Neap

Trial Examination 2022

Question and Response Booklet

QCE Chemistry Units 1&2

Paper 1

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.
- QCAA-approved calculator permitted.
- Formula and data booklet provided.
- Planning paper will not be marked.

Section 1 (25 marks)

- 25 multiple choice questions

Section 2 (35 marks)

- 8 short response questions

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SECTION 1

Instructions

- Choose the best answer for Questions 1–25.
- This section has 25 questions and is worth 25 marks.
- Use a 2B pencil to fill in the A, B, C or D answer bubble completely.
- If you change your mind or make a mistake, use an eraser to remove your response and fill in the new answer bubble completely.

	A	B	C	D
Example:	●	○	○	○

	A	B	C	D
1.	○	○	○	○
2.	○	○	○	○
3.	○	○	○	○
4.	○	○	○	○
5.	○	○	○	○
6.	○	○	○	○
7.	○	○	○	○
8.	○	○	○	○
9.	○	○	○	○
10.	○	○	○	○
11.	○	○	○	○
12.	○	○	○	○
13.	○	○	○	○
14.	○	○	○	○
15.	○	○	○	○
16.	○	○	○	○
17.	○	○	○	○
18.	○	○	○	○
19.	○	○	○	○
20.	○	○	○	○
21.	○	○	○	○
22.	○	○	○	○
23.	○	○	○	○
24.	○	○	○	○
25.	○	○	○	○

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SECTION 2

Instructions

- Write using black or blue pen.
- 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.
- This section has eight questions and is worth 35 marks.

QUESTION 26 (4 marks)

a) Write the full electron configurations of the following using spdf notation.

i) aluminium atom *[1 mark]*

_____

ii) iron atom *[1 mark]*

_____

iii) ion with a 2+ charge and the same electron configuration as krypton *[1 mark]*

_____

b) Identify the ion in 26aiii). *[1 mark]*

_____

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QUESTION 27 (5 marks)

Chlorofluorocarbons (CFCs) were widely used as propellants and refrigerants until their usage was linked to ozone destruction in the upper atmosphere.

A particular CFC was found to have the following elemental composition by mass.

Element	Percentage (%)
C	17.8
H	1.50
Cl	52.6
F	28.1

Its molecular mass was found to be 135.

Use the data to determine the empirical formula and molecular formula of the CFC.

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QUESTION 28 (3 marks)

Hydrogen fluoride is formed by reacting hydrogen gas and fluorine gas according to the following equation.

$$H–H(g) + F–F(g) \rightarrow 2H–F(g)$$

Calculate the energy change of this reaction. Show your working.

energy change = _____ kJ mol^{-1}

QUESTION 29 (3 marks)

An unknown solution is thought to contain copper(II) ions.

a) Propose a chemical test that could confirm the presence of these ions. *[1 mark]*

b) Describe what would be observed during the test proposed in 29a). *[1 mark]*

c) Write the ionic equation for the reaction that occurs during the test proposed in 29a). *[1 mark]*

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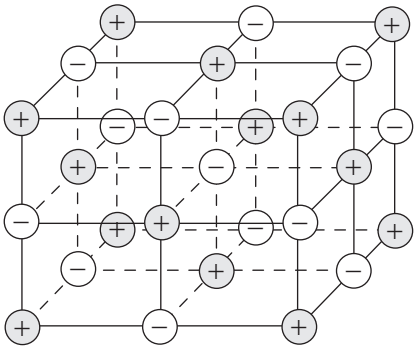
QUESTION 30 (7 marks)

The diagram illustrates the structure of part of a sodium chloride crystal. The positive and negative circles represent the sodium and chloride ions.



a) Deduce why sodium chloride has a high melting point of 801°C. *[1 mark]*

b) Explain why sodium chloride conducts electricity when melted, but not when it is a solid. *[2 marks]*

c) Explain why sodium chloride dissolves in water but not in petrol (octane). *[4 marks]*

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QUESTION 31 (5 marks)

Argon is a noble gas that makes up almost 1% of the atmosphere. It exists as single atoms.

a) State two assumptions that can be made about argon based on the kinetic theory of gases. *[2 marks]*

b) State the number of atoms that are present in 1 mol of argon. *[1 mark]*

c) In a light bulb, a thin filament of tungsten glows white hot from its resistance to an electrical current.

Propose why argon, not air, is used in light bulbs. *[2 marks]*

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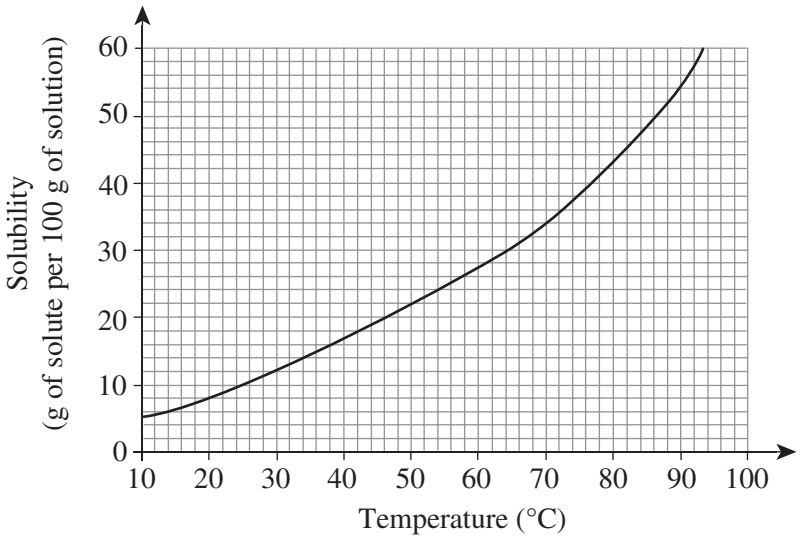
QUESTION 32 (3 marks)

A solid was purified using a technique called recrystallisation. This involved dissolving the impure solid in a minimum amount of hot water and then allowing the solution to cool so that crystals of pure solid were formed.

The solubility curve for the pure solid is shown.



a) Use the solubility curve to calculate the mass of pure solid that would form from cooling 100 g of solution from 90°C to 20°C. Show your working. *[2 marks]*

mass = _____ g

b) If a greater amount of hot water was used to dissolve the impure solid, predict the effect this would have on the mass obtained in 32a). *[1 mark]*

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QUESTION 33 (5 marks)

Calcium and barium are group 2 metals. They both react with water according to the following equation, where M represents either metal.

$$M(s) + 2H_2O(l) \rightarrow M(OH)_2(aq) + H_2(g)$$

A student added 5 g of calcium to water in a conical flask and collected the hydrogen gas produced in a syringe. They repeated the experiment using 5 g of barium under the same temperature and pressure conditions. They were surprised to see that the volume of gas produced by the reaction using barium was less than that produced by the reaction using calcium.

a) Deduce why the reaction using barium produced a lower volume of gas. *[1 mark]*

b) The student observed one other difference between the reactions.
Identify and explain the difference. *[2 marks]*

c) The student did not label the flasks containing the two solutions.
Propose a test they could perform to distinguish between the two solutions. *[2 marks]*

END OF PAPER

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ADDITIONAL PAGE FOR STUDENT RESPONSES

Write the question number you are responding to.

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ADDITIONAL PAGE FOR STUDENT RESPONSES

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Neap

Trial Examination 2022

Formula and Data Booklet

QCE Chemistry Units 1&2

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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 $= \dfrac{\text{moles of solute } (n)}{\text{volume of solution } (V)}$
$c_1V_1 = c_2V_2$

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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	$1\ \text{dm}^3 = 1 \times 10^{-3}\ \text{m}^3 = 1 \times 10^3\ \text{cm}^3 = 1\ \text{L}$

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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

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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

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PERIODIC TABLE OF THE ELEMENTS

KEY

1 H 1.01 — atomic number; symbol; 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.

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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.

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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.

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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

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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

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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

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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

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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^+

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