Metric Scale

Giga (G)			Mega (M)			kilo (k)	hecto (h)	deca (da)	Basic Unit	deci (d)	centi (c)	milli (m)			micro (μ)			nano (n)
1000000000	100000000	10000000	1000000	100000	10000	1000	100	10	1	0.1	0.01	0.001	0.0001	0.00001	0.000001	0.0000001	0.00000001	0.000000001
10^9	10^8	10^7	10^6	10^5	10^4	10^3	10^2	10^1	length meter (m) mass: gram (g) volume: liter (L) time: second (s)	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}	10^{-8}	10^{-9}

Scientific Measurement

Length
1 inch = 2.54 centimeters
1 mile = 1.61 kilometers

Mass
1 kilogram = 2.204 pounds
1 ounce = 28.35 grams

Volume
1 gallon = 4.55 Litres
1 millilitre = 1 centimeter cubed

Area
1 hectare = 10000 meters squared
= 2.47 acres

Temperature Conversions

K = C + 273 $\quad C = \frac{5}{9}(F - 32) \quad F = \frac{9}{5}(C) + 32$

C = Celsius
K = Kelvin
F= Fahrenheit

Atomic Structure

$Average\ Atomic\ Mass = (mass)(abundance) + (mass)(abundance)\ldots$

Gases

1.00 atm = 760 mm Hg = 101325 Pa

$P = \frac{F}{A} \quad F = PA \quad A = \frac{F}{P}$

P= pressure (Pa)
F= force (N)
A = area (m^2)

$P_1V_1 = P_2V_2$

P = pressure (atm or Pa)
V = volume (L or mL)

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$

V = volume (L or mL)
T = temperature (K)

$\frac{P_1}{T_1} = \frac{P_2}{T_2}$

P = pressure (atm or Pa)
T = temperature (K)

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

P = pressure (atm or Pa)
V = volume (L or mL)
T = temperature (K)

1 mole = 22.4 L at STP

$PV = nRT$

P = pressure (Pa or atm)
V = volume (L)
n = moles (mol)
R = 0.0821 L atm/mol K or 8314 L Pa/mol K
T = temperature (K)

Density

$D = \frac{m}{V}$

$V = \frac{m}{D}$

$m = D \times V$

D = Density (g/mL or g/cm^3)
m = mass (g)
V = Volume (mL or cm^3)

Substance	Density (g/mL or g/cm^3)
water	1.00
ethanol	0.800
aluminum	2.70
iron	7.86
lead	11.34
gold	19.30
tin	7.31
silver	10.50
chromium	7.20
copper	8.95

Acids and Bases

$\mathbf{pH = -\log[H^+]} \qquad \mathbf{[H^+] = 10^{-pH}}$

$\mathbf{pOH = -\log[OH^-]} \qquad \mathbf{[OH^-] = 10^{-pOH}}$

$\mathbf{pH + pOH = 14.00}$

$\mathbf{[H^+]\,[OH^-] = 1.0 \times 10^{-14}}$

Solutions

$C = \frac{n}{V}$

$n = CV$

$V = \frac{n}{C}$

C = concentration (M)
n = number of moles (mol)
V = volume of solution (L)

$C_1V_1 = C_2V_2$

C_1 = initial concentration (M)
V_1 = initial volume (L)
C_2 = final concentration (M)
V_2 = final volume (L)

Solubility Table

Soluble >0.1 M at 25 °C Insoluble <0.1 M at 25 °C

Anion	Cation	Solubility
All	Alkali ions: Li^+, Na^+, K^+, Rb^+, Cs^+, Fr^+	Soluble
All	Hydrogen ion: H^+	Soluble
All	Ammonium ion: NH_4^+	Soluble
Nitrate, NO_3^- or Chlorate, ClO_3^- or Hypochlorite, ClO^- or Perchlorate, ClO_4^- or Acetate, $C_2H_3O_2^-$	All	Soluble
Chloride, Cl^- or Bromide, Br^- or Iodide, I^-	All others	Soluble
	Ag^+, Pb^{2+}, Cu^+	Insoluble
Fluoride, F^-	All others	Soluble
	Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}	Insoluble
Sulphide, S^{2-}	Alkali ions, H^+, NH_4^+, Be^{2+}, Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}	Soluble
	All others	Insoluble
Hydroxide, OH^-	Alkali ions, H^+, NH_4^+, Ba^{2+}, Sr^{2+}	Soluble
	All others	Insoluble
Sulphate, SO_4^{2-}	All others	Soluble
	Ag^+, Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}	Insoluble
Oxalate, $C_2O_4^{2-}$ or Phosphate, PO_4^{3-} or Carbonate, CO_3^{2-} or Sulphite, SO_3^{2-}	Alkali ions, H^+, NH_4^+	Soluble
	All others	Insoluble

Light

$$c = \lambda \nu$$

$$E = h\nu$$

$$E = \frac{hc}{\lambda}$$

$E = Energy\,(J)$

$h = 6.626x10^{-34}\,Js$

$c = 3.00x10^{8}\,m/s$

$\lambda = wavelength\,(m)$

$\nu = frequency\,(Hz)$

Periodic Trends and Bonding

Electronegativity Values

H 2.1																	He 0
Li 1.0	Be 1.5											B 2.0	C 2.5	N 3.0	O 3.5	F 4.0	Ne 0
Na 0.9	Mg 1.2											Al 1.5	Si 1.8	P 2.1	S 2.5	Cl 3.0	Ar 0
K 0.8	Ca 1.0	Sc 1.3	Ti 1.5	V 1.6	Cr 1.6	Mn 1.5	Fe 1.8	Co 1.9	Ni 1.8	Cu 1.9	Zn 1.6	Ga 1.6	Ge 1.8	As 2.0	Se 2.4	Br 2.8	Kr 0
Rb 0.8	Sr 1.0	Y 1.2	Zr 1.4	Nb 1.6	Mo 1.8	Tc 1.9	Ru 2.2	Rh 2.2	Pd 2.2	Ag 1.9	Cd 1.7	In 1.7	Sn 1.8	Sb 1.9	Te 2.1	I 2.5	Xe 0
Cs 0.7	Ba 0.9	Lu 1.2	Hf 1.3	Ta 1.5	W 1.7	Re 1.9	Os 2.2	Ir 2.2	Pt 2.2	Au 2.4	Hg 1.9	Tl 1.8	Pb 1.9	Bi 1.9	Po 2.0	At 2.2	Rn 0
Fr 0.7	Ra 0.9																

Formal Charge = # valence electrons – # unshared electrons – $\frac{1}{2}$ shared electrons

Thermochemistry

Melting and Freezing

$$\Delta H = H_{fus} m$$

ΔH = Heat (J)
H_{fus} = Heat of Fusion (J/g)
m = mass (g)

Boiling and Condensing

$$\Delta H = H_{vap} m$$

ΔH = Heat (J)
H_{vap} = Heat of Vapourization (J/g)
m = mass (g)

Substance	Melting/Freezing Point (˚C)	H_{fus} (J/g)	Boiling/Condensing Point (˚C)	H_{vap} (J/g)
Water	0	334	100	2256
Aluminum	660	397	2519	10856
Gold	1064	63.7	2856	1697
Mercury	−38.8	11.4	357	295
Sulphur	115	53.6	445	1400
Methane	−182	58.6	−161	511
Ethanol	−114	109	78	586
Acetic Acid	16.6	192	118	395

Heating and Cooling

$$\Delta H = m c \Delta T$$

ΔH = Heat (J)
m = mass (g)
c = specific heat capacity (J/g˚C)
ΔT = Temperature Change (˚C)
(Final Temperature – Initial Temperature)

Specific Heat Capacity

Substance	Specific Heat Capacity (J/g˚C)
Ice	2.09
Water	4.18
Steam	2.00
Aluminum	0.920
Gold	0.130
Silver	0.240
Lead	0.130
Copper	0.390
Iron	0.450
Ethanol	2.50
Air	0.995
Glass	0.840

Heats of Formation

ΔH = total Hf products – total Hf reactants

ΔHf = 0 for elements in standard state

Standard State	Elements in Standard State
Solid metals	any solid metal
Solid non metals	C (s) or I_2 (s)
Gases	H_2 (g), F_2 (g), N_2 (g), O_2 (g), or Cl_2 (g)
Liquids	Br_2 (l) or Hg (l)

ΔHf for compounds

Substance	Heat of Formation ΔHf (kJ/mol)
CO_2 (g)	−393.5
CO (g)	−110.5
CH_4 (g)	−74.6
C_2H_2 (g)	+54.5
C_2H_4 (g)	+52.5
C_2H_6 (g)	−83.8
C_3H_8 (g)	−104.7
C_4H_{10} (g)	−125.6
C_8H_{18} (l)	−250.1
C_6H_6 (l)	+49.0
CH_3OH (l)	−239.1
C_2H_5OH (l)	−235.2
C_2H_3Cl (g)	+37.3
H_2SO_4 (l)	−814.0
HCl (g)	−92.3
H_2O (l)	−285.8
H_2O (g)	−242.0
H_2O_2 (g)	−187.8
SO_2 (g)	−296.8
SO_3 (g)	−395.7
NO (g)	+90.2
NO_2 (g)	+33.2
NH_4Cl (s)	−314.4
NH_3 (g)	−45.9
H_2S (g)	−20.6
HNO_3 (l)	−174.1
Fe_2O_3 (s)	−824.2
ZnO (s)	−348.3

Bond Energies

ΔH = total energy of bonds broken – total energy of bonds formed

Bond	Bond Energy (kJ/mol)
C–C	348
C=C	614
C≡C	839
C–H	413
C–O	360
C=O	805
C–N	308
O=O	498
H–H	436
F–F	159
Cl–Cl	199
Br–Br	228
I–I	151
H–F	568
H–O	464
H–Cl	432
H–Br	366
H–I	298
N–H	391
N≡N	945