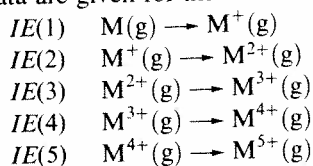


Appendices from Inorganic Chemistry, 4th ed. by Housecroft and Sharpe (Pearson, 2012).

Appendix 8 ★★ See your textbook (Appendix B.1) for a table of ionic radii. ★★

Ground state electronic configurations of the elements and ionization energies

Data are given for the first five ionizations. [†] $IE(n)$ in kJ mol^{-1} for the processes:



Atomic number, Z	Element	Ground state electronic configuration	$IE(1)$	$IE(2)$	$IE(3)$	$IE(4)$	$IE(5)$
1	H	$1s^1$	1312				
2	He	$1s^2 = [\text{He}]$	2372	5250			
3	Li	$[\text{He}]2s^1$	520.2	7298	11820		
4	Be	$[\text{He}]2s^2$	899.5	1757	14850	21010	
5	B	$[\text{He}]2s^2 2p^1$	800.6	2427	3660	25030	32830
6	C	$[\text{He}]2s^2 2p^2$	1086	2353	4620	6223	37830
7	N	$[\text{He}]2s^2 2p^3$	1402	2856	4578	7475	9445
8	O	$[\text{He}]2s^2 2p^4$	1314	3388	5300	7469	10990
9	F	$[\text{He}]2s^2 2p^5$	1681	3375	6050	8408	11020
10	Ne	$[\text{He}]2s^2 2p^6 = [\text{Ne}]$	2081	3952	6122	9371	12180
11	Na	$[\text{Ne}]3s^1$	495.8	4562	6910	9543	13350
12	Mg	$[\text{Ne}]3s^2$	737.7	1451	7733	10540	13630
13	Al	$[\text{Ne}]3s^2 3p^1$	577.5	1817	2745	11580	14840
14	Si	$[\text{Ne}]3s^2 3p^2$	786.5	1577	3232	4356	16090
15	P	$[\text{Ne}]3s^2 3p^3$	1012	1907	2914	4964	6274
16	S	$[\text{Ne}]3s^2 3p^4$	999.6	2252	3357	4556	7004
17	Cl	$[\text{Ne}]3s^2 3p^5$	1251	2298	3822	5159	6540
18	Ar	$[\text{Ne}]3s^2 3p^6 = [\text{Ar}]$	1521	2666	3931	5771	7238
19	K	$[\text{Ar}]4s^1$	418.8	3052	4420	5877	7975
20	Ca	$[\text{Ar}]4s^2$	589.8	1145	4912	6491	8153
21	Sc	$[\text{Ar}]4s^2 3d^1$	633.1	1235	2389	7091	8843
22	Ti	$[\text{Ar}]4s^2 3d^2$	658.8	1310	2653	4175	9581
23	V	$[\text{Ar}]4s^2 3d^3$	650.9	1414	2828	4507	6299
24	Cr	$[\text{Ar}]4s^1 3d^5$	652.9	1591	2987	4743	6702

[†] Values are from several sources, but mostly from the *Handbook of Chemistry and Physics* (1993) 74th edn, CRC Press, Boca Raton, FL, and from the NIST Physics Laboratory, Physical Reference Data. The values in kJ mol^{-1} are quoted to four significant figures or less depending upon the accuracy of the original data in eV. A conversion factor of $1 \text{ eV} = 96.485 \text{ kJ mol}^{-1}$ has been applied.

Atomic number, Z	Element	Ground state electronic configuration	$IE(1)$	$IE(2)$	$IE(3)$	$IE(4)$	$IE(5)$
25	Mn	[Ar]4s ² 3d ⁵	717.3	1509	3248	4940	6990
26	Fe	[Ar]4s ² 3d ⁶	762.5	1562	2957	5290	7240
27	Co	[Ar]4s ² 3d ⁷	760.4	1648	3232	4950	7670
28	Ni	[Ar]4s ² 3d ⁸	737.1	1753	3395	5300	7339
29	Cu	[Ar]4s ¹ 3d ¹⁰	745.5	1958	3555	5536	7700
30	Zn	[Ar]4s ² 3d ¹⁰	906.4	1733	3833	5730	7970
31	Ga	[Ar]4s ² 3d ¹⁰ 4p ¹	578.8	1979	2963	6200	
32	Ge	[Ar]4s ² 3d ¹⁰ 4p ²	762.2	1537	3302	4411	9020
33	As	[Ar]4s ² 3d ¹⁰ 4p ³	947.0	1798	2735	4837	6043
34	Se	[Ar]4s ² 3d ¹⁰ 4p ⁴	941.0	2045	2974	4144	6590
35	Br	[Ar]4s ² 3d ¹⁰ 4p ⁵	1140	2100	3500	4560	5760
36	Kr	[Ar]4s ² 3d ¹⁰ 4p ⁶ = [Kr]	1351	2350	3565	5070	6240
37	Rb	[Kr]5s ¹	403.0	2633	3900	5080	6850
38	Sr	[Kr]5s ²	549.5	1064	4138	5500	6910
39	Y	[Kr]5s ² 4d ¹	599.8	1181	1980	5847	7430
40	Zr	[Kr]5s ² 4d ²	640.1	1267	2218	3313	7752
41	Nb	[Kr]5s ¹ 4d ⁴	652.1	1382	2416	3700	4877
42	Mo	[Kr]5s ¹ 4d ⁵	684.3	1559	2618	4480	5257
43	Tc	[Kr]5s ² 4d ⁵	702	1472	2850		
44	Ru	[Kr]5s ¹ 4d ⁷	710.2	1617	2747		
45	Rh	[Kr]5s ¹ 4d ⁸	719.7	1744	2997		
46	Pd	[Kr]5s ⁰ 4d ¹⁰	804.4	1875	3177		
47	Ag	[Kr]5s ¹ 4d ¹⁰	731.0	2073	3361		
48	Cd	[Kr]5s ² 4d ¹⁰	867.8	1631	3616		
49	In	[Kr]5s ² 4d ¹⁰ 5p ¹	558.3	1821	2704	5200	
50	Sn	[Kr]5s ² 4d ¹⁰ 5p ²	708.6	1412	2943	3930	6974
51	Sb	[Kr]5s ² 4d ¹⁰ 5p ³	830.6	1595	2440	4260	5400
52	Te	[Kr]5s ² 4d ¹⁰ 5p ⁴	869.3	1790	2698	3610	5668
53	I	[Kr]5s ² 4d ¹⁰ 5p ⁵	1008	1846	3200		
54	Xe	[Kr]5s ² 4d ¹⁰ 5p ⁶ = [Xe]	1170	2046	3099		
55	Cs	[Xe]6s ¹	375.7	2234	3400		
56	Ba	[Xe]6s ²	502.8	965.2	3619		
57	La	[Xe]6s ² 5d ¹	538.1	1067	1850	4819	5940
58	Ce	[Xe]4f ¹ 6s ² 5d ¹	534.4	1047	1949	3546	6325
59	Pr	[Xe]4f ³ 6s ²	527.2	1018	2086	3761	5551
60	Nd	[Xe]4f ⁴ 6s ²	533.1	1035	2130	3898	
61	Pm	[Xe]4f ⁵ 6s ²	538.8	1052	2150	3970	
62	Sm	[Xe]4f ⁶ 6s ²	544.5	1068	2260	3990	
63	Eu	[Xe]4f ⁷ 6s ²	547.1	1085	2404	4120	
64	Gd	[Xe]4f ⁷ 6s ² 5d ¹	593.4	1167	1990	4245	
65	Tb	[Xe]4f ⁹ 6s ²	565.8	1112	2114	3839	
66	Dy	[Xe]4f ¹⁰ 6s ²	573.0	1126	2200	3990	
67	Ho	[Xe]4f ¹¹ 6s ²	581.0	1139	2204	4100	

Atomic number, Z	Element	Ground state electronic configuration	IE(1)	IE(2)	IE(3)	IE(4)	IE(5)
68	Er	[Xe]4f ¹² 6s ²	589.3	1151	2194	4120	
69	Tm	[Xe]4f ¹³ 6s ²	596.7	1163	2285	4120	
70	Yb	[Xe]4f ¹⁴ 6s ²	603.4	1175	2417	4203	
71	Lu	[Xe]4f ¹⁴ 6s ² 5d ¹	523.5	1340	2022	4366	
72	Hf	[Xe]4f ¹⁴ 6s ² 5d ²	658.5	1440	2250	3216	
73	Ta	[Xe]4f ¹⁴ 6s ² 5d ³	728.4	1500	2100		
74	W	[Xe]4f ¹⁴ 6s ² 5d ⁴	758.8	1700	2300		
75	Re	[Xe]4f ¹⁴ 6s ² 5d ⁵	755.8	1260	2510		
76	Os	[Xe]4f ¹⁴ 6s ² 5d ⁶	814.2	1600	2400		
77	Ir	[Xe]4f ¹⁴ 6s ² 5d ⁷	865.2	1680	2600		
78	Pt	[Xe]4f ¹⁴ 6s ¹ 5d ⁹	864.4	1791	2800		
79	Au	[Xe]4f ¹⁴ 6s ¹ 5d ¹⁰	890.1	1980	2900		
80	Hg	[Xe]4f ¹⁴ 6s ² 5d ¹⁰	1007	1810	3300		
81	Tl	[Xe]4f ¹⁴ 6s ² 5d ¹⁰ 6p ¹	589.4	1971	2878	4900	
82	Pb	[Xe]4f ¹⁴ 6s ² 5d ¹⁰ 6p ²	715.6	1450	3081	4083	6640
83	Bi	[Xe]4f ¹⁴ 6s ² 5d ¹⁰ 6p ³	703.3	1610	2466	4370	5400
84	Po	[Xe]4f ¹⁴ 6s ² 5d ¹⁰ 6p ⁴	812.1	1800	2700		
85	At	[Xe]4f ¹⁴ 6s ² 5d ¹⁰ 6p ⁵	930	1600	2900		
86	Rn	[Xe]4f ¹⁴ 6s ² 5d ¹⁰ 6p ⁶ = [Rn]	1037				
87	Fr	[Rn]7s ¹	393.0	2100	3100		
88	Ra	[Rn]7s ²	509.3	979.0	3300		
89	Ac	[Rn]6d ¹ 7s ²	499	1170	1900		
90	Th	[Rn]6d ² 7s ²	608.5	1110	1930	2780	
91	Pa	[Rn]5f ² 7s ² 6d ¹	568	1130	1810		
92	U	[Rn]5f ³ 7s ² 6d ¹	597.6	1440	1840		
93	Np	[Rn]5f ⁴ 7s ² 6d ¹	604.5	1130	1880		
94	Pu	[Rn]5f ⁶ 7s ²	581.4	1130	2100		
95	Am	[Rn]5f ⁷ 7s ²	576.4	1160	2160		
96	Cm	[Rn]5f ⁷ 7s ² 6d ¹	578.0	1200	2050		
97	Bk	[Rn]5f ⁹ 7s ²	598.0	1190	2150		
98	Cf	[Rn]5f ¹⁰ 7s ²	606.1	1210	2280		
99	Es	[Rn]5f ¹¹ 7s ²	619	1220	2330		
100	Fm	[Rn]5f ¹² 7s ²	627	1230	2350		
101	Md	[Rn]5f ¹³ 7s ²	635	1240	2450		
102	No	[Rn]5f ¹⁴ 7s ²	642	1250	2600		
103	Lr	[Rn]5f ¹⁴ 7s ² 6d ¹	440 (?)				

Appendix 9

Electron affinities

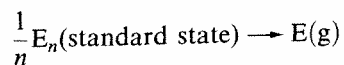
Approximate enthalpy changes, $\Delta_{\text{EA}}H(298 \text{ K})$, associated with the gain of one electron by a gaseous atom or anion. A negative enthalpy (ΔH), but a positive electron affinity (EA), corresponds to an exothermic process (see Section 1.10).
 $\Delta_{\text{EA}}H(298 \text{ K}) \approx \Delta U(0 \text{ K}) = -EA$

	Process	$\approx \Delta_{\text{EA}}H / \text{kJ mol}^{-1}$
Hydrogen	$\text{H}(\text{g}) + \text{e}^{-} \rightarrow \text{H}^{-}(\text{g})$	-73
Group 1	$\text{Li}(\text{g}) + \text{e}^{-} \rightarrow \text{Li}^{-}(\text{g})$	-60
	$\text{Na}(\text{g}) + \text{e}^{-} \rightarrow \text{Na}^{-}(\text{g})$	-53
	$\text{K}(\text{g}) + \text{e}^{-} \rightarrow \text{K}^{-}(\text{g})$	-48
	$\text{Rb}(\text{g}) + \text{e}^{-} \rightarrow \text{Rb}^{-}(\text{g})$	-47
	$\text{Cs}(\text{g}) + \text{e}^{-} \rightarrow \text{Cs}^{-}(\text{g})$	-45
Group 15	$\text{N}(\text{g}) + \text{e}^{-} \rightarrow \text{N}^{-}(\text{g})$	≈ 0
	$\text{P}(\text{g}) + \text{e}^{-} \rightarrow \text{P}^{-}(\text{g})$	-72
	$\text{As}(\text{g}) + \text{e}^{-} \rightarrow \text{As}^{-}(\text{g})$	-78
	$\text{Sb}(\text{g}) + \text{e}^{-} \rightarrow \text{Sb}^{-}(\text{g})$	-103
	$\text{Bi}(\text{g}) + \text{e}^{-} \rightarrow \text{Bi}^{-}(\text{g})$	-91
Group 16	$\text{O}(\text{g}) + \text{e}^{-} \rightarrow \text{O}^{-}(\text{g})$	-141
	$\text{O}^{-}(\text{g}) + \text{e}^{-} \rightarrow \text{O}^{2-}(\text{g})$	+798
	$\text{S}(\text{g}) + \text{e}^{-} \rightarrow \text{S}^{-}(\text{g})$	-201
	$\text{S}^{-}(\text{g}) + \text{e}^{-} \rightarrow \text{S}^{2-}(\text{g})$	+640
	$\text{Se}(\text{g}) + \text{e}^{-} \rightarrow \text{Se}^{-}(\text{g})$	-195
	$\text{Te}(\text{g}) + \text{e}^{-} \rightarrow \text{Te}^{-}(\text{g})$	-190
Group 17	$\text{F}(\text{g}) + \text{e}^{-} \rightarrow \text{F}^{-}(\text{g})$	-328
	$\text{Cl}(\text{g}) + \text{e}^{-} \rightarrow \text{Cl}^{-}(\text{g})$	-349
	$\text{Br}(\text{g}) + \text{e}^{-} \rightarrow \text{Br}^{-}(\text{g})$	-325
	$\text{I}(\text{g}) + \text{e}^{-} \rightarrow \text{I}^{-}(\text{g})$	-295

Appendix 10

Standard enthalpies of atomization ($\Delta_a H^\circ$) of the elements at 298 K

Enthalpies are given in kJ mol^{-1} for the process:



Elements (E) are arranged according to their position in the periodic table. The lanthanoids and actinoids are excluded. The noble gases are omitted because they are monatomic at 298 K.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
H 218																
Li 161	Be 324											B 582	C 717	N 473	O 249	F 79
Na 108	Mg 146											Al 330	Si 456	P 315	S 277	Cl 121
K 90	Ca 178	Sc 378	Ti 470	V 514	Cr 397	Mn 283	Fe 418	Co 428	Ni 430	Cu 338	Zn 130	Ga 277	Ge 375	As 302	Se 227	Br 112
Rb 82	Sr 164	Y 423	Zr 609	Nb 721	Mo 658	Tc 677	Ru 651	Rh 556	Pd 377	Ag 285	Cd 112	In 243	Sn 302	Sb 264	Te 197	I 107
Cs 78	Ba 178	La 423	Hf 619	Ta 782	W 850	Re 774	Os 787	Ir 669	Pt 566	Au 368	Hg 61	Tl 182	Pb 195	Bi 210	Po ≈146	At 92

Appendix 12

Selected bond enthalpy terms

Bond	Bond enthalpy / kJ mol ⁻¹	Bond	Bond enthalpy / kJ mol ⁻¹	Bond	Bond enthalpy / kJ mol ⁻¹
H-H	436	F-F	159	C-F	485
C-C	346	Cl-Cl	242	C-Cl	327
C=C	598	Br-Br	193	C-Br	285
C≡C	813	I-I	151	C-I	213
Si-Si	226	C-H	416	C-O	359
Ge-Ge	186	Si-H	326	C=O	806
Sn-Sn	152	Ge-H	289	C-N	285
N-N	159	Sn-H	251	C≡N	866
N=N	≈400	N-H	391	C-S	272
N≡N	945	P-H	322	Si-O	466
P-P	200	As-H	247	Si=O	642
P≡P	490	O-H	464	N-F	272
As-As	177	S-H	366	N-Cl	193
O-O	146	Se-H	276	N-O	201
O=O	498	F-H	570	P-F	490
S-S	266	Cl-H	432	P-Cl	319
S=S	425	Br-H	366	P-O	340
Se-Se	193	I-H	298	S-F	326