P_0$	11.2603	Johansson (1966)
7 N	Nitrogen	$1s^2\ 2s^2\ 2p^3$	$^4S^o_{3/2}$	14.5341	Eriksson & Pettersson (1971)
8 O	Oxygen	$1s^2\ 2s^2\ 2p^4$	$^3P_2$	13.6181	Eriksson & Isberg (1968)
9 F	Fluorine	$1s^2\ 2s^2\ 2p^5$	$^2P^o_{3/2}$	17.4228	(1949), (1969)
10 Ne	Neon	$1s^2\ 2s^2\ 2p^6$	$^1S_0$	21.5645	Kaufman & Minnhagen (1972)
11 Na	Sodium	[Ne] $3s$	$^2S_{1/2}$	5.1391	(1992), (1998)
12 Mg	Magnesium	[Ne] $3s^2$	$^1S_0$	7.6462	(1987), (1991)
13 Al	Aluminum	[Ne] $3s^2\ 3p$	$^2P^o_{1/2}$	5.9858	(1990), (1991)
14 Si	Silicon	[Ne] $3s^2\ 3p^2$	$^3P_0$	8.1517	Martin & Zalubas (1983)
15 P	Phosphorus	[Ne] $3s^2\ 3p^3$	$^4S^o_{3/2}$	10.4867	Svendenius (1980)
16 S	Sulfur	[Ne] $3s^2\ 3p^4$	$^3P_2$	10.3600	Martin et al. (1990)
17 Cl	Chlorine	[Ne] $3s^2\ 3p^5$	$^2P^o_{3/2}$	12.9676	Radziemski & Kaufman (1969)
18 Ar	Argon	[Ne] $3s^2\ 3p^6$	$^1S_0$	15.7596	Velchev et al. (1999)
19 K	Potassium	[Ar] $4s$	$^2S_{1/2}$	4.3407	(1983), (1985)
20 Ca	Calcium	[Ar] $4s^2$	$^1S_0$	6.1132	Sugar & Corliss (1985)
21 Sc	Scandium	[Ar] $3d\ 4s^2$	$^2D_{3/2}$	6.5615	Sugar & Corliss (1985)
22 Ti	Titanium	[Ar] $3d^2\ 4s^2$	$^3F_2$	6.8281	Sohl et al. (1990)
23 V	Vanadium	[Ar] $3d^3\ 4s^2$	$^4F_{3/2}$	6.7462	James et al. (1994)
24 Cr	Chromium	[Ar] $3d^5\ 4s$	$^7S_3$	6.7665	Sugar & Corliss (1985)
25 Mn	Manganese	[Ar] $3d^5\ 4s^2$	$^6S_{5/2}$	7.4340	Sugar & Corliss (1985)
26 Fe	Iron	[Ar] $3d^6\ 4s^2$	$^5D_4$	7.9024	Sugar & Corliss (1985)
27 Co	Cobalt	[Ar] $3d^7\ 4s^2$	$^4F_{9/2}$	7.8810	Page & Gudeman (1990)
28 Ni	Nickel	[Ar] $3d^8\ 4s^2$	$^3F_4$	7.6398	Page & Gudeman (1990)
29 Cu	Copper	[Ar] $3d^{10}\ 4s$	$^2S_{1/2}$	7.7264	(1948), (1980), (1999)
30 Zn	Zinc	[Ar] $3d^{10}\ 4s^2$	$^1S_0$	9.3942	Brown et al. (1975)

31	Ga	Gallium	[Ar] $3d^{10}$	$4s^2$	$4p$	$^2P^o_{1/2}$	5.9993	Tursunov & Eshkobilov (1985)
32	Ge	Germanium	[Ar] $3d^{10}$	$4s^2$	$4p^2$	$^3P_0$	7.8994	Sugar & Musgrove (1993)
33	As	Arsenic	[Ar] $3d^{10}$	$4s^2$	$4p^3$	$^4S^o_{3/2}$	9.7886	Bhatia & Jones (1971)
34	Se	Selenium	[Ar] $3d^{10}$	$4s^2$	$4p^4$	$^3P_2$	9.7524	(1974), (1983)
35	Br	Bromine	[Ar] $3d^{10}$	$4s^2$	$4p^5$	$^2P^o_{3/2}$	11.8138	(1961), (1967)
36	Kr	Krypton	[Ar] $3d^{10}$	$4s^2$	$4p^6$	$^1S_0$	13.9996	Sugar & Musgrove (1991)
37	Rb	Rubidium	[Kr]		$5s$	$^2S_{1/2}$	4.1771	(1961), (1983)
38	Sr	Strontium	[Kr]		$5s^2$	$^1S_0$	5.6949	Rubbmark & Borgstrom (1978)
39	Y	Yttrium	[Kr] $4d$		$5s^2$	$^2D_{3/2}$	6.2173	(1973), (2000)
40	Zr	Zirconium	[Kr] $4d^2$		$5s^2$	$^3F_2$	6.6339	Hackett et al. (1986)
41	Nb	Niobium	[Kr] $4d^4$		$5s$	$^6D_{1/2}$	6.7589	Rayner et al. (1987)
42	Mo	Molybdenum	[Kr] $4d^5$		$5s$	$^7S_3$	7.0924	Rayner et al. (1987)
43	Tc	Technetium	[Kr] $4d^5$		$5s^2$	$^6S_{5/2}$	7.28	Finkelnburg & Humbach (1955)
44	Ru	Ruthenium	[Kr] $4d^7$		$5s$	$^5F_5$	7.3605	(1979), (1988)
45	Rh	Rhodium	[Kr] $4d^8$		$5s$	$^4F_{9/2}$	7.4589	Callender et al. (1988)
46	Pd	Palladium	[Kr] $4d^{10}$			$^1S_0$	8.3369	Callender et al. (1988)
47	Ag	Silver	[Kr] $4d^{10}$		$5s$	$^2S_{1/2}$	7.5762	(1940), (1999)
48	Cd	Cadmium	[Kr] $4d^{10}$		$5s^2$	$^1S_0$	8.9938	Brown et al. (1975)
49	In	Indium	[Kr] $4d^{10}$	$5s^2$	$5p$	$^2P^o_{1/2}$	5.7864	Dönszelmann & Neijzen (1983)
50	Sn	Tin	[Kr] $4d^{10}$	$5s^2$	$5p^2$	$^3P_0$	7.3439	Brown et al. (1977)
51	Sb	Antimony	[Kr] $4d^{10}$	$5s^2$	$5p^3$	$^4S^o_{3/2}$	8.6084	Beigang & Wynne (1986)
52	Te	Tellurium	[Kr] $4d^{10}$	$5s^2$	$5p^4$	$^3P_2$	9.0096	Cantú et al. (1986)
53	I	Iodine	[Kr] $4d^{10}$	$5s^2$	$5p^5$	$^2P^o_{3/2}$	10.4513	Minnhagen (1962)
54	Xe	Xenon	[Kr] $4d^{10}$	$5s^2$	$5p^6$	$^1S_0$	12.1298	(1985), (2001)
55	Cs	Cesium	[Xe]		$6s$	$^2S_{1/2}$	3.8939	Weber & Sansonetti (1984)
56	Ba	Barium	[Xe]		$6s^2$	$^1S_0$	5.2117	Post et al. (1985)
57	La	Lanthanum	[Xe]	$5d$	$6s^2$	$^2D_{3/2}$	5.5769	Garton & Wilson (1966)
58	Ce	Cerium	[Xe] $4f$	$5d$	$6s^2$	$^1G^o_4$	5.5387	Worden et al. (1978)
59	Pr	Praseodymium	[Xe] $4f^3$		$6s^2$	$^4I^o_{9/2}$	5.473	Worden et al. (1978)
60	Nd	Neodymium	[Xe] $4f^4$		$6s^2$	$^5I_4$	5.5250	Worden et al. (1978)
61	Pm	Promethium	[Xe] $4f^5$		$6s^2$	$^6H^o_{5/2}$	5.582	Worden et al. (1978)
62	Sm	Samarium	[Xe] $4f^6$		$6s^2$	$^7F_0$	5.6437	T. Jaysekharan et al. (2000)
63	Eu	Europium	[Xe] $4f^7$		$6s^2$	$^8S^o_{7/2}$	5.6704	Nakhate et al. (2000)
64	Gd	Gadolinium	[Xe] $4f^7$	$5d$	$6s^2$	$^9D^o_2$	6.1498	Miyabe et al. (1998)
65	Tb	Terbium	[Xe] $4f^9$		$6s^2$	$^6H^o_{15/2}$	5.8638	Worden et al. (1978)
66	Dy	Dysprosium	[Xe] $4f^{10}$		$6s^2$	$^5I_8$	5.9389	Worden et al. (1978)
67	Ho	Holmium	[Xe] $4f^{11}$		$6s^2$	$^4I^o_{15/2}$	6.0215	Worden et al. (1978)
68	Er	Erbium	[Xe] $4f^{12}$		$6s^2$	$^3H_6$	6.1077	Worden et al. (1978)
69	Tm	Thulium	[Xe] $4f^{13}$		$6s^2$	$^2F^o_{7/2}$	6.1843	Camus (1971)
70	Yb	Ytterbium	[Xe] $4f^{14}$		$6s^2$	$^1S_0$	6.2542	Aymar et al. (1980)
71	Lu	Lutetium	[Xe] $4f^{14}$	$5d$	$6s^2$	$^2D_{3/2}$	5.4259	(1972), (1989)

72	Hf	Hafnium	[Xe] $4f^{14}\ 5d^2\ 6s^2$		$^3F_2$	6.8251	Callender et al. (1988)
73	Ta	Tantalum	[Xe] $4f^{14}\ 5d^3\ 6s^2$		$^4F_{3/2}$	7.5496	Simard et al. (1994)
74	W	Tungsten	[Xe] $4f^{14}\ 5d^4\ 6s^2$		$^5D_0$	7.8640	Campbell-Miller & Simard (1996)
75	Re	Rhenium	[Xe] $4f^{14}\ 5d^5\ 6s^2$		$^6S_{5/2}$	7.8335	Campbell-Miller & Simard (1996)
76	Os	Osmium	[Xe] $4f^{14}\ 5d^6\ 6s^2$		$^5D_4$	8.4382	Colarusso et al. (1997)
77	Ir	Iridium	[Xe] $4f^{14}\ 5d^7\ 6s^2$		$^4F_{9/2}$	8.9670	Colarusso et al. (1997)
78	Pt	Platinum	[Xe] $4f^{14}\ 5d^9\ 6s$		$^3D_3$	8.9588	(1995), (2000)
79	Au	Gold	[Xe] $4f^{14}\ 5d^{10}\ 6s$		$^2S_{1/2}$	9.2255	(1978), (1999)
80	Hg	Mercury	[Xe] $4f^{14}\ 5d^{10}\ 6s^2$		$^1S_0$	10.4375	Baig (1983)
81	Tl	Thallium	[Xe] $4f^{14}\ 5d^{10}\ 6s^2$	$6p$	$^2P^o_{1/2}$	6.1082	Baig & Connerade (1985)
82	Pb	Lead	[Xe] $4f^{14}\ 5d^{10}\ 6s^2$	$6p^2$	$^3P_0$	7.4167	Brown et al. (1977)
83	Bi	Bismuth	[Xe] $4f^{14}\ 5d^{10}\ 6s^2$	$6p^3$	$^4S^o_{3/2}$	7.2855	Matthews et al. (1989)
84	Po	Polonium	[Xe] $4f^{14}\ 5d^{10}\ 6s^2$	$6p^4$	$^3P_2$	8.414	Charles (1966)
85	At	Astatine	[Xe] $4f^{14}\ 5d^{10}\ 6s^2$	$6p^5$	$^2P^o_{3/2}$		
86	Rn	Radon	[Xe] $4f^{14}\ 5d^{10}\ 6s^2$	$6p^6$	$^1S_0$	10.7485	(1933), (1970)
87	Fr	Francium	[Rn]	$7s$	$^2S_{1/2}$	4.0727	Arnold et al. (1990)
88	Ra	Radium	[Rn]	$7s^2$	$^1S_0$	5.2784	Amstrong et al. (1980)
89	Ac	Actinium	[Rn] $6d$	$7s^2$	$^2D_{3/2}$	5.17	(1955), (1974)
90	Th	Thorium	[Rn] $6d^2$	$7s^2$	$^3F_2$	6.3067	Köhler et al. (1997)
91	Pa	Protactinium	[Rn] $5f^2(^3H_4)\ 6d\ 7s^2$		$(4,^3/_2)_{11/2}$	5.89	Sugar (1974)
92	U	Uranium	[Rn] $5f^3(^4I^o_{9/2})\ 6d\ 7s^2$		$(^9/_2,^3/_2)^o_6$	6.1941	Coste et al. (1982)
93	Np	Neptunium	[Rn] $5f^4(^5I_4)\ 6d\ 7s^2$		$(4,^3/_2)_{11/2}$	6.2657	(1979), (1994), (1997)
94	Pu	Plutonium	[Rn] $5f^6$	$7s^2$	$^7F_0$	6.0260	(1993), (1997)
95	Am	Americium	[Rn] $5f^7$	$7s^2$	$^8S^o_{7/2}$	5.9738	Köhler et al. (1997)
96	Cm	Curium	[Rn] $5f^7\ 6d$	$7s^2$	$^9D^o_2$	5.9914	Köhler et al. (1997)
97	Bk	Berkelium	[Rn] $5f^9$	$7s^2$	$^6H^o_{15/2}$	6.1979	Köhler et al. (1997)
98	Cf	Californium	[Rn] $5f^{10}$	$7s^2$	$^5I_8$	6.2817	Köhler et al. (1997)
99	Es	Einsteinium	[Rn] $5f^{11}$	$7s^2$	$^4I^o_{15/2}$	6.42	Sugar (1974)
100	Fm	Fermium	[Rn] $5f^{12}$	$7s^2$	$^3H_6$	6.50	Sugar (1974)
101	Md	Mendelevium	[Rn] $5f^{13}$	$7s^2$	$^2F^o_{7/2}$	6.58	Sugar (1974)
102	No	Nobelium	[Rn] $5f^{14}$	$7s^2$	$^1S_0$	6.65	Sugar (1974)
103	Lr	Lawrencium	[Rn] $5f^{14}$	$7s^2\ 7p$?	$^2P^o_{1/2}$?	4.9 ?	Eliav et al. (1995)
104	Rf	Rutherfordium	[Rn] $5f^{14}\ 6d^2$	$7s^2$?	$^3F_2$?	6.0 ?	Eliav et al. (1995)

Return to Table Introduction