CHEMICAL DATA AND CONSTANTS

QUANTITY	APPROXIMATE VALUE
Standard atmospheric pressure	1.000 atm
	101.3 kPa
	760.0 mm Hg
Absolute zero temperature (zero kelvin)	–273 °C
Standard temperature and pressure (S.T.P.)	0°C (273 K) and 101.3 kPa
Standard laboratory conditions (S.L.C.)	25°C (298 K) and 101.3 kPa
Avogadro's constant (N_A)	6.022×10^{23} mol^{-1}
Ideal gas constant (R)	0.0821 L atm K^{-1} mol^{-1}
	8.31 J K^{-1} mol^{-1}
	8.31 L kPa K^{-1} mol^{-1}
	62.4 L mm Hg K^{-1} mol^{-1}
Molar volume of an ideal gas (S.T.P.)	22.4 L mol^{-1}
Molar volume of an ideal gas (S.L.C.)	24.5 L mol^{-1}
Charge on the electron	-1.602×10^{-19} C
Faraday's constant (F)	96 500 C mol^{-1}
Specific heat of water (c_w)	4.184 J g^{-1} K^{-1}
Density of liquid water	1.00 g mL^{-1}
One litre (1.00 L)	1000 mL or 1000 cm^3
One cubic metre (1.00 m^3)	1000 L

UNIT PREFIXES:

nano (n)	micro (μ)	milli (m)	kilo (k)	mega (M)	giga (G)	tera (T)
10^{-9}	10^{-6}	10^{-3}	10^{3}	10^{6}	10^{9}	10^{12}

CHEMICAL INFORMATION:

$$n = \frac{m}{M}$$

n	=	amount of substance (mol)
m	=	mass (g)
M	=	molar mass (g mol^{-1})

$$N = nN_A$$

N	=	number of particles
N_A	=	Avogadro's constant (see p.1)

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

c	=	concentration (mol L^{-1})
V	=	volume of solution (L)

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

Combined Gas Equation (n constant)

V	=	gas volume
P	=	gas pressure
T	=	temperature (K)

$$PV = nRT$$

R	=	Ideal Gas Constant (see p.1)

$$n(e^-) = \frac{q}{F} = \frac{It}{F}$$

$n(e^-)$	=	amount of electrons (mol)
q	=	electrical charge (C)
F	=	Faraday Constant (see p.1)

$$E = mc\Delta T$$

E	=	energy change (J)
c	=	specific heat capacity (J g^{-1} K^{-1})
ΔT	=	temperature change (K)

$$E = VIt$$

V	=	potential difference (V)
I	=	electrical current (A)
t	=	time (s)

$$C_f = \frac{VIt}{\Delta T}$$

$$C_f = \frac{E}{\Delta T}$$

ΔT	=	temperature change (K)
C_f	=	calibration factor (J K^{-1})

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

ρ	=	density (g mL^{-1} or g L^{-1})

COMMON POSITIVE IONS (CATIONS)

1+	2+	3+	4+
ammonium NH_4^+	barium Ba^{2+}	aluminium Al^{3+}	tin(IV) Sn^{4+}
hydrogen H^+	calcium Ca^{2+}	chromium(III) Cr^{3+}	lead(IV) Pb^{4+}
lithium Li^+	copper(II) Cu^{2+}	iron(III) Fe^{3+}	
potassium K^+	iron(II) Fe^{2+}		
silver Ag^+	lead(II) Pb^{2+}		
sodium Na^+	magnesium Mg^{2+}		
	mercury(II) Hg^{2+}		
	nickel(II) Ni^{2+}		
	tin(II) Sn^{2+}		
	zinc Zn^{2+}		

COMMON NEGATIVE IONS (ANIONS)

1−	2−	3−
bromide Br^-	carbonate CO_3^{2-}	nitride N^{3-}
chloride Cl^-	chromate CrO_4^{2-}	phosphate PO_4^{3-}
dihydrogen phosphate $H_2PO_4^-$	dichromate $Cr_2O_7^{2-}$	phosphide P^{3-}
ethanoate (acetate) CH_3COO^-	hydrogen phosphate HPO_4^{2-}	
fluoride F^-	oxalate $C_2O_4^{2-}$	
hydride H^-	oxide O^{2-}	
hydrogen carbonate HCO_3^-	sulfate SO_4^{2-}	
hydrogen sulfate HSO_4^-	sulfide S^{2-}	
hydrogen sulfide HS^-	sulfite SO_3^{2-}	
hydrogen sulfite HSO_3^-	thiosulfate $S_2O_3^{2-}$	
hydroxide OH^-		
iodide I^-		
nitrate NO_3^-		
nitrite: NO_2^-		
permanganate MnO_4^-		

SOLUBILITY TABLE FOR SOME IONIC COMPOUNDS

Negative Ions (anions)	Solubility of Compounds
ethanoates (acetates) (CH_3COO^-)	All soluble
nitrates (NO_3^-)	All soluble
chlorides (Cl^-)	All soluble except $AgCl$, $PbCl_2$
bromides (Br^-)	All soluble except $AgBr$, $PbBr_2$
iodides (I^-)	All soluble except AgI, PbI_2
sulfates (SO_4^{2-})	All soluble except $BaSO_4$, $CaSO_4$, $SrSO_4$, $PbSO_4$, Ag_2SO_4
hydroxides (OH^-)	Insoluble except $LiOH$, $NaOH$, KOH, $RbOH$, NH_4OH, $Sr(OH)_2$, $Ba(OH)_2$
sulfides (S^{2-})	Insoluble except Li_2S, Na_2S, K_2S, Rb_2S, $(NH_4)_2S$, MgS, CaS, SrS, BaS
carbonates (CO_3^{2-})	Insoluble except Li_2CO_3, Na_2CO_3, K_2CO_3, Rb_2CO_3, $(NH_4)_2CO_3$
phosphates (PO_4^{3-})	Insoluble except Li_3PO_4, Na_3PO_4, K_3PO_4, Rb_3PO_4, $(NH_4)_3PO_4$
sulfites (SO_3^{2-})	Insoluble except Li_2SO_3, Na_2SO_3, K_2SO_3, Rb_2SO_3, $(NH_4)_2SO_3$

CHEMICAL EQUILIBRIUM FORMULAE:

For the equilibrium system:

$$xP + yQ \rightleftharpoons zR + wS$$

$$K_c = \frac{[R]^z[S]^w}{[P]^x[Q]^y}$$ (where none of components P, Q, R or S is a solid)

$$K_w = [H^+_{(aq)}]\,[OH^-_{(aq)}] = 1.00 \times 10^{-14}\ \text{mol}^2\ \text{L}^{-2} \text{ at } 25^\circ\text{C}$$

$$pH = -\log[H^+_{(aq)}]$$ Note: $[H^+_{(aq)}] = [H_3O^+_{(aq)}]$

$$[H^+_{(aq)}] = 10^{-pH}$$

COMMON COLOURED AQUEOUS IONS:

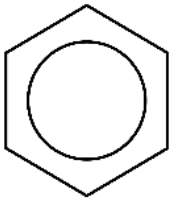
COLOURED CATIONS:			COLOURED ANIONS:		
chromium(III)	Cr^{3+}	green	chromate	CrO_4^{2-}	yellow
cobalt(II)	Co^{2+}	pink	dichromate	$Cr_2O_7^{2-}$	orange
copper(II)	Cu^{2+}	blue	permanganate	MnO_4^-	purple
iron(II)	Fe^{2+}	pale green			
iron(III)	Fe^{3+}	orange/brown			
manganese(II)	Mn^{2+}	pale pink			
nickel(II)	Ni^{2+}	green			

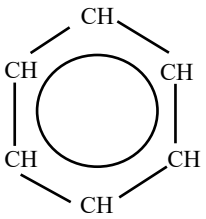
(* most other non-listed aqueous ions are colourless in solution)

ORGANIC CHEMISTRY:

Alkanes	C_nH_{2n+2}
Alkenes	C_nH_{2n}
Alkynes	C_nH_{2n-2}
Cyclic Alkanes	C_nH_{2n}
Cyclic Alkenes	C_nH_{2n-2}

Benzene: C_6H_6





STEM NAMES

Carbon atoms in chain	1	2	3	4	5	6	7	8	9	10
Stem name	meth-	eth-	prop-	but-	pent-	hex-	hept-	oct-	non-	dec-

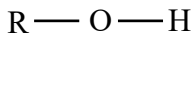
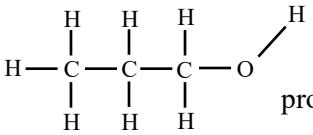
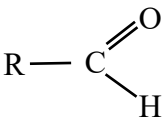
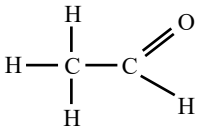
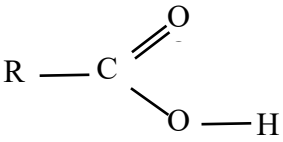
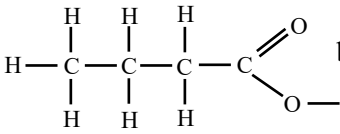
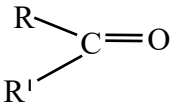
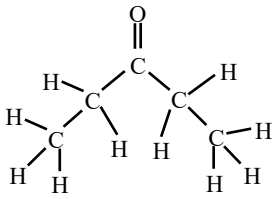
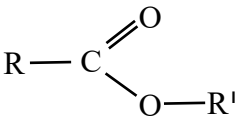
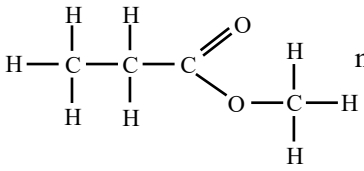
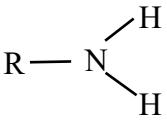
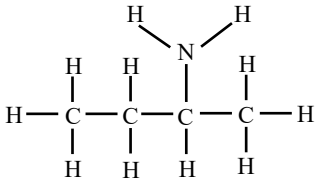
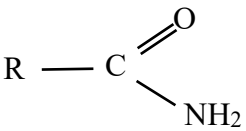
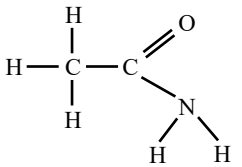
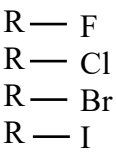
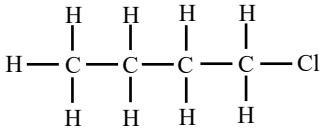
SIDE CHAINS AND SUBSTITUTES

methyl	$-CH_3$	bromo	$-Br$
ethyl	$-C_2H_5$	chloro	$-Cl$
propyl	$-C_3H_7$	fluoro	$-F$
		iodo	$-I$

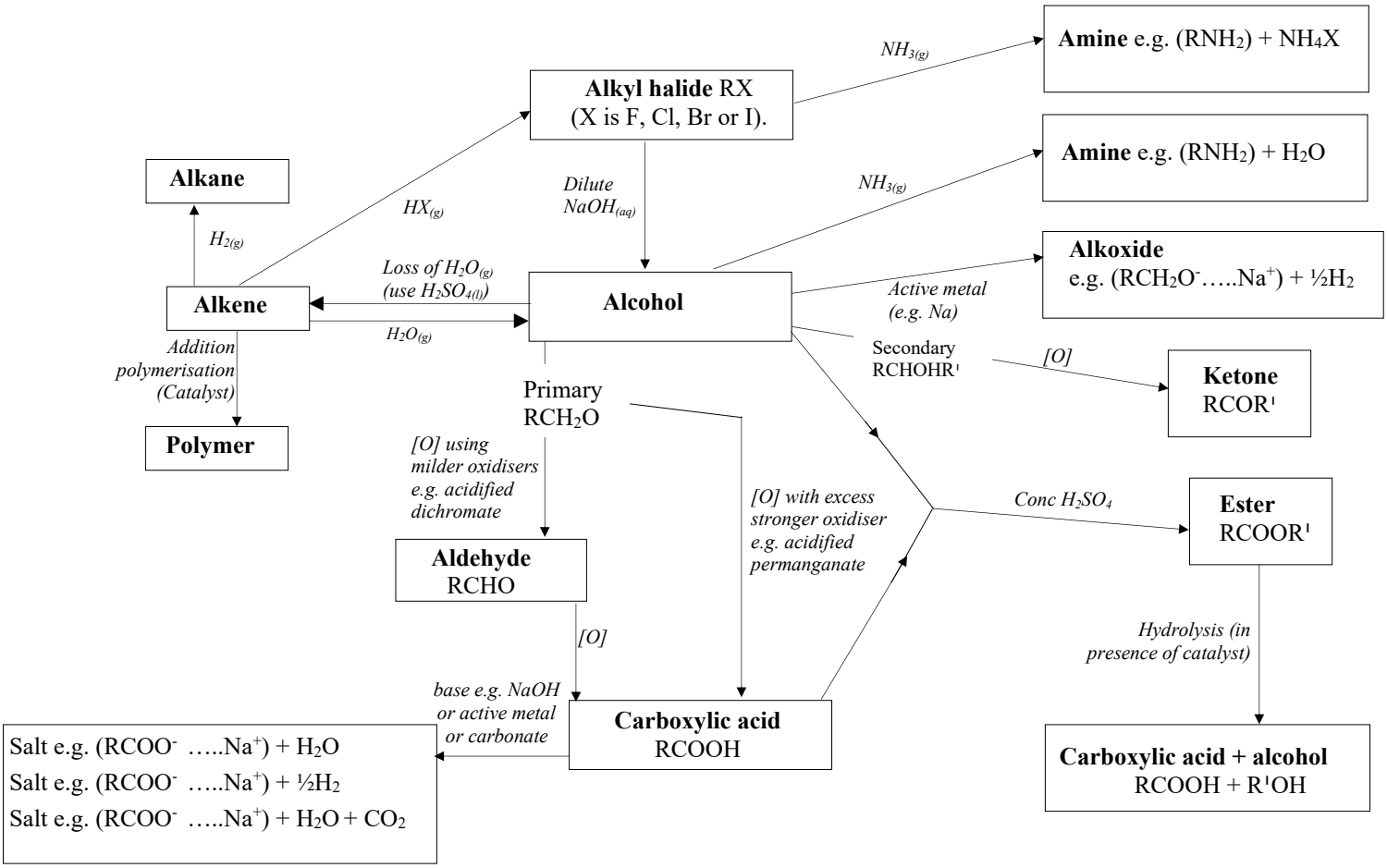
PREFIXES

Atoms in molecule	1	2	3	4	5	6	7	8	9	10
Prefix	mono-	di-	tri-	tetra-	penta-	hexa-	hepta-	octa-	nona-	deca-

ALIPHATIC FUNCTIONAL GROUPS

Compound	Functional Group	Monofunctional General Formula	Example
alcohols		$C_nH_{2n+2}O$	 propan-1-o1
aldehydes		$C_nH_{2n}O$	 ethanal
carboxylic acids		$C_nH_{2n}O_2$	 butanoic acid
ketones		$C_nH_{2n}O$	 pentan-3-one
esters		$C_nH_{2n}O_2$	 methyl propanoate
amines		$C_nH_{2n+3}N$	 butan-2-amine
amides		$C_nH_{2n+1}ON$	 ethanamide
alkyl halides		$C_nH_{2n+1}X$	 l-chlorobutane

SOME ORGANIC REACTIONS OF ALIPHATIC COMPOUNDS



FREQUENCIES OF IMPORTANT IR STRETCHING VIBRATIONS

Bond type	Wavenumber (cm^{-1})	Intensity
O – H (alcohol)	3 650 – 3 200	strong, broad
O – H (carboxylic acid)	3 300 – 2 500	strong, very broad
C = O (carbonyl)	1 780 – 1 650	strong

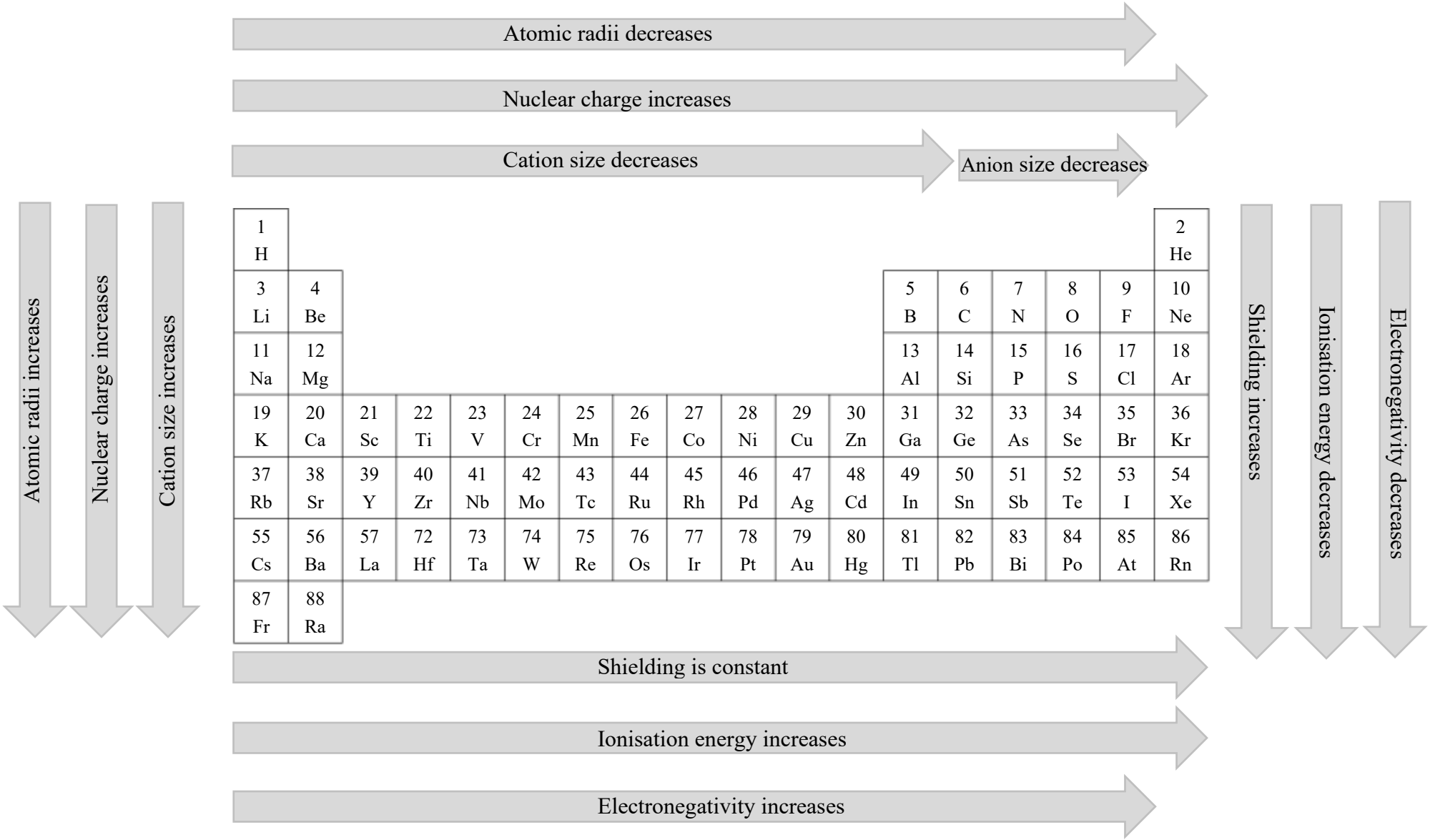
STANDARD REDUCTION POTENTIALS - AQUEOUS IONS (1 mol L^{-1} and 25°C)

VERY STRONG OXIDISERS	REDUCTION HALF-EQUATIONS	VERY WEAK REDUCERS	E°(volts)
	$F_{2(g)} + 2e^- \rightleftharpoons 2F^-_{(aq)}$		+2.87
	$H_2O_{2(aq)} + 2H^+_{(aq)} + 2e^- \rightleftharpoons 2H_2O_{(l)}$		+1.78
	$Au^{3+}_{(aq)} + 3e^- \rightleftharpoons Au_{(s)}$		+1.50
	$MnO_4^-{}_{(aq)} + 8H^+_{(aq)} + 5e^- \rightleftharpoons Mn^{2+}_{(aq)} + 4H_2O_{(l)}$		+1.49
	$Cl_{2(g)} + 2e^- \rightleftharpoons 2Cl^-_{(aq)}$		+1.36
	$Cr_2O_7^{2-}{}_{(aq)} + 14H^+_{(aq)} + 6e^- \rightleftharpoons 2Cr^{3+}_{(aq)} + 7H_2O_{(l)}$		+1.36
	$MnO_{2(s)} + 4H^+_{(aq)} + 2e^- \rightleftharpoons Mn^{2+}_{(aq)} + 2H_2O_{(l)}$		+1.28
	$O_{2(g)} + 4H^+_{(aq)} + 4e^- \rightleftharpoons 2H_2O_{(l)}$		+1.23
	$Br_{2(l)} + 2e^- \rightleftharpoons 2Br^-_{(aq)}$		+1.09
	$Ag^+_{(aq)} + e^- \rightleftharpoons Ag_{(s)}$		+0.80
	$Hg^{2+}_{(aq)} + 2e^- \rightleftharpoons Hg_{(l)}$		+0.78
	$Fe^{3+}_{(aq)} + e^- \rightleftharpoons Fe^{2+}_{(aq)}$		+0.77
	$O_{2(g)} + 2H^+_{(aq)} + 2e^- \rightleftharpoons H_2O_{2\,(aq)}$		+0.68
	$I_{2(s)} + 2e^- \rightleftharpoons 2I^-_{(aq)}$		+0.54
INCREASING STRENGTH AS OXIDISERS	$O_{2(g)} + 2H_2O_{(l)} + 4e^- \rightleftharpoons 4OH^-_{(aq)}$	INCREASING STRENGTH AS REDUCERS	+0.40
	$Cu^{2+}_{(aq)} + 2e^- \rightleftharpoons Cu_{(s)}$		+0.34
	$Sn^{4+}_{(aq)} + 2e^- \rightleftharpoons Sn^{2+}_{(aq)}$		+0.15
	$S_{(s)} + 2H^+_{(aq)} + 2e^- \rightleftharpoons H_2S_{(g)}$		+0.14
	$2H^+_{(aq)} + 2e^- \rightleftharpoons H_{2(g)}$		**0.00**
	$Pb^{2+}_{(aq)} + 2e^- \rightleftharpoons Pb_{(s)}$		–0.13
	$Sn^{2+}_{(aq)} + 2e^- \rightleftharpoons Sn_{(s)}$		–0.14
	$Ni^{2+}_{(aq)} + 2e^- \rightleftharpoons Ni_{(s)}$		–0.25
	$Co^{2+}_{(aq)} + 2e^- \rightleftharpoons Co_{(s)}$		–0.28
	$Cd^{2+}_{(aq)} + 2e^- \rightleftharpoons Cd_{(s)}$		–0.40
	$Fe^{2+}_{(aq)} + 2e^- \rightleftharpoons Fe_{(s)}$		–0.41
	$Cr^{3+}_{(aq)} + 3e^- \rightleftharpoons Cr_{(s)}$		–0.74
	$Zn^{2+}_{(aq)} + 2e^- \rightleftharpoons Zn_{(s)}$		–0.76
	$2H_2O_{(l)} + 2e^- \rightleftharpoons 2OH^-_{(aq)} + H_{2(g)}$		–0.83
	$Mn^{2+}_{(aq)} + 2e^- \rightleftharpoons Mn_{(s)}$		–1.18
	$Al^{3+}_{(aq)} + 3e^- \rightleftharpoons Al_{(s)}$		–1.71
	$Mg^{2+}_{(aq)} + 2e^- \rightleftharpoons Mg_{(s)}$		–2.38
	$Na^+_{(aq)} + e^- \rightleftharpoons Na_{(s)}$		–2.71
	$Ca^{2+}_{(aq)} + 2e^- \rightleftharpoons Ca_{(s)}$		–2.87
	$Sr^{2+}_{(aq)} + 2e^- \rightleftharpoons Sr_{(s)}$		–2.89
VERY WEAK OXIDISERS	$K^+_{(aq)} + e^- \rightleftharpoons K_{(s)}$	VERY STRONG REDUCERS	–2.92
	$Li^+_{(aq)} + e^- \rightleftharpoons Li_{(s)}$		–3.05
	OXIDATION HALF-EQUATIONS		

Name	Symbol	Atomic Number	Relative Atomic Mass	Name	Symbol	Atomic Number	Relative Atomic Mass
actinium	Ac	89	227.03	mercury	Hg	80	200.6
aluminium	Al	13	26.98	molybdenum	Mo	42	95.94
americium	Am	95	-	neodymium	Nd	60	144.2
antimony	Sb	51	121.8	neon	Ne	10	20.18
argon	Ar	18	39.95	neptunium	Np	93	-
arsenic	As	33	74.92	nickel	Ni	28	58.69
astatine	At	85	-	niobium	Nb	41	92.91
barium	Ba	56	137.3	nitrogen	N	7	14.01
berkelium	Bk	97	-	nobelium	No	102	-
beryllium	Be	4	9.012	osmium	Os	76	190.2
bismuth	Bi	83	209.0	oxygen	O	8	16.00
boron	B	5	10.81	palladium	Pd	46	106.4
bromine	Br	35	79.90	phosphorus	P	15	30.97
cadmium	Cd	48	112.4	platinum	Pt	78	195.1
caesium	Cs	55	132.9	plutonium	Pu	94	-
calcium	Ca	20	40.08	polonium	Po	84	-
californium	Cf	98	-	potassium	K	19	39.10
carbon	C	6	12.01	praseodymium	Pr	59	140.9
cerium	Ce	58	140.1	promethium	Pm	61	-
chlorine	Cl	17	35.45	protactinium	Pa	91	-
chromium	Cr	24	52.00	radium	Ra	88	226.03
cobalt	Co	27	58.93	radon	Rn	86	-
copper	Cu	29	63.55	rhenium	Re	75	186.2
curium	Cm	96	-	rhodium	Rh	45	102.9
dysprosium	Dy	66	162.5	rubidium	Rb	37	85.47
einsteinium	Es	99	-	ruthenium	Ru	44	101.1
erbium	Er	68	167.3	samarium	Sm	62	150.4
europium	Eu	63	152.0	scandium	Sc	21	44.96
fermium	Fm	100	-	selenium	Se	34	78.96
fluorine	F	9	19.00	silicon	Si	14	28.09
francium	Fr	87	-	silver	Ag	47	107.9
gadolinium	Gd	64	157.3	sodium	Na	11	22.99
gallium	Ga	31	69.72	strontium	Sr	38	87.62
germanium	Ge	32	72.63	sulfur	S	16	32.06
gold	Au	79	197.0	tantalum	Ta	73	180.9
hafnium	Hf	72	178.5	technetium	Tc	43	-
helium	He	2	4.003	tellurium	Te	52	127.6
holmium	Ho	67	164.9	terbium	Tb	65	158.9
hydrogen	H	1	1.008	thallium	Tl	81	204.4
indium	In	49	114.8	thorium	Th	90	232.0
iodine	I	53	126.9	thulium	Tm	69	168.9
iridium	Ir	77	192.2	tin	Sn	50	118.7
iron	Fe	26	55.85	titanium	Ti	22	47.87
krypton	Kr	36	83.80	tungsten	W	74	183.8
lanthanum	La	57	138.9	uranium	U	92	238.0
lawrencium	Lr	103	-	vanadium	V	23	50.94
lead	Pb	82	207.2	xenon	Xe	54	131.3
lithium	Li	3	6.941	ytterbium	Yb	70	173.0
lutetium	Lu	71	175.0	yttrium	Y	39	88.91
magnesium	Mg	12	24.31	zinc	Zn	30	65.38
manganese	Mn	25	54.94	zirconium	Zr	40	91.22
mendelevium	Md	101	-				

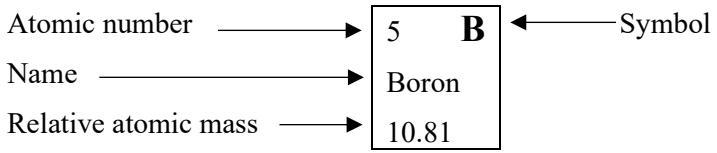
TABLE OF RELATIVE ATOMIC MASSES (BASED ON $^{12}C = 12.00$)

GENERAL PERIODIC TRENDS



1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra																

PERIODIC TABLE OF ELEMENTS



I	II											III	IV	V	VI	VII	VIII
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 **H** Hydrogen 1.008																	2 **He** Helium 4.003
3 **Li** Lithium 6.941	4 **Be** Beryllium 9.012											5 **B** Boron 10.81	6 **C** Carbon 12.01	7 **N** Nitrogen 14.01	8 **O** Oxygen 16.00	9 **F** Fluorine 19.00	10 **Ne** Neon 20.18
11 **Na** Sodium 22.99	12 **Mg** Magnesium 24.31											13 **Al** Aluminium 26.98	14 **Si** Silicon 28.09	15 **P** Phosphorus 30.97	16 **S** Sulfur 32.06	17 **Cl** Chlorine 35.45	18 **Ar** Argon 39.95
19 **K** Potassium 39.10	20 **Ca** Calcium 40.08	21 **Sc** Scandium 44.96	22 **Ti** Titanium 47.87	23 **V** Vanadium 50.94	24 **Cr** Chromium 52.00	25 **Mn** Manganese 54.94	26 **Fe** Iron 55.85	27 **Co** Cobalt 58.93	28 **Ni** Nickel 58.69	29 **Cu** Copper 63.55	30 **Zn** Zinc 65.38	31 **Ga** Gallium 69.72	32 **Ge** Germanium 72.63	33 **As** Arsenic 74.92	34 **Se** Selenium 78.96	35 **Br** Bromine 79.90	36 **Kr** Krypton 83.80
37 **Rb** Rubidium 85.47	38 **Sr** Strontium 87.62	39 **Y** Yttrium 88.91	40 **Zr** Zirconium 91.22	41 **Nb** Niobium 92.91	42 **Mo** Molybdenum 95.94	43 **Tc** Technetium	44 **Ru** Ruthenium 101.1	45 **Rh** Rhodium 102.9	46 **Pd** Palladium 106.4	47 **Ag** Silver 107.9	48 **Cd** Cadmium 112.4	49 **In** Indium 114.8	50 **Sn** Tin 118.7	51 **Sb** Antimony 121.8	52 **Te** Tellurium 127.6	53 **I** Iodine 126.9	54 **Xe** Xenon 131.3
55 **Cs** Caesium 132.9	56 **Ba** Barium 137.3	57 **La** Lanthanum 138.9	72 **Hf** Hafnium 178.5	73 **Ta** Tantalum 180.9	74 **W** Tungsten 183.8	75 **Re** Rhenium 186.2	76 **Os** Osmium 190.2	77 **Ir** Iridium 192.2	78 **Pt** Platinum 195.1	79 **Au** Gold 197.0	80 **Hg** Mercury 200.6	81 **Tl** Thallium 204.4	82 **Pb** Lead 207.2	83 **Bi** Bismuth 209.0	84 **Po** Polonium	85 **At** Astatine	86 **Rn** Radon
87 **Fr** Francium	88 **Ra** Radius	89 **Ac** Actinium	104 **Rf** Rutherfordium	105 **Db** Dubnium	106 **Sg** Seaborgium	107 **Bh** Bohrium	108 **Hs** Hassium	109 **Mt** Meitnerium	110 **Ds** Darmstadtium	111 **Rg** Roentgenium	112 **Cn** Copernicium	113 **Nh** Nihonium	114 **Fl** Flerovium	115 **Mc** Moscovium	116 **Lv** Livermorium	117 **Ts** Tennessine	118 **Og** Oganesson

58–71 Lanthanide Series	58 **Ce** Cerium 140.1	59 **Pr** Praseodymium 140.9	60 **Nd** Neodymium 144.2	61 **Pm** Promethium	62 **Sm** Samarium 150.4	63 **Eu** Europium 152.0	64 **Gd** Gadolinium 157.3	65 **Tb** Terbium 158.9	66 **Dy** Dysprosium 162.5	67 **Ho** Holmium 164.9	68 **Er** Erbium 167.3	69 **Tm** Thulium 168.9	70 **Yb** Ytterbium 173.0	71 **Lu** Lutetium 175.0
90–103 Actinide Series	90 **Th** Thorium 232.0	91 **Pa** Protactinium	92 **U** Uranium 238.0	93 **Np** Neptunium	94 **Pu** Plutonium	95 **Am** Americium	96 **Cm** Curium	97 **Bk** Berkelium	98 **Cf** Californium	99 **Es** Einsteinium	100 **Fm** Fermium	101 **Md** Mendelevium	102 **No** Nobelium	103 **Lr** Lawrencium