



GCE A LEVEL

A410U10-1A



S24-A410U10-1A



MONDAY, 10 JUNE 2024 – MORNING

CHEMISTRY – A level component 1

Data Booklet

Avogadro constant	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$
molar gas constant	$R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$
molar gas volume at 273 K and 1 atm	$V_m = 22.4 \text{ dm}^3 \text{ mol}^{-1}$
molar gas volume at 298 K and 1 atm	$V_m = 24.5 \text{ dm}^3 \text{ mol}^{-1}$
Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$
speed of light	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
density of water	$d = 1.00 \text{ g cm}^{-3}$
specific heat capacity of water	$c = 4.18 \text{ J g}^{-1} \text{ K}^{-1}$
ionic product of water at 298 K	$K_w = 1.00 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$
fundamental electronic charge	$e = 1.60 \times 10^{-19} \text{ C}$

temperature (K) = temperature (°C) + 273

$1 \text{ dm}^3 = 1000 \text{ cm}^3$
 $1 \text{ m}^3 = 1000 \text{ dm}^3$
 $1 \text{ tonne} = 1000 \text{ kg}$
 $1 \text{ atm} = 1.01 \times 10^5 \text{ Pa}$

Multiple	Prefix	Symbol
10^{-9}	nano	n
10^{-6}	micro	μ
10^{-3}	milli	m

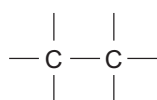
Multiple	Prefix	Symbol
10^3	kilo	k
10^6	mega	M
10^9	giga	G

Infrared absorption values

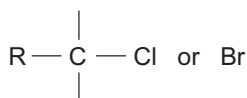
Bond	Wavenumber / cm^{-1}
C — Br	500 to 600
C — Cl	650 to 800
C — O	1000 to 1300
C = C	1620 to 1670
C = O	1650 to 1750
C $\equiv$ N	2100 to 2250
C — H	2800 to 3100
O — H (carboxylic acid)	2500 to 3200 (very broad)
O — H (alcohol / phenol)	3200 to 3550 (broad)
N — H	3300 to 3500

¹³C NMR chemical shifts relative to TMS = 0

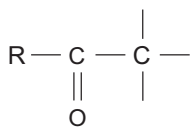
Type of carbon	Chemical shift, δ (ppm)
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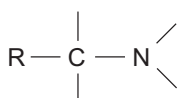
5 to 40



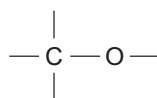
10 to 70



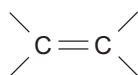
20 to 50



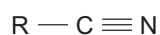
25 to 60



50 to 90



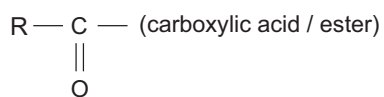
90 to 150



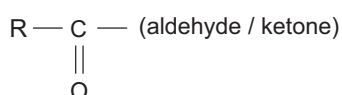
110 to 125



110 to 160



160 to 185



190 to 220

¹H NMR chemical shifts relative to TMS = 0

Type of proton	Chemical shift, δ (ppm)
$-\text{CH}_3$	0.1 to 2.0
$\text{R}-\text{CH}_3$	0.9
$\text{R}-\text{CH}_2-\text{R}$	1.3
$\text{CH}_3-\text{C}\equiv\text{N}$	2.0
$\text{CH}_3-\text{C}(=\text{O})$	2.0 to 2.5
$-\text{CH}_2-\text{C}(=\text{O})$	2.0 to 3.0
 - CH_3	2.2 to 2.3
$\text{HC}-\text{Cl}$ or $\text{HC}-\text{Br}$	3.1 to 4.3
$\text{HC}-\text{O}$	3.3 to 4.3
$\text{R}-\text{OH}$	4.5 *
$-\text{C}=\text{CH}$	4.5 to 6.3
$-\text{C}=\text{CH}-\text{CO}$	5.8 to 6.5
 - $\text{CH}=\text{C}$	6.5 to 7.5
 - H	6.5 to 8.0
 - OH	7.0 *
$\text{R}-\text{C}(=\text{O})\text{H}$	9.8 *
$\text{R}-\text{C}(=\text{O})\text{OH}$	11.0 *

*variable figure dependent on concentration and solvent

Group	1	2	3	4	5	6	7	0
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1.01 H Hydrogen 1		Key Ar Symbol Name Z relative atomic mass atomic number										4.00 He Helium 2	
p block													
10.8 B Boron 5		12.0 C Carbon 6		14.0 N Nitrogen 7		16.0 O Oxygen 8		19.0 F Fluorine 9		20.2 Ne Neon 10			
27.0 Al Aluminium 13		28.1 Si Silicon 14		31.0 P Phosphorus 15		32.1 S Sulfur 16		35.5 Cl Chlorine 17		40.0 Ar Argon 18			
69.7 Ga Gallium 31		72.6 Ge Germanium 32		74.9 As Arsenic 33		79.0 Se Selenium 34		79.9 Br Bromine 35		83.8 Kr Krypton 36			
115 In Indium 49		119 Sn Tin 50		122 Sb Antimony 51		128 Te Tellurium 52		127 I Iodine 53		131 Xe Xenon 54			
204 Tl Thallium 81		207 Pb Lead 82		209 Bi Bismuth 83		(210) Po Polonium 84		(210) At Astatine 85		(222) Rn Radon 86			
d block													
45.0 Sc Scandium 21		47.9 Ti Titanium 22		50.9 V Vanadium 23		52.0 Cr Chromium 24		54.9 Mn Manganese 25		55.8 Fe Iron 26			
58.9 Co Cobalt 27		58.7 Ni Nickel 28		63.5 Cu Copper 29		65.4 Zn Zinc 30							
101 Ru Ruthenium 44		98.9 Tc Technetium 43		95.9 Mo Molybdenum 42		103 Rh Rhodium 45		106 Pd Palladium 46		108 Ag Silver 47			
190 Os Osmium 76		186 Re Rhenium 75		184 W Tungsten 74		192 Ir Iridium 77		195 Pt Platinum 78		197 Au Gold 79			
201 Hg Mercury 80		204 Tl Thallium 81		207 Pb Lead 82		209 Bi Bismuth 83		(210) Po Polonium 84		(210) At Astatine 85			
f block													
(223) Fr Francium 87		(226) Ra Radium 88		(227) Ac Actinium 89									

►► Actinoid elements

140	Ce	Cerium	58
141	Pr	Praseodymium	59
144	Nd	Neodymium	60
(147)	Pm	Promethium	61
150	Sm	Samarium	62
(153)	Eu	Europium	63
157	Gd	Gadolinium	64
159	Tb	Terbium	65
163	Dy	Dysprosium	66
165	Ho	Holmium	67
167	Er	Erbium	68
169	Tm	Thulium	69
173	Yb	Ytterbium	70
175	Lu	Lutetium	71