

H	2.20
Li	0.98
Be	1.57
Na	0.93
Mg	1.31
K	0.82
Ca	1.00
Sc	1.36
Rb	0.82
Sr	Y
Cs	0.95
Ba	1.22
La	1.1
Fr	0.79
Ra	Ac
Og	0.7
He	1.8

1s² 2s² 2p⁶ 3s² 3p⁶ 4s² 3d¹⁰ 4p⁶ 5s² 4d¹⁰ 5p⁶ 6s² 4f¹⁴ 5d¹⁰ 6p⁶ 7s² 5f¹⁴ 6d¹⁰ 7p⁶

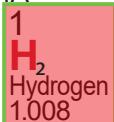
PERIODIC TABLE OF ELEMENTS

$$\begin{aligned}\Delta H_{\text{vap}} &= -\Delta H_{\text{cond}} = 40.67 \text{ kJ/mol} \\ C_{\text{water}} &= 4.184 \text{ J/(g} \cdot \text{K)} \\ C_{\text{steam}} &= 1.865 \text{ J/(g} \cdot \text{K)} \\ C_{\text{ice}} &= 2.11 \text{ J/(g} \cdot \text{K)} \\ \Delta H_{\text{fus}} &= -\Delta H_{\text{solid}} = 6.01 \text{ J/(g} \cdot \text{K)}\end{aligned}$$

$$P \propto V^{-1} \text{ and } V \propto T$$

$$\left[P + \frac{an^2}{V^2} \right] [V - nb] = nRT$$

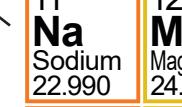
IA 1



IIA 2



IIIIB



IIIB



Radius
Metallic Character

Electronegativity
Electron Affinity
Effective Nuclear Charge

CO₂
CO
CH₄
C₂H₆
C₃H₈
C₄H₁₀
NO
NO₂
N₂O
NH₃
SO₃
SO₂
H₂S
HCl

(Ideal Gas Law) $PV = nRT$

Combined Gas) $\frac{PV}{T} = k$ (for constant amount)

(Molarity) $M = \frac{\text{moles solute}}{\text{L solution}}$

(Molality) $m = \frac{\text{moles solute}}{\text{kg solvent}}$

(Mole Fraction) $x = \frac{\text{moles component}}{\text{moles total}}$

(Graham) $\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$

$v_{\text{rms}} = \sqrt{\frac{3RT}{M}}$

pH = $-\log_{10}[H^+]$

pH + pOH = 14

Radius
Metallic Character

Electronegativity
Ionization Energy
Electron Affinity

Effective Nuclear Charge

Z_{eff}

$\frac{1}{Z_{\text{eff}}} = \frac{1}{Z} + \frac{1}{N}$

$\Delta E = q + w = q - P\Delta V$

$\Delta H = \Delta E + P\Delta V$

$P_{\text{sea}} = 101325 \text{ Pa} = 1 \text{ atm} = 760 \text{ mmHg, torr} = 14.7 \text{ psi}$

$K_{b,\text{water}} = 0.512$

$K_f_{\text{water}} = 1.86$

$\rho_{\text{water}} = 1 \text{ g/mL}$

$\Delta E = R_H = \frac{1}{m^2} - \frac{1}{n^2}$

$\lambda = \frac{h}{p}$

$E_{\text{photon}} = h\nu = hc/\lambda$

$E_n = -\frac{R_H}{n^2}$

$R_H = 2.18 \times 10^{-18} \text{ J (Rydberg)}$

$\Delta E = R_H \left(\frac{1}{m^2} - \frac{1}{n^2} \right)$

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$E_n = -\frac{R_H}{n^2}$

$R_H = 2.18 \times 10^{-18} \text{ J (Rydberg)}$

$\Delta E = R_H \left(\frac{1}{m^2} - \frac{1}{n^2} \right)$

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Solubility Chart

Cations	Soluble with _____ (aq)	Forms Precipitates with _____ (s)
Na^+ , K^+ , and NH_4^+	Most Anions	$(\text{NH}_4)_2\text{C}_2\text{O}_4$ forms a precipitate
Bi^{3+}	Nothing	Most anions
As^{3+}	I^{1-}	Most anions
Sb^{3+}	Cl^{1-}	Most anions

Anions	Soluble with _____ (aq)	Forms Precipitates with _____ (s)
NO_3^{1-} nitrate	Most cations	No common cations
ClO_4^{1-} perchlorate	Most cations	No common cations
ClO_3^{1-} chlorate	Most cations	No common cations
$\text{C}_2\text{H}_3\text{O}_2^{1-}$ acetate	Most cations	$\text{Ag}^{1+}, \text{Hg}_2^{2+}$
F^{1-} fluoride	Most cations	Cr^{3+}
Cl^{1-} chloride	Most cations	$\text{Ag}^+, \text{Pb}^{2+, 4+}, \text{Hg}_2^{2+}, \text{Tl}^{1+}$
Br^{1-} bromide	Most cations	$\text{Ag}^+, \text{Pb}^{2+, 4+}, \text{Hg}_2^{2+}, \text{Tl}^{1+}$
I^{1-} iodide	Most cations	$\text{Ag}^+, \text{Pb}^{2+, 4+}, \text{Hg}_2^{2+}, \text{Tl}^{1+}$
SO_4^{2-} sulfate	Most cations	$\text{Ag}^+, \text{Ba}^{2+}, \text{Sr}^{2+}, \text{Pb}^{2+, 4+}, \text{Ca}^{2+}, \text{Hg}_2^{2+}$
CrO_4^{2-} chromate	Most cations	$\text{Ba}^{2+}, \text{Sr}^{2+}, \text{Pb}^{2+, 4+}, \text{Ca}^{2+}, \text{Hg}_2^{2+}$
S^{2-} sulfide	$\text{Na}^+, \text{K}^+, \text{NH}_4^+, \text{Li}^+, \text{Sr}^{2+}$	Most other cations
OH^{1-} hydroxide	$\text{Na}^+, \text{K}^+, \text{NH}_4^+, \text{Li}^+, \text{Sr}^{2+}, \text{Ba}^{2+}, \text{Ca}^{2+}$	Most other cations
CO_3^{2-} carbonate	$\text{Na}^+, \text{K}^+, \text{NH}_4^+, \text{Li}^+$	Most other cations
PO_4^{3-} phosphate	$\text{Na}^+, \text{K}^+, \text{NH}_4^+$	Most other cations
O^{2-} oxide	No common cations	Most cations

Polyatomic Ions			
1+		2-	
$(\text{NH}_4)^{+1}$	ammonium	$(\text{CrO}_4)^{-2}$	chromate
		$(\text{Cr}_2\text{O}_7)^{-2}$	dichromate
	1-	$(\text{CO}_3)^{-2}$	carbonate
$(\text{NO}_3)^{-1}$	nitrate	$(\text{HPO}_4)^{-2}$	dibasic phosphate or <u>hydrogen phosphate</u>
$(\text{NO}_2)^{-1}$	nitrite		
$(\text{OH})^{-1}$	hydroxide		
$(\text{HCO}_3)^{-1}$	bicarbonate or hydrogen carbonate	$(\text{MnO}_4)^{-2}$	manganate
$(\text{C}_2\text{H}_3\text{O}_2)^{-1}$	acetate	$(\text{O}_2)^{-2}$	peroxide
$(\text{ClO}_4)^{-1}$	perchlorate	$(\text{S}_2\text{O}_3)^{-2}$	thiosulfate
$(\text{ClO}_3)^{-1}$	chlorate	$(\text{SO}_4)^{-2}$	sulfate
$(\text{ClO}_2)^{-1}$	chlorite	$(\text{SO}_3)^{-2}$	sulfite
$(\text{ClO})^{-1}$	hypochlorite	$(\text{C}_2\text{O}_4)^{-2}$	oxalate
			3-
$(\text{CN})^{-1}$	cyanide	$(\text{AsO}_4)^{-3}$	arsenate
$(\text{SCN})^{-1}$	thiocyanate	$(\text{AsO}_3)^{-3}$	arsenite
$(\text{HSO}_4)^{-1}$	bisulfate or hydrogen sulfate	$(\text{BO}_3)^{-3}$	borate
$(\text{MnO}_4)^{-1}$	permanganate		
$(\text{H}_2\text{PO}_4)^{-1}$	dihydrogen phosphate	$(\text{C}_6\text{H}_5\text{O}_7)^{-3}$	citrate
$(\text{IO}_4)^{-1}$	periodate	$(\text{PO}_4)^{-3}$	phosphate or tribasic phosphate
$(\text{IO}_3)^{-1}$	iodate	$(\text{PO}_3)^{-3}$	phosphite
$(\text{IO})^{-1}$	hypoiodite		4-
$(\text{NH}_2)^{-1}$	amide		
$(\text{CHO}_2)^{-1}$	formate	$(\text{SiO}_4)^{-4}$	silicate (ortho)

Atomic Ions			
+1		-1	
Li^{+1}	Lithium	F^{-1}	Fluoride
Na^{+1}	Sodium	Br^{-1}	Bromide
K^{+1}	Potassium	Cl^{-1}	Chloride
Ag^{+1}	Silver	I^{-1}	iodide
Cu^{+1}	Copper (I) or Cuprous	H^{-1}	hydride
Cs^{+1}	Cesium		
H^{+1}	Hydrogen		
+2		-2	
Mg^{+2}	Magnesium	O^{-2}	Oxide
Ca^{+2}	Calcium	O_2^{-2}	Peroxide
Ba^{+2}	Barium	S^{-2}	Sulfide
Zn^{+2}	Zinc		
Cd^{+2}	Cadmium (II)		+2 (cont)
Cr^{+2}	Chromium (II) or Chromous	Cu^{+2}	Copper (II) or Cupric
Co^{+2}	Cobalt (II) or Cobaltous	Pb^{+2}	Lead (II) or Plumbous
Hg^{+2}	Mercury (II) or Mercuric	Fe^{+2}	Iron (II) or Ferrous
Hg_2^{+2}	Mercury (I) or Mercurous	Ni^{+2}	Nickel (II)
Mn^{+2}	Manganese (II) or manganous	Sn^{+2}	Tin (II) or Stannous
		Sr^{+2}	Strontium
+3		-3	
Al^{+3}	Aluminum		
Fe^{+3}	Iron (III) or Ferric	N^{-3}	Nitride
Ni^{+3}	Nickel (III)	P^{-3}	Phosphide
Cr^{+3}	Chromium (III) or Chromic		
+4			
Pb^{+4}	Lead (IV)		
Si^{+4}	Silicon (IV)		
Sn^{+4}	Tin (IV) or Stannic		
Mn^{+4}	Manganese (IV)		

Metal Activity Series / Redox Table

Element	Metal Ion(s) Found in nature	Metal Obtained
Lithium	Li^+	$\text{Li}_{(\text{s})}$
Potassium	K^+	$\text{K}_{(\text{s})}$
Barium	Ba^{2+}	$\text{Ba}_{(\text{s})}$
Calcium	Ca^{2+}	$\text{Ca}_{(\text{s})}$
Sodium	Na^+	$\text{Na}_{(\text{s})}$
Magnesium	Mg^{2+}	$\text{Mg}_{(\text{s})}$
Aluminum	Al^{3+}	$\text{Al}_{(\text{s})}$
Manganese	Mn^{2+}	$\text{Mn}_{(\text{s})}$
Zinc	Zn^{2+}	$\text{Zn}_{(\text{s})}$
Chromium	$\text{Cr}^{3+}, \text{Cr}^{2+}$	$\text{Cr}_{(\text{s})}$
Iron	$\text{Fe}^{3+}, \text{Fe}^{2+}$	$\text{Fe}_{(\text{s})}$
Cobalt	Co^{2+}	$\text{Co}_{(\text{s})}$
Nickel	Ni^+	$\text{Ni}_{(\text{s})}$
Tin	Sn^{2+}	$\text{Sn}_{(\text{s})}$
Lead	Pb^{2+}	$\text{Pb}_{(\text{s})}$
Hydrogen	2H^+	$\text{H}_2_{(\text{g})}$
Copper	$\text{Cu}^{2+}, \text{Cu}^+$	$\text{Cu}_{(\text{s})}$
Silver	Ag^+	$\text{Ag}_{(\text{s})}$
Mercury	Hg^{2+}	$\text{Hg}_{(\text{l})}$
Platinum	Pt^{2+}	$\text{Pt}_{(\text{s})}$
Gold	$\text{Au}^{3+}, \text{Au}^+$	$\text{Au}_{(\text{s})}$

Table 20-1 Processes Leading to Oxidation and Reduction

<u>Oxidation</u>	<u>Reduction</u>
Complete loss of electrons (ionic reactions)	Complete gain of electrons (ionic reactions)
Shift of electrons away from an atom in a covalent bond	Shift of electrons toward an atom in a covalent bond
Gain of oxygen	Loss of oxygen
Loss of hydrogen by a covalent compound	Gain of hydrogen by a covalent compound
An increase in oxidation number	A decrease in oxidation number