Neap

Trial Examination 2021

Question and response booklet

QCE Chemistry Units 1&2

Paper 2

Student's Name: _____

Teacher's Name: _____

Time allowed

- Perusal time – 10 minutes
- Working time – 90 minutes

General instructions

- Answer all questions in this question and response booklet.
- Write using black or blue pen.
- QCAA-approved calculator permitted.
- Formula and data booklet provided.
- Planning paper will not be marked.

Section 1 (65 marks)

- 7 short response questions

SECTION 1

Instructions

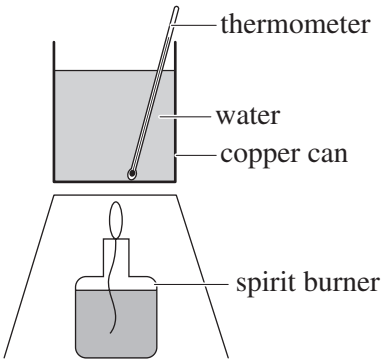
- If you need more space for a response, use the additional pages at the back of this booklet.
  - On the additional pages, write the question number you are responding to.
  - Cancel any incorrect response by ruling a single diagonal line through your work.
  - Write the page number of your alternative/additional response, i.e. See page …
  - If you do not do this, your original response will be marked.

DO NOT WRITE ON THIS PAGE

THIS PAGE WILL NOT BE MARKED

QUESTION 1 (11 marks)

A student performed a calorimetric experiment to find the molar heat of combustion (kJ mol^{-1}) of ethanol (CH_3CH_2OH). Their experimental set-up and results are shown below. The student also noted there was soot on the bottom of the copper can after the experiment.



Initial mass of burner + ethanol (g)	120.04 ± 0.01
Final mass of burner + ethanol (g)	119.61 ± 0.01
Mass of water (g)	175 ± 2
Initial temperature of water (°C)	22.0 ± 0.5
Final temperature of water (°C)	32.5 ± 0.5

a) Calculate the experimental molar heat of combustion of ethanol. Show your working. *[5 marks]*

MHC = _____ kJ mol^{-1} (to three significant figures)

b) Calculate the absolute uncertainty in the answer to a). Show your working. *[4 marks]*

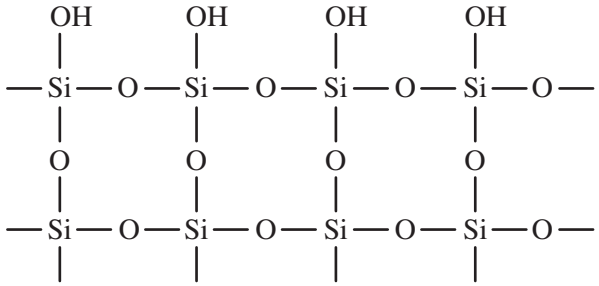
Absolute uncertainty = _____ kJ (to three significant figures)

c) The accepted value for the molar heat of combustion of ethanol is 1360 kJ mol^{-1}.
Identify two reasons why the experimental value differs from the accepted value. *[2 marks]*

QUESTION 2 (9 marks)

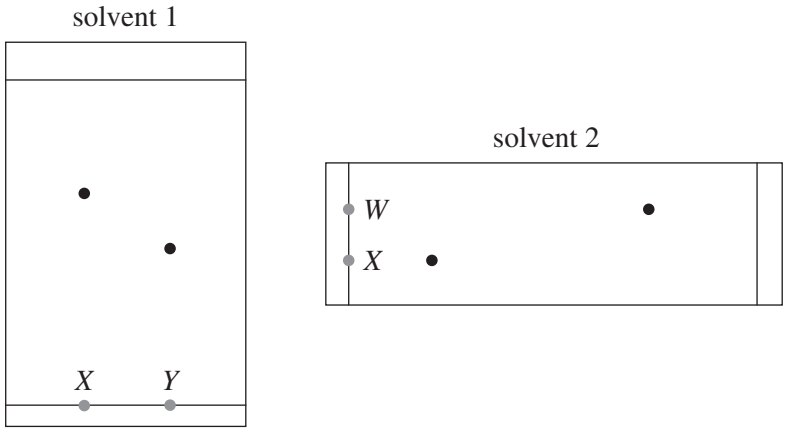
Chromatography can be used to separate and identify components of a mixture.

a) A mixture of trichloromethane and carbon dioxide was separated using gas chromatography. The carrier gas was nitrogen and the column was packed with silica gel, shown in the diagram below.



Use your knowledge of intermolecular forces to predict and justify which component of the mixture will leave the column first. *[5 marks]*

b) Analyse the chromatograms and R_f values shown below to determine the identity of amino acid X. Show all working and reasoning. *[4 marks]*



Amino acid	R_f in solvent 1	R_f in solvent 2
alanine	0.64	0.57
arginine	0.17	0.81
histidine	0.65	0.20
leucine	0.89	0.48
methionine	0.66	0.39
proline	0.80	0.19
serine	0.20	0.22
tryptophan	0.44	0.63

QUESTION 3 (9 marks)

The reaction between sodium thiosulfate and hydrochloric acid can be used to examine the effect of different factors on the rate of reaction.

$$Na_2S_2O_3(aq) + 2HCl(aq) \rightarrow S(s) + SO_2(g) + H_2O(l) + 2NaCl(aq)$$

A small cross is drawn on a piece of paper and then a test tube containing the reactants is placed over it. As the reaction proceeds, the mixture becomes cloudy and obscures the cross.

a) Explain why it took 12 seconds to lose sight of the cross at 50°C but 72 seconds when the reactants were cooled to 10°C before mixing. *[4 marks]*

b) A student mixed 5.0 mL of 0.30 M $Na_2S_2O_3$ with 4.0 mL of 0.70 M HCl and retrieved 0.039 g of precipitate.

Calculate the experimental yield, showing all working. *[5 marks]*

Percentage yield = _____ % (to two significant figures)

QUESTION 4 (10 marks)

a) A number of trends can be observed in the structure and properties of elements.

i) Determine the missing values from the table below. *[2 marks]*

Element	Protons	Shielding electrons	Effective nuclear charge
nitrogen	7	2	5
magnesium	12		2
phosphorus	15	10	

ii) Explain the increase in atomic radius for the elements nitrogen (71×10^{-12} m), phosphorus (109×10^{-12} m) and magnesium (140×10^{-12} m). *[5 marks]*

b) The table shows the successive ionisation energies for aluminium.

Electron	1st	2nd	3rd	4th	5th	6th	7th	8th
Ionisation energy ($kJ\ mol^{-1}$)	578	1817	2745		14 842	18 379	23 326	27 464

Predict and justify the value for the fourth ionisation energy. *[3 marks]*

QUESTION 5 (6 marks)

Eight unknown substances were put through a series of tests, as summarised in the table below.
The 'hammer' test consisted of striking the substance with a hammer, and if there was no change, then the substance was struck again with more force.

Substance	Melting/boiling points (°C)	'Hammer' test (number of strikes, result)	Solubility in water	Conductivity*		
				(s)	(l)	(aq)
1	114/184	1, crumbled	none	0	0	–
2	801/1465	2, shattered	soluble	0	2	3
3	–114/–45	–	soluble	–	0	0
4	1085/2562	2, dented	none	10	7	–
5	sublimes at 3642	3, shattered	none	8	–	–
6	48/375	1, flattened	none	0	0	–
7	1710/2230	4, cracked	none	0	0	–
8	328/1749	1, dented	none	9	6	–

*Conductivity is measured on an arbitrary scale.

a) Identify a metallic substance from the table. *[1 mark]*

b) Infer whether substance 6 is MgO or $C_{20}H_{42}$. *[1 mark]*

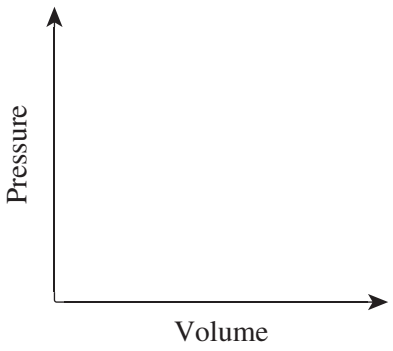
c) Analyse the data to classify substance 2 as covalent molecular, covalent network, ionic or metallic. Show your reasoning. *[4 marks]*

QUESTION 6 (9 marks)

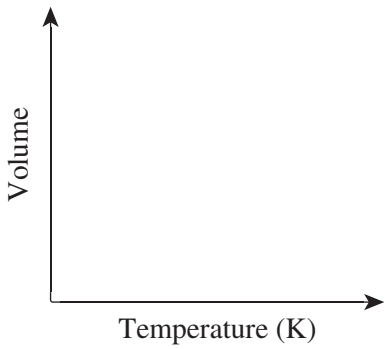
The physical properties and behaviour of gases can be explained by the kinetic theory of gases.

a) Sketch the ideal relationship between each pair of variables on the axes below. *[3 marks]*

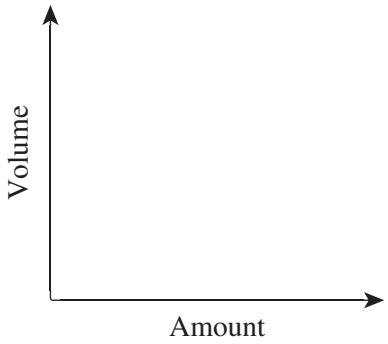
i)



ii)



iii)



b) Calculate the number of molecules in 58.2 L hydrogen at standard temperature and pressure (STP). Show your working. *[2 marks]*

Number of molecules = _____

c) Calculate the volume occupied by 0.20 kg of argon gas at –20.0°C and 180 kPa.
Show your working. *[3 marks]*

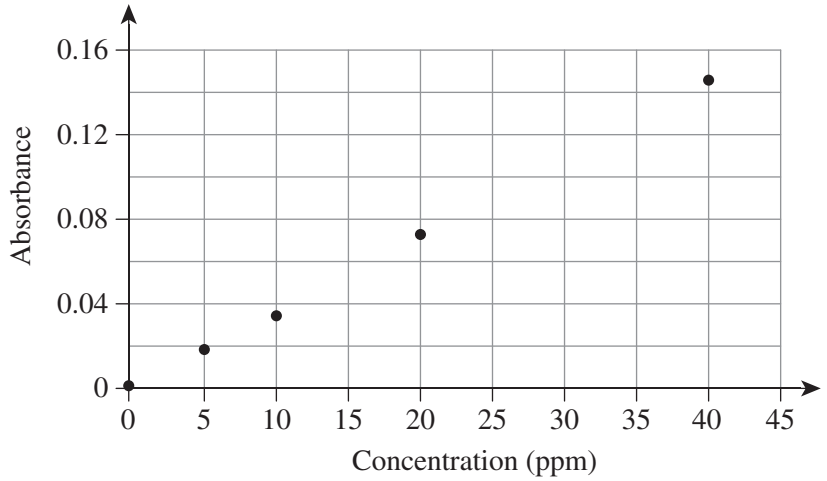
Volume = _____ L (to two significant figures)

d) Gases do not exhibit ideal behaviour at extremely low temperatures or high pressures.
Describe a reason for this deviation in behaviour. *[1 mark]*

QUESTION 7 (11 marks)

a) Compare atomic emission spectroscopy (AES) and flame tests. *[5 marks]*

b) Atomic absorption spectroscopy (AAS) can be used to determine the amount of analyte in a sample of soil. A series of standard solutions of Fe^{2+} ions were analysed, as shown on the graph below.



A 3.27 g sample of garden soil was treated with dilute acid to free the iron for analysis. The treated sample was filtered and the resulting solution made up to 250.0 mL. This soil solution was analysed using AAS and produced an absorbance of 0.105.

i) Determine the concentration of Fe^{2+} in the soil solution in ppm. Show your working on the graph above. *[2 marks]*

ii) The required iron content of garden soil is 0.50–5.0 % m/m.

Assuming the soil solution has a density of 1.0 g mL^{-1}, calculate the concentration of iron in the sample of garden soil and hence comment on its suitability. Show all working and reasoning. *[4 marks]*

END OF PAPER

ADDITIONAL PAGE FOR STUDENT RESPONSES

Write the question number you are responding to.

ADDITIONAL PAGE FOR STUDENT RESPONSES

Write the question number you are responding to.

ADDITIONAL PAGE FOR STUDENT RESPONSES

Write the question number you are responding to.

ADDITIONAL PAGE FOR STUDENT RESPONSES

Write the question number you are responding to.

ADDITIONAL PAGE FOR STUDENT RESPONSES

Write the question number you are responding to.

Neap

Trial Examination 2021

Formula and data booklet

QCE Chemistry Units 1&2

FORMULAS

Processing of data
Absolute uncertainty of the mean $\Delta\overline{x} = \pm\dfrac{\left(x_{\max} - x_{\min}\right)}{2}$
Percentage uncertainty (%) $= \dfrac{\text{absolute uncertainty}}{\text{measurement}} \times \dfrac{100}{1}$
Percentrage error (%) $= \left\lvert\dfrac{\text{measured value} - \text{true value}}{\text{true value}}\right\rvert \times 100$

Chemical reactions – reactants, products and energy change
$\Delta H = H_{(\text{products})} - H_{(\text{reactants})}$
$\Delta H = \Sigma\left(\text{bonds broken}\right) - \Sigma\left(\text{bonds formed}\right)$
$Q = mc\Delta T$
Percentage yield (%) $= \dfrac{\text{experimental yield}}{\text{theoretical yield}} \times \dfrac{100}{1}$
$\text{A}_\text{r} = \dfrac{\left(\text{isotopic mass} \times \%\text{ abundance}\right) + \left(\text{isotopic mass} \times \%\text{ abundance}\right)}{100}$
Moles $(n) = \dfrac{\text{number of particles } (N)}{\text{Avogadro's constant } (N_\text{A})}$
Moles $= \dfrac{\text{mass of substance}\left(m\right)}{\text{molar mass}\left(M\right)}$

Intermolecular forces and gas
$PV = nRT$

Aqueous solutions and acidity
Molarity $= \dfrac{\text{moles of solute } (n)}{\text{volume of solution } (V)}$
$c_1V_1 = c_2V_2$

PHYSICAL CONSTANTS AND UNIT CONVERSIONS

Physical constants and unit conversions	
Absolute zero	$0\ \text{K} = -273°\text{C}$
Atomic mass unit	$1\ \text{amu} = 1.66 \times 10^{-27}\ \text{kg}$
Avogadro's constant	$N_\text{A} = 6.02 \times 10^{23}\ \text{mol}^{-1}$
Ideal gas constant	$R = 8.31\ \text{J mol}^{-1}\ \text{K}^{-1}$
Molar volume of an ideal gas (at STP)	$2.27 \times 10^{-2}\ \text{m}^3\ \text{mol}^{-1} = 22.7\ \text{dm}^3\ \text{mol}^{-1}$
Specific heat capacity of water (at 298 K)	$c_\text{w} = 4.18\ \text{J g}^{-1}\ \text{K}^{-1}$
Standard temperature and pressure (STP)	273 K and 100 kPa
Volume and capacity conversions	$1\ \text{dm}^3 = 1 \times 10^{-3}\ \text{m}^3 = 1 \times 10^3\ \text{cm}^3 = 1\ \text{L}$

LIST OF ELEMENTS

Name	Atomic no.	Symbol
Hydrogen	1	H
Helium	2	He
Lithium	3	Li
Beryllium	4	Be
Boron	5	B
Carbon	6	C
Nitrogen	7	N
Oxygen	8	O
Fluorine	9	F
Neon	10	Ne
Sodium	11	Na
Magnesium	12	Mg
Aluminium	13	Al
Silicon	14	Si
Phosphorus	15	P
Sulfur	16	S
Chlorine	17	Cl
Argon	18	Ar
Potassium	19	K
Calcium	20	Ca
Scandium	21	Sc
Titanium	22	Ti
Vanadium	23	V
Chromium	24	Cr
Manganese	25	Mn
Iron	26	Fe
Cobalt	27	Co
Nickel	28	Ni
Copper	29	Cu
Zinc	30	Zn
Gallium	31	Ga
Germanium	32	Ge
Arsenic	33	As
Selenium	34	Se
Bromine	35	Br

Name	Atomic no.	Symbol
Krypton	36	Kr
Rubidium	37	Rb
Strontium	38	Sr
Yttrium	39	Y
Zirconium	40	Zr
Niobium	41	Nb
Molybdenum	42	Mo
Technetium	43	Tc
Ruthenium	44	Ru
Rhodium	45	Rh
Palladium	46	Pd
Silver	47	Ag
Cadmium	48	Cd
Indium	49	In
Tin	50	Sn
Antimony	51	Sb
Tellerium	52	Te
Iodine	53	I
Xenon	54	Xe
Cesium	55	Cs
Barium	56	Ba
Lanthanum	57	La
Cerium	58	Ce
Praseodymium	59	Pr
Neodymium	60	Nd
Promethium	61	Pm
Samarium	62	Sm
Europium	63	Eu
Gadolinium	64	Gd
Terbium	65	Tb
Dysprosium	66	Dy
Holmium	67	Ho
Erbium	68	Er
Thulium	69	Tm
Ytterbium	70	Yb

LIST OF ELEMENTS (CONTINUED)

Name	Atomic no.	Symbol
Lutetium	71	Lu
Hafnium	72	Hf
Tantalum	73	Ta
Tungsten	74	W
Rhenium	75	Re
Osmium	76	Os
Iridium	77	Ir
Platinum	78	Pt
Gold	79	Au
Mercury	80	Hg
Thallium	81	Tl
Lead	82	Pb
Bismuth	83	Bi
Polonium	84	Po
Astatine	85	At
Radon	86	Rn
Francium	87	Fr
Radium	88	Ra
Actinium	89	Ac
Thorium	90	Th
Protactinium	91	Pa
Uranium	92	U
Neptunium	93	Np
Plutonium	94	Pu

Name	Atomic no.	Symbol
Americium	95	Am
Curium	96	Cm
Berkelium	97	Bk
Californium	98	Cf
Einsteinium	99	Es
Fermium	100	Fm
Mendelevium	101	Md
Nobelium	102	No
Lawrencium	103	Lr
Rutherfordium	104	Rf
Dubnium	105	Db
Seaborgium	106	Sg
Bohrium	107	Bh
Hassium	108	Hs
Meitnerium	109	Mt
Darmstadtium	110	Ds
Roentgenium	111	Rg
Copernicium	112	Cn
Nihonium	113	Nh
Flerovium	114	Fl
Moscovium	115	Mc
Livermorium	116	Lv
Tennessine	117	Ts
Oganesson	118	Og

PERIODIC TABLE OF THE ELEMENTS

KEY

1	atomic number
H	symbol
1.01	relative atomic mass*

1																	18
1 H 1.01	2											13	14	15	16	17	2 He 4.00
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
11 Na 22.99	12 Mg 24.31	3	4	5	6	7	8	9	10	11	12	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	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 72.63	33 As 74.92	34 Se 78.97	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.95	43 Tc (98.91)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57–71 Lanthanoids	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (210.0)	85 At (210.0)	86 Rn (222.0)
87 Fr (223.0)	88 Ra (226.1)	89–103 Actinoids	104 Rf (261.1)	105 Db (262.1)	106 Sg (263.1)	107 Bh (264.1)	108 Hs (265.1)	109 Mt (268)	110 Ds (281)	111 Rg (272)	112 Cn (285)	113 Nh (284)	114 Fl (289)	115 Mc (288)	116 Lv (293)	117 Ts (294)	118 Og (294)

Lanthanoids

57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (146.9)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.05	71 Lu 174.97

Actinoids

89 Ac (227.0)	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np (237.0)	94 Pu (239.1)	95 Am (241.1)	96 Cm (244.1)	97 Bk (249.1)	98 Cf (252.1)	99 Es (252.1)	100 Fm (252.1)	101 Md (258.1)	102 No (259.1)	103 Lr (262.1)

Groups are numbered according to IUPAC convention 1–18.

*Values in brackets are for the isotope with the longest half-life.

ATOMIC AND IONIC RADII OF SELECTED ELEMENTS

KEY

Li 3
130
76 (1+)

atomic number
symbol
atomic radius (10^{-12} m)
charge of ion

ionic radius (10^{-12} m)

1																	18
H 1 32 208 (1–)	2											13	14	15	16	17	**He** 2 37
Li 3 130 76 (1+)	**Be** 4 99 45 (2+)											**B** 5 84 27 (3+)	**C** 6 75 16 (4+)	**N** 7 71 146 (3–)	**O** 8 64 140 (2–)	**F** 9 60 133 (1–)	**Ne** 10 62
Na 11 160 102 (1+)	**Mg** 12 140 72 (2+)	3	4	5	6	7	8	9	10	11	12	**Al** 13 124 53 (3+)	**Si** 14 114 40 (4+)	**P** 15 109 38 (5+)	**S** 16 104 184 (2–)	**Cl** 17 100 181 (1–)	**Ar** 18 101
K 19 200 138 (1+)	**Ca** 20 174 100 (2+)	**Sc** 21 159 75 (3+)	**Ti** 22 148 86 (2+) 61 (4+)	**V** 23 144 79 (2+) 54 (5+)	**Cr** 24 130 62 (3+) 44 (6+)	**Mn** 25 129 83 (2+) 64 (3+)	**Fe** 26 124 78 (2+) 64 (3+)	**Co** 27 118 74 (2+) 61 (3+)	**Ni** 28 117 69 (2+) 60 (3+)	**Cu** 29 122 77 (1+) 73 (2+)	**Zn** 30 120 74 (2+)	**Ga** 31 123 62 (3+)	**Ge** 32 120 53 (4+) 272 (4–)	**As** 33 120 58 (3+) 46 (5+)	**Se** 34 118 198 (2–)	**Br** 35 117 196 (1–)	**Kr** 36 116
Rb 37 215 152 (1+)	**Sr** 38 190 118 (2+)	**Y** 39 176 90 (3+)	**Zr** 40 164 72 (4+)	**Nb** 41 156 64 (5+)	**Mo** 42 148 65 (4+)	**Tc** 43 138 65 (4+)	**Ru** 44 136 62 (4+)	**Rh** 45 134 67 (3+)	**Pd** 46 130 86 (2+)	**Ag** 47 136 115 (1+)	**Cd** 48 140 95 (2+)	**In** 49 142 80 (3+)	**Sn** 50 140 69 (4+)	**Sb** 51 140 76 (3+)	**Te** 52 137 221 (2–)	**I** 53 136 220 (1–)	**Xe** 54 136
Cs 55 238 167 (1+)	**Ba** 56 206 135 (2+)																

Groups are numbered according to IUPAC convention 1–18.

ELECTRONEGATIVITIES AND FIRST IONISATION ENERGIES OF SELECTED ELEMENTS

KEY

H 1 2.2 1318	atomic number symbol electronegativity first ionisation enthalpies (kJ mol^{-1})

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
H 1 2.2 1318																	He 2 2379
Li 3 1.0 526	Be 4 1.6 906											B 5 2.0 807	C 6 2.6 1093	N 7 3.0 1407	O 8 3.4 1320	F 9 4.0 1687	Ne 10 2087
Na 11 0.9 502	Mg 12 1.3 744											Al 13 1.6 584	Si 14 1.9 793	P 15 2.2 1018	S 16 2.6 1006	Cl 17 3.2 1257	Ar 18 1527
K 19 0.8 425	Ca 20 1.0 596	Sc 21 1.4 637	Ti 22 1.5 664	V 23 1.6 656	Cr 24 1.7 659	Mn 25 1.6 724	Fe 26 1.8 766	Co 27 1.9 765	Ni 28 1.9 743	Cu 29 1.9 752	Zn 30 1.7 913	Ga 31 1.8 585	Ge 32 2.0 768	As 33 2.2 953	Se 34 2.6 947	Br 35 3.0 1146	Kr 36 2.9 1357
Rb 37 0.8 409	Sr 38 1.0 556	Y 39 1.2 606	Zr 40 1.3 666	Nb 41 1.6 670	Mo 42 2.2 691	Tc 43 1.9 708	Ru 44 2.2 717	Rh 45 2.3 726	Pd 46 2.2 811	Ag 47 1.9 737	Cd 48 1.7 874	In 49 1.8 565	Sn 50 2.0 715	Sb 51 2.1 840	Te 52 2.1 876	I 53 2.7 1015	Xe 54 2.6 1177
Cs 55 0.8 382	Ba 56 0.9 509																

Groups are numbered according to IUPAC convention 1–18.

SOLUBILITY OF SELECTED COMPOUNDS AT 298 K

	bromide	carbonate	chloride	hydroxide	iodide	nitrate	oxide	phosphate	sulfate
aluminium	s	–	s	i	s	s	i	i	s
ammonium	s	s	s	s	s	s	–	s	s
barium	s	i	s	s	s	s	s	i	i
calcium	s	i	s	p	s	s	p	i	p
cobalt(II)	s	i	s	i	s	s	i	i	s
copper(II)	s	–	s	i	i	s	i	i	s
iron(II)	s	i	s	i	s	s	i	i	s
iron(III)	s	–	s	i	s	s	i	i	s
lead(II)	p	i	s	i	i	s	i	i	i
lithium	s	s	s	s	s	s	s	–	s
magnesium	s	i	s	i	s	s	i	p	s
manganese(II)	s	i	s	i	s	s	i	p	s
potassium	s	s	s	s	s	s	s	s	s
silver	i	i	i	i	i	s	i	i	p
sodium	s	s	s	s	s	s	s	s	s
zinc	s	i	s	i	s	s	i	i	s

Key

Abbreviation	Explanation
s	soluble in water (solubility greater than 10 g L^{-1})
p	partially soluble in water (solubility between 1 and 10 g L^{-1})
i	insoluble in water (solubility less than 1 g L^{-1})
–	no data

AVERAGE BOND ENTHALPIES AT 298 K

Single bonds

	ΔH (kJ mol^{-1})								
	H	**C**	**N**	**O**	**F**	**S**	**Cl**	**Br**	**I**
H	436								
C	414	346							
N	391	286	158						
O	463	358	214	144					
F	567	492	278	191	159				
S	364	289			327	266			
Cl	431	324	192	206	255	271	242		
Br	366	285		201	249	218	219	193	
I	298	228		201	280		211	178	151

Multiple bonds

Bond	ΔH (kJ mol^{-1})
C=C	614
C≡C	839
C=N	615
C≡N	890
C=O	804
N=N	470
N≡N	945
O=O	498

REACTIVITY SERIES OF METALS

Element	Reactivity
K	most reactive
Na	
Li	
Ba	
Sr	
Ca	
Mg	
Al	
C*	
Mn	
Zn	
Cr	
Fe	
Cd	
Co	
Ni	
Sn	
Pb	
H_2*	
Sb	
Bi	
Cu	
Hg	
Ag	
Au	
Pt	least reactive

* Carbon (C) and hydrogen gas (H_2) added for comparison

ACID–BASE INDICATORS

Name	pKa	pH range of colour change	Colour change (acidic to basic)
Methyl orange	3.7	3.1–4.4	red to yellow
Bromophenol blue	4.2	3.0–4.6	yellow to blue
Bromocresol green	4.7	3.8–5.4	yellow to blue
Methyl red	5.1	4.4–6.2	pink to yellow
Bromothymol blue	7.0	6.0–7.6	yellow to blue
Phenol red	7.9	6.8–8.4	yellow to red
Phenolphthalein	9.6	8.3–10.0	colourless to pink

FORMULAS AND CHARGES FOR COMMON POLYATOMIC IONS

Anions	
acetate (ethanoate)	CH_3COO^- or $C_2H_3O_2^-$
carbonate	CO_3^{2-}
chlorate	ClO_3^-
chlorite	ClO_2^-
chromate	CrO_4^{2-}
citrate	$C_6H_5O_7^{3-}$
cyanide	CN^-
dichromate	$Cr_2O_7^{2-}$
dihydrogen phosphate	$H_2PO_4^-$
hypochlorite	ClO^-
hydrogen carbonate	HCO_3^-
hydrogen sulfate	HSO_4^-
hydrogen phosphate	HPO_4^{2-}
hydroxide	OH^-
nitrate	NO_3^-
nitrite	NO_2^-
perchlorate	ClO_4^-
permanganate	MnO_4^-
peroxide	O_2^{2-}
phosphate	PO_4^{3-}
sulfate	SO_4^{2-}
sulfite	SO_3^{2-}
thiosulfate	$S_2O_3^{2-}$

Cations	
ammonium	NH_4^+
hydronium	H_3O^+

REFERENCES

Aylward, G and Findlay, T 2008, *SI Chemical Data*, 5th ed, John Wiley & Sons, Brisbane.

Haynes, WM (ed) 2016, *CRC Handbook of Chemistry and Physics*, 97th ed, CRC Press, Boca Raton, US.

