



GCE A LEVEL

A410U20-1A



S24-A410U20-1A



TUESDAY, 18 JUNE 2024 – MORNING

CHEMISTRY – A level component 2

Data Booklet

Avogadro constant
molar gas constant
molar gas volume at 273 K and 1 atm
molar gas volume at 298 K and 1 atm
Planck constant
speed of light
density of water
specific heat capacity of water
ionic product of water at 298 K
fundamental electronic charge

$$\begin{aligned}N_A &= 6.02 \times 10^{23} \text{ mol}^{-1} \\R &= 8.31 \text{ J mol}^{-1} \text{ K}^{-1} \\V_m &= 22.4 \text{ dm}^3 \text{ mol}^{-1} \\V_m &= 24.5 \text{ dm}^3 \text{ mol}^{-1} \\h &= 6.63 \times 10^{-34} \text{ Js} \\c &= 3.00 \times 10^8 \text{ ms}^{-1} \\d &= 1.00 \text{ g cm}^{-3} \\c &= 4.18 \text{ J g}^{-1} \text{ K}^{-1} \\K_w &= 1.00 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6} \\e &= 1.60 \times 10^{-19} \text{ C}\end{aligned}$$

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

$1 \text{ dm}^3 = 1000 \text{ cm}^3$
 $1 \text{ m}^3 = 1000 \text{ dm}^3$
1 tonne = 1000 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)
$\begin{array}{c} \quad \\ -\text{C}-\text{C}- \\ \quad \end{array}$	5 to 40
$\begin{array}{c} \\ \text{R}-\text{C}-\text{Cl} \text{ or } \text{Br} \\ \end{array}$	10 to 70
$\begin{array}{c} \\ \text{R}-\text{C}-\text{C}- \\ \quad \\ \text{O} \end{array}$	20 to 50
$\begin{array}{c} \\ \text{R}-\text{C}-\text{N} \diagup \diagdown \\ \end{array}$	25 to 60
$\begin{array}{c} \\ -\text{C}-\text{O}- \\ \end{array}$	50 to 90
$\begin{array}{c} \diagdown \quad \diagup \\ \text{C}=\text{C} \\ \diagup \quad \diagdown \end{array}$	90 to 150
$\text{R}-\text{C} \equiv \text{N}$	110 to 125
	110 to 160
$\begin{array}{c} \text{R}-\text{C}- \text{ (carboxylic acid / ester)} \\ \\ \text{O} \end{array}$	160 to 185
$\begin{array}{c} \text{R}-\text{C}- \text{ (aldehyde / ketone)} \\ \\ \text{O} \end{array}$	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

THE PERIODIC TABLE

Period **1** **2** **3** **4** **5** **6** **7** **0**

Group

s block		p block											
1	2	3	4	5	6	7	8	9	10	11	12		
1.01 H Hydrogen 1	4.00 He Helium 2												
6.94 Li Lithium 3	9.01 Be Beryllium 4	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
39.1 K Potassium 19	40.1 Ca Calcium 20	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	127 I Iodine 53	131 Xe Xenon 54	(222) Rn Radon 86
85.5 Rb Rubidium 37	87.6 Sr Strontium 38	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	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
133 Cs Caesium 55	137 Ba Barium 56	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	(210) Po Polonium 84	(210) At Astatine 85	(222) Rn Radon 86	(222) Rn Radon 86	(222) Rn Radon 86	(222) Rn Radon 86	(222) Rn Radon 86	(222) Rn Radon 86
(223) Fr Francium 87	(226) Ra Radium 88	(227) Ac Actinium 89	(227) Ac Actinium 89	(227) Ac Actinium 89	(227) Ac Actinium 89	(227) Ac Actinium 89	(227) Ac Actinium 89	(227) Ac Actinium 89	(227) Ac Actinium 89	(227) Ac Actinium 89	(227) Ac Actinium 89	(227) Ac Actinium 89	(227) Ac Actinium 89
▶ Lanthanoid elements		f block											
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
232 Th Thorium 90	(231) Pa Protactinium 91	238 U Uranium 92	(237) Np Neptunium 93	(242) Pu Plutonium 94	(243) Am Americium 95	(247) Cm Curium 96	(245) Bk Berkelium 97	(251) Cf Californium 98	(254) Es Einsteinium 99	(253) Fm Fermium 100	(256) Md Mendelevium 101	(254) No Nobelium 102	(257) Lr Lawrencium 103
▶▶ Actinoid elements													

Key

Ar

Symbol

Name

Z

relative atomic mass

atomic number