Periodic Table of the Elements

	IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIII			IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
1	1 **H** 1.008																	2 **He** 4.00
2	3 **Li** 6.94	4 **Be** 9.01											5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
3	11 **Na** 22.99	12 **Mg** 24.30											13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.06	17 **Cl** 35.45	18 **Ar** 39.95
4	19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.88	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.69	29 **Cu** 63.55	30 **Zn** 65.38	31 **Ga** 69.72	32 **Ge** 72.59	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.90	36 **Kr** 83.80
5	37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.94	43 **Tc** (98)	44 **Ru** 101.1	45 **Rh** 102.9	46 **Pd** 106.4	47 **Ag** 107.9	48 **Cd** 112.4	49 **In** 114.8	50 **Sn** 118.7	51 **Sb** 121.8	52 **Te** 127.6	53 **I** 126.9	54 **Xe** 131.3
6	55 **Cs** 132.9	56 **Ba** 137.3	57 **La** 138.9	72 **Hf** 178.5	73 **Ta** 180.9	74 **W** 183.8	75 **Re** 186.2	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.1	79 **Au** 197.0	80 **Hg** 200.6	81 **Tl** 204.4	82 **Pb** 207.2	83 **Bi** 209.0	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
7	87 **Fr** (223)	88 **Ra** 226.0	89 **Ac** 227.0	104 (261)	105 (262)	106 (263)												

Lanthanides	58 **Ce** 140.1	59 **Pr** 140.9	60 **Nd** 144.2	61 **Pm** (145)	62 **Sm** 150.4	63 **Eu** 152.0	64 **Gd** 157.2	65 **Tb** 158.9	66 **Dy** 162.5	67 **Ho** 164.9	68 **Er** 167.3	69 **Tm** 168.9	70 **Yb** 173.0	71 **Lu** 175.0
Actinides	90 **Th** 232.0	91 **Pa** 231.0	92 **U** 238.0	93 **Np** 237.0	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (260)

Useful Information

$PV = nRT$

$R = 0.0821 \frac{L \cdot atm}{mol \cdot K} = 8.314 \frac{J}{mol \cdot K}$

$\ln\left(\frac{vp_2}{vp_1}\right) = -\frac{\Delta H^\circ_{vap}}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$

density of $H_2O = 1.00 \frac{g}{cm^3}$

edge length (l) = 2r

edge length (l) = $2\sqrt{2} \cdot$ r

edge length (l) = $\frac{4r}{\sqrt{3}}$

density of $H_2O = 1.00 \frac{g}{cm^3}$

$\Delta H^\circ_{rxn} = \Sigma(\Delta H_f^\circ(\text{products})) - \Sigma(\Delta H_f^\circ(\text{reactants}))$

$\Delta S^\circ_{rxn} = \Sigma(S^\circ(\text{products})) - \Sigma(S^\circ(\text{reactants}))$

$\Delta G^\circ_{rxn} = \Sigma(\Delta G_f^\circ(\text{products})) - \Sigma(\Delta G_f^\circ(\text{reactants}))$

$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$

Temperature (°C)	Vapor Pressure(mmHg)	Temperature (°C)	Vapor Pressure(mmHg)
-5	3.2	50	92.5
0	4.6	55	118.0
5	6.52	60	149.4
10	9.20	65	187.5
15	12.8	70	233.7
20	17.5	75	289.1
25	23.8	80	355.1
30	31.8	85	433.6
35	42.1	90	525.8
40	55.3	95	633.9
45	71.9	100	760

Solubility Table

Ion	Solubility	Exceptions
NO_3^-	soluble	none
ClO_4^-	soluble	none
Cl^-	soluble	except Ag^+, Hg_2^{2+}, *Pb^{2+}
I^-	soluble	except Ag^+, Hg_2^{2+}, Pb^{2+}
SO_4^{2-}	soluble	except Ca^{2+}, Ba^{2+}, Sr^{2+}, Hg^{2+}, Pb^{2+}, Ag^+
CO_3^{2-}	insoluble	except Group IA and NH_4^+
PO_4^{3-}	insoluble	except Group IA and NH_4^+
^-OH	insoluble	except Group IA, *Ca^{2+}, Ba^{2+}, Sr^{2+}
S^{2-}	insoluble	except Group IA, IIA and NH_4^+
Na^+	soluble	none
NH_4^+	soluble	none
K^+	soluble	none

*slightly soluble

Thermodynamic Values (25 ˚C)

Substance and State	ΔH^o_f $\left(\frac{kJ}{mol}\right)$	ΔG^o_f $\left(\frac{kJ}{mol}\right)$	S^o $\left(\frac{J}{K \cdot mol}\right)$
Carbon			
C(*s*) (graphite)	0	0	6
C(*s*) (diamond)	2	3	2
CO(*g*)	-110.5	-137	198
CO_2(*g*)	-393.5	-394	214
CH_4(*g*)	?	-51	186
CH_3OH(*g*)	-201	-163	240
CH_3OH(*l*)	-239	-166	127
CH_3Cl(*g*)	-80.8	-57.4	234
$CHCl_3$(*g*)	-100.8		
$CHCl_3$(*l*)	-131.8		
H_2CO(*g*)	-116	-110	219
HCOOH(*g*)	-363	-351	249
HCN(*g*)	135.1	125	202
C_2H_2(*g*)	227	209	201
C_2H_4(*g*)	52	68	219
CH_3CHO(*g*)	-166	-129	250
C_2H_5OH(*l*)	-278	-175	161
C_2H_6(*g*)	-84.7	-32.9	229.5
C_3H_6(*g*)	20.9	62.7	266.9
C_3H_8(*g*)	-104	-24	270
Bromine			
Br_2(*l*)	0	0	152.
BrCl(*g*)	14.64	-0.96	240
Chlorine			
Cl_2(*g*)	0	0	223
Cl_2(*aq*)	-23	7	121
Cl^-(*aq*)	-167	-131	57
HCl(*g*)	-92	-95	187
Fluorine			
F_2(*g*)	0	0	203
F^-(*aq*)	-333	-279	-14
HF(*g*)	-271	-273	174
Hydrogen			
H_2(*g*)	0	0	131
H(*g*)217	203	115	
H^+(*aq*)	0	0	0
OH^-(*aq*)	-230	-157	-11
H_2O(*l*)			
H_2O(*g*)	-242	-229	189
Magnesium			
Mg(s)	0	0	33
Mg(aq)	-492	-456	-118
MgO(s)	-601	-569	26.9

Substance and State	ΔH^o_f $\left(\frac{kJ}{mol}\right)$	ΔG^o_f $\left(\frac{kJ}{mol}\right)$	S^o $\left(\frac{J}{K \cdot mol}\right)$
Oxygen			
O_2(*g*)	0	0	205
O(*g*)249	232	161	
O_3(*g*)	143	163	239
Nitrogen			
N_2(*g*)	0	0	192
NCl_3(*g*)	230	271	-137
NF_3(*g*)	-125	-83.6	-139
NH_3(*g*)	?	-17	193
NH_3(*aq*)	?	-27	111
NH_2CONH_2(aq)	?	?	174
NO(*g*)	90	87	211
NO_2(*g*)	32	52	240
N_2O(*g*)	82	104	220
N_2O_4(*g*)	10	98	304
N_2O_5(*g*)	-42	134	178
HNO_3(*aq*)	-207	-111	146
HNO_3(*l*)	-174	-81	156
NH_4Cl(s)	-314	-201	95
NH_4ClO_4(*s*)	-295	-89	186
Silver			
Ag(*s*)	0	0	42.6
Ag^+(*aq*)	105.6	77.1	72.7
$Ag(S_2O_3)^{3-}$(*aq*)	-1285.7	--	--
AgBr(s)	-100.4	-96.9	107.1
AgCl(s)	-127.1	-109.8	96.2
Sulfur			
S(rhombic)	0	0	31.8
SO_2(g)	-296.8	-300.2	248.8
SO_3(g)	-395.7	-371.1	256.3
H_2S(g)	-20.17	-33.0	205.6
Titanium			
$TiCl_4$(*g*)	-763	-727	355
TiO_2(*s*)	-945	-890	50
Aluminum			
$AlCl_3$(*s*)	-526	-505	184
Barium			
$BaCl_2$(*aq*)	-872	-823	123
$Ba(OH)_2 \cdot 8H_2O$(s)	-3342	-2793	427
Iodine			
I_2(*s*)	0	0	116.7
HI(*g*)	25.94	1.30	206.3

Simple Ionic Structures Grouped According to Anion Packing

Structure Name	Anion Packing	Coordination Number	Sites Occupied by Cations	Examples
Rock Salt	ccp	6:6 MO	all octahedral	NaCl, LiF, KBr, CdO, FeO, MgO
Zinc Blende	ccp	4:4 MO	$\frac{1}{2}$ tetrahedral	ZnS, BeO, SiC
Antifluorite	ccp	4:8 M_2O	all tetrahedral	Li_2O, sulfides
Rutile	distorted ccp	6:3 MO_2	$\frac{1}{2}$ octahedral	TiO_2, GeO_2, MnO_2, OsO_2
Perovskite	ccp	12:6:6 ABO_3	$\frac{1}{4}$ octahedral(B)	$CaTiO_3$, $SrSnO_3$
Spinel	ccp	4:6:4 AB_2O_4	$\frac{1}{8}$ tetrahedral(A) $\frac{1}{2}$ octahedral(B)	$MgAl_2O_4$, $FeAlO_4$
Cesium Chloride	simple cubic	8:8 MO	all cubic	CsCl, CsBr, CsI
Florite	simple cubic	8:4 MO_2	$\frac{1}{2}$ cubic	CaF_2, UO_2, ThO_2

Lattice Types and Radius Ratios of Cations and Anions

Radius Ratio (Cation/Anion)	Lattice Type	Coordination Number of Cation	Coordination Number of Anion
A. 1:1 Stoichiometry of Salt (MX)			
0.225 – 0.414	Zinc Blende	4	4
0.414 – 0.732	Rock salt (NaCl)	6	6
0.732 – 1.000	Cesium chloride	8	8
B. 1:2 Stoichiometry of Salt (MX_2)			
0.225 – 0.414	Beta-quartz	4	2
0.414 – 0.732	Rutile (TiO_2)	6	3
0.732 – 1.000	Fluorite (CaF_2)	8	4