Data Booklet
Placement test for entry into Grade 12 Chemistry CHEM 182

Common Polyatomic Ions			
Ion	**Name**	**Ion**	**Name**
CH_3COO^-	acetate	H_3O^+	hydronium
NH_4^+	ammonium	OH^-	hydroxide
$C_6H_5COO^-$	benzoate	ClO^-	hypochlorite
BO_3^{3-}	borate	IO_3^-	iodate
C_2^{2-}	carbide	Hg_2^{+2}	mercury(I)
CO_3^{2-}	carbonate	NO_3^-	nitrate
ClO_3^-	chlorate	NO_2^-	nitrite
ClO_2^-	chlorite	$OOCCOO^{-2}$	oxalate
CrO_4^{2-}	chromate	ClO_4^-	perchlorate
CN^-	cyanide	MnO_4^-	permanganate
$Cr_2O_7^{2-}$	dichromate	O_2^{2-}	peroxide
$H_2PO_4^-$	dihydrogen phosphate	S_2^{2-}	persulfide
HCO_3^-	hydrogen carbonate (bicarbonate)	PO_4^{3-}	phosphate
$HOOCCOO^-$	hydrogen oxalate	PO_3^{3-}	phosphite
HPO_4^{2-}	hydrogen phosphate	SiO_3^{2-}	silicate
HSO_4^-	hydrogen sulfate (bisulfate)	SO_4^{2-}	sulfate
HSO_3^-	hydrogen sulfite (bisulfite)	SO_3^{2-}	sulfite
HS^-	hydrogen sulphide (bisulfide)	SCN^-	thiocyanate
		$S_2O_3^{2-}$	thiosulfate

Solubility of Some Common Ionic Compounds in Water at 25°C								
Ion	**Group1 NH_4^+ H_3O^+,H^+**	**ClO_3^- NO_3^- ClO_4^-**	**CH_3COO^-**	**Cl^- Br^- I^-**	**SO_4^{2-}**	**S^{2-}**	**OH^-**	**PO_4^{3-} SO_3^{2-} CO_3^{2-}**
Solubility greater than or equal to 0.1 mol/L (very soluble)	all	all	most	most	most	Group1 Group2 NH_4^+	Group1 NH_4^+ Sr^{2+} Ba^{2+} Tl^+	Group1 NH_4^+
Solubility less than 0.1 mol/L (slightly soluble)	none	none	Ag^+ Hg^+	Ag^+ Pb^{2+} Hg^+ Cu^+ Tl^+	Ca^{2+} Sr^{2+} Ba^{2+} Ra^{2+} Pb^{2+} Ag^+	most	most	most

Chem 181 Formulas and Constants

1.000 atm= 101.325 kPa = 760.0 mm Hg = 760.0 torr = 14.69 psi

SATP: T= 25°C and P = 100kPa; molar volume = 24.8 L/mol

STP: T=0°C and P = 1 atm (101.325kPa); molar volume = 22.4 L/mol

Kelvins = Celsius + 273.15

1 mole = 6.022×10^{23}

$c = \frac{n}{v}$ $\quad c_1v_1 = c_2v_2$ $\quad ppm = \frac{m_{solute}}{m_{solvent}} x10^6$

$P_1V_1 = P_2V_2$ $\quad \frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\quad \frac{V_1}{n_1} = \frac{V_2}{n_2}$

$PV=nRT$ $\quad \frac{V_1P_1}{n_1T_1} = \frac{V_2P_2}{n_2T_2}$

$pH = -\log [H_3O^+]$ $\quad [H_3O^+] = 10^{-pH}$ $\quad pOH = -\log [OH^-]$ $\quad [OH^-] = 10^{-pOH}$

$R = 8.31\ kPa \cdot L \cdot mol^{-1} \cdot K^{-1} = 0.08206\ atm \cdot L \cdot mol^{-1} \cdot K^{-1}$

Acid–Base Indicators at 298.15 K

Indicator	Suggested Abbreviations	pH Range	Colour Change as pH Increases	K_a
methyl violet	$HMv_{(aq)}$ / $Mv^-_{(aq)}$	0.0 – 1.6	yellow to blue	$\sim 2 \times 10^{-1}$
cresol red	$H_2Cr_{(aq)}$/ $HCr^-_{(aq)}$ $HCr^-_{(aq)}$ / $Cr^{2-}_{(aq)}$	0.0 – 1.0 7.0 – 8.8	red to yellow yellow to red	$\sim 3 \times 10^{-1}$ 3.5×10^{-9}
thymol blue	$H_2Tb_{(aq)}$/ $HTb^-_{(aq)}$ $HTb^-_{(aq)}$/ $Tb^{2-}_{(aq)}$	1.2 – 2.8 8.0 – 9.6	red to yellow yellow to blue	2.2×10^{-2} 6.3×10^{-10}
orange IV	$HOr_{(aq)}$/ $Or^-_{(aq)}$	1.4 – 2.8	red to yellow	$\sim 1 \times 10^{-2}$
methyl orange	$HMo_{(aq)}$ / $Mo^-_{(aq)}$	3.2 – 4.4	red to yellow	3.5×10^{-4}
bromocresol green	$HBg_{(aq)}$/ $Bg^-_{(aq)}$	3.8 – 5.4	yellow to blue	1.3×10^{-5}
methyl red	$HMr_{(aq)}$ / $Mr^-_{(aq)}$	4.8 – 6.0	red to yellow	1.0×10^{-5}
chlorophenol red	$HCh_{(aq)}$ / $Ch^-_{(aq)}$	5.2 – 6.8	yellow to red	5.6×10^{-7}
bromothymol blue	$HBb_{(aq)}$ / $Bb^-_{(aq)}$	6.0 – 7.6	yellow to blue	5.0×10^{-8}
phenol red	$HPr_{(aq)}$ / $Pr^-_{(aq)}$	6.6 – 8.0	yellow to red	1.0×10^{-8}
phenolphthalein	$HPh_{(aq)}$/ $Ph^-_{(aq)}$	8.2 – 10.0	colourless to pink	3.2×10^{-10}
thymolphthalein	$HTh_{(aq)}$/ $Th^-_{(aq)}$	9.4 – 10.6	colourless to blue	1.0×10^{-10}
alizarin yellow R	$HAy_{(aq)}$/ $Ay^-_{(aq)}$	10.1 – 12.0	yellow to red	6.9×10^{-12}
indigo carmine	$HIc_{(aq)}$ / $Ic^-_{(aq)}$	11.4 – 13.0	blue to yellow	$\sim 6 \times 10^{-12}$
1,3,5–trinitrobenzene	$HNb_{(aq)}$ / $Nb^-_{(aq)}$	12.0 – 14.0	colourless to orange	$\sim 1 \times 10^{-13}$

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

Table of Common Polyatomic Ions

acetate (ethanoate)	CH_3COO^-	chromate	CrO_4^{2-}	phosphate	PO_4^{3-}
ammonium	NH_4^+	dichromate	$Cr_2O_7^{2-}$	hydrogen phosphate	HPO_4^{2-}
benzoate	$C_6H_5COO^-$	cyanide	CN^-	dihydrogen phosphate	$H_2PO_4^-$
borate	BO_3^{3-}	hydroxide	OH^-	silicate	SiO_3^{2-}
carbide	C_2^{2-}	iodate	IO_3^-	sulfate	SO_4^{2-}
carbonate	CO_3^{2-}	nitrate	NO_3^-	hydrogen sulfate	HSO_4^-
hydrogen carbonate (bicarbonate)	HCO_3^-	nitrite	NO_2^-	sulfite	SO_3^{2-}
		oxalate	$OOCCOO^{2-}$	hydrogen sulfite	HSO_3^-
perchlorate	ClO_4^-	hydrogen oxalate	$HOOCCOO^-$	hydrogen sulfide	HS^-
chlorate	ClO_3^-	permanganate	MnO_4^-	thiocyanate	SCN^-
chlorite	ClO_2^-	peroxide	O_2^{2-}	thiosulfate	$S_2O_3^{2-}$
hypochlorite	ClO^- or OCl^-	persulfide	S_2^{2-}		

Key

Atomic number → 26; Atomic molar mass (g/mol)* → 55.85; Common ion charges (most common first) → 3+, 2+; Electronegativity → 1.8; Symbol → Fe; Name → iron

* Based on $^{12}_{6}C$

( ) Indicates mass of the most stable isotope

Legend for Elements

Solid	*Liquid*	Gas
Natural	Synthetic	

Note: The legend denotes the physical state of the elements at exactly 101.325 kPa and 298.15 K.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 1.01 1+,1− 2.2 H hydrogen																	2 4.00 — — −269 −272† He helium
3 6.94 1+ 1.0 Li lithium	4 9.01 2+ 1.6 Be beryllium											5 10.81 — 2.0 B boron	6 12.01 — 2.6 C carbon	7 14.01 3− 3.0 N nitrogen	8 16.00 2− 3.4 O oxygen	9 19.00 1− 4.0 F fluorine	10 20.18 — — Ne neon
11 22.99 1+ 0.9 Na sodium	12 24.31 2+ 1.3 Mg magnesium											13 26.98 3+ 1.6 Al aluminium	14 28.09 — 1.9 Si silicon	15 30.97 3− 2.2 P phosphorus	16 32.07 2− 2.6 S sulfur	17 35.45 1− 3.2 Cl chlorine	18 39.95 — — Ar argon
19 39.10 1+ 0.8 K potassium	20 40.08 2+ 1.0 Ca calcium	21 44.96 3+ 1.4 Sc scandium	22 47.87 4+, 3+ 1.5 Ti titanium	23 50.94 5+, 4+ 1.6 V vanadium	24 52.00 3+, 2+ 1.7 Cr chromium	25 54.94 2+, 4+ 1.6 Mn manganese	26 55.85 3+, 2+ 1.8 Fe iron	27 58.93 2+, 3+ 1.9 Co cobalt	28 58.69 2+, 3+ 1.9 Ni nickel	29 63.55 2+, 1+ 1.9 Cu copper	30 65.39 2+ 1.7 Zn zinc	31 69.72 3+ 1.8 Ga gallium	32 72.64 4+ 2.0 Ge germanium	33 74.92 3− 2.2 As arsenic	34 78.96 2− 2.6 Se selenium	35 79.90 1− 3.0 ***Br*** bromine	36 83.80 — — Kr krypton
37 85.47 1+ 0.8 Rb rubidium	38 87.62 2+ 1.0 Sr strontium	39 88.91 3+ 1.2 Y yttrium	40 91.22 4+ 1.3 Zr zirconium	41 92.91 5+, 3+ 1.6 Nb niobium	42 95.94 6+ 2.2 Mo molybdenum	43 (97) 7+ 2.1 Tc technetium	44 101.07 3+, 4+ 2.2 Ru ruthenium	45 102.91 3+ 2.3 Rh rhodium	46 106.42 2+, 4+ 2.2 Pd palladium	47 107.87 1+ 1.9 Ag silver	48 112.41 2+ 1.7 Cd cadmium	49 114.82 3+ 1.8 In indium	50 118.71 4+, 2+ 2.0 Sn tin	51 121.76 3+, 5+ 2.1 Sb antimony	52 127.60 2− 2.1 Te tellurium	53 126.90 1− 2.7 I iodine	54 131.29 — 2.6 Xe xenon
55 132.91 1+ 0.8 Cs cesium	56 137.33 2+ 0.9 Ba barium	57-71 lanthanoids	72 178.49 4+ 1.3 Hf hafnium	73 180.95 5+ 1.5 Ta tantalum	74 183.84 6+ 1.7 W tungsten	75 186.21 7+ 1.9 Re rhenium	76 190.23 4+ 2.2 Os osmium	77 192.22 4+ 2.2 Ir iridium	78 195.08 4+, 2+ 2.2 Pt platinum	79 196.97 3+, 1+ 2.4 Au gold	80 200.59 2+, 1+ 1.9 ***Hg*** mercury	81 204.38 1+, 3+ 1.8 Tl thallium	82 207.21 2+, 4+ 1.8 Pb lead	83 208.98 1.9 Bi bismuth	84 (209) 2+, 4+ 2.0 Po polonium	85 (210) 1− 2.2 At astatine	86 (222) — — Rn radon
87 (223) 1+ 0.7 Fr francium	88 (226) 2+ 0.9 Ra radium	89-103 actinoids	104 (267) Rf rutherfordium	105 (268) Db dubnium	106 (269) Sg seaborgium	107 (270) Bh bohrium	108 (269) Hs hassium	109 (277) Mt meitnerium	110 (281) Ds darmstadtium	111 (282) Rg roentgenium	112 (285) Cn copernicium	113 (286) Nh nihonium	114 (290) Fl flerovium	115 (290) Mc moscovium	116 (293) Lv livermorvium	117 (297) Ts tennessine	118 (294) Og oganesson

57 138.91 3+ 1.1 La lanthanum	58 140.12 3+ 1.1 Ce cerium	59 140.91 3+ 1.1 Pr praseodymium	60 144.24 3+ 1.1 Nd neodymium	61 (145) 3+ — Pm promethium	62 150.36 3+, 2+ 1.2 Sm samarium	63 151.96 3+, 2+ — Eu europium	64 157.25 3+ 1.2 Gd gadolinium	65 158.93 3+ — Tb terbium	66 162.50 3+ 1.2 Dy dysprosium	67 164.93 3+ 1.2 Ho holmium	68 167.26 3+ 1.2 Er erbium	69 168.93 3+ 1.3 Tm thulium	70 173.04 3+, 2+ — Yb ytterbium	71 174.97 2+ 1.0 Lu lutetium
89 (227) 3+ 1.1 Ac actinium	90 232.04 4+ 1.3 Th thorium	91 231.04 5+, 4+ 1.5 Pa protactinium	92 238.03 6+, 4+ 1.7 U uranium	93 (237) 5+ 1.3 Np neptunium	94 (244) 4+, 6+ 1.3 Pu plutonium	95 (243) 3+, 4+ — Am americium	96 (247) 3+ — Cm curium	97 (247) 3+, 4+ — Bk berkelium	98 (251) 3+ — Cf californium	99 (252) 3+ — Es einsteinium	100 (257) 3+ — Fm fermium	101 (258) 2+, 3+ — Md mendelevium	102 (259) 2+, 3+ — No nobelium	103 (262) 3+ — Lr lawrencium

References

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