



GCE AS

B410U10-1A



S24-B410U10-1A



TUESDAY, 14 MAY 2024 – MORNING

CHEMISTRY – AS component 1
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

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

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

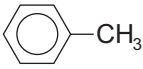
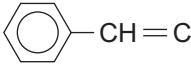
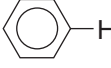
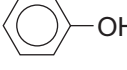
Infrared absorption values

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
$\begin{array}{c} \\ \text{R}-\text{C}-\text{Cl or Br} \\ \end{array}$	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
	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
	6.5 to 7.5
	6.5 to 8.0
	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	0
1.01 H Hydrogen 1	6.94 Li Lithium 3	23.0 Na Sodium 11	39.1 K Potassium 19	85.5 Rb Rubidium 37	133 Cs Caesium 55	(223) Fr Francium 87	4.00 He Helium 2
9.01 Be Beryllium 4	24.3 Mg Magnesium 12	40.1 Ca Calcium 20	40.1 Ca Calcium 20	87.6 Sr Strontium 38	137 Ba Barium 56	(226) Ra Radium 88	20.2 Ne Neon 10
45.0 Sc Scandium 21	45.0 Sc Scandium 21	45.0 Sc Scandium 21	45.0 Sc Scandium 21	45.0 Sc Scandium 21	45.0 Sc Scandium 21	45.0 Sc Scandium 21	40.0 Ar Argon 18
47.9 Ti Titanium 22	47.9 Ti Titanium 22	47.9 Ti Titanium 22	47.9 Ti Titanium 22	47.9 Ti Titanium 22	47.9 Ti Titanium 22	47.9 Ti Titanium 22	35.5 Cl Chlorine 17
50.9 V Vanadium 23	50.9 V Vanadium 23	50.9 V Vanadium 23	50.9 V Vanadium 23	50.9 V Vanadium 23	50.9 V Vanadium 23	50.9 V Vanadium 23	32.1 S Sulfur 16
52.0 Cr Chromium 24	52.0 Cr Chromium 24	52.0 Cr Chromium 24	52.0 Cr Chromium 24	52.0 Cr Chromium 24	52.0 Cr Chromium 24	52.0 Cr Chromium 24	31.0 P Phosphorus 15
54.9 Mn Manganese 25	54.9 Mn Manganese 25	54.9 Mn Manganese 25	54.9 Mn Manganese 25	54.9 Mn Manganese 25	54.9 Mn Manganese 25	54.9 Mn Manganese 25	28.1 Si Silicon 14
55.8 Fe Iron 26	55.8 Fe Iron 26	55.8 Fe Iron 26	55.8 Fe Iron 26	55.8 Fe Iron 26	55.8 Fe Iron 26	55.8 Fe Iron 26	27.0 Al Aluminium 13
58.9 Co Cobalt 27	58.9 Co Cobalt 27	58.9 Co Cobalt 27	58.9 Co Cobalt 27	58.9 Co Cobalt 27	58.9 Co Cobalt 27	58.9 Co Cobalt 27	27.0 Al Aluminium 13
58.7 Ni Nickel 28	58.7 Ni Nickel 28	58.7 Ni Nickel 28	58.7 Ni Nickel 28	58.7 Ni Nickel 28	58.7 Ni Nickel 28	58.7 Ni Nickel 28	27.0 Al Aluminium 13
63.5 Cu Copper 29	63.5 Cu Copper 29	63.5 Cu Copper 29	63.5 Cu Copper 29	63.5 Cu Copper 29	63.5 Cu Copper 29	63.5 Cu Copper 29	27.0 Al Aluminium 13
65.4 Zn Zinc 30	65.4 Zn Zinc 30	65.4 Zn Zinc 30	65.4 Zn Zinc 30	65.4 Zn Zinc 30	65.4 Zn Zinc 30	65.4 Zn Zinc 30	27.0 Al Aluminium 13
69.7 Ga Gallium 31	69.7 Ga Gallium 31	69.7 Ga Gallium 31	69.7 Ga Gallium 31	69.7 Ga Gallium 31	69.7 Ga Gallium 31	69.7 Ga Gallium 31	27.0 Al Aluminium 13
72.6 Ge Germanium 32	72.6 Ge Germanium 32	72.6 Ge Germanium 32	72.6 Ge Germanium 32	72.6 Ge Germanium 32	72.6 Ge Germanium 32	72.6 Ge Germanium 32	27.0 Al Aluminium 13
74.9 As Arsenic 33	74.9 As Arsenic 33	74.9 As Arsenic 33	74.9 As Arsenic 33	74.9 As Arsenic 33	74.9 As Arsenic 33	74.9 As Arsenic 33	27.0 Al Aluminium 13
79.0 Se Selenium 34	79.0 Se Selenium 34	79.0 Se Selenium 34	79.0 Se Selenium 34	79.0 Se Selenium 34	79.0 Se Selenium 34	79.0 Se Selenium 34	27.0 Al Aluminium 13
83.8 Kr Krypton 36	83.8 Kr Krypton 36	83.8 Kr Krypton 36	83.8 Kr Krypton 36	83.8 Kr Krypton 36	83.8 Kr Krypton 36	83.8 Kr Krypton 36	27.0 Al Aluminium 13
115 In Indium 49	115 In Indium 49	115 In Indium 49	115 In Indium 49	115 In Indium 49	115 In Indium 49	115 In Indium 49	27.0 Al Aluminium 13
112 Cd Cadmium 48	112 Cd Cadmium 48	112 Cd Cadmium 48	112 Cd Cadmium 48	112 Cd Cadmium 48	112 Cd Cadmium 48	112 Cd Cadmium 48	27.0 Al Aluminium 13
108 Ag Silver 47	108 Ag Silver 47	108 Ag Silver 47	108 Ag Silver 47	108 Ag Silver 47	108 Ag Silver 47	108 Ag Silver 47	27.0 Al Aluminium 13
106 Pd Palladium 46	106 Pd Palladium 46	106 Pd Palladium 46	106 Pd Palladium 46	106 Pd Palladium 46	106 Pd Palladium 46	106 Pd Palladium 46	27.0 Al Aluminium 13
103 Rh Rhodium 45	103 Rh Rhodium 45	103 Rh Rhodium 45	103 Rh Rhodium 45	103 Rh Rhodium 45	103 Rh Rhodium 45	103 Rh Rhodium 45	27.0 Al Aluminium 13
190 Os Osmium 76	190 Os Osmium 76	190 Os Osmium 76	190 Os Osmium 76	190 Os Osmium 76	190 Os Osmium 76	190 Os Osmium 76	27.0 Al Aluminium 13
186 Re Rhenium 75	186 Re Rhenium 75	186 Re Rhenium 75	186 Re Rhenium 75	186 Re Rhenium 75	186 Re Rhenium 75	186 Re Rhenium 75	27.0 Al Aluminium 13
184 W Tungsten 74	184 W Tungsten 74	184 W Tungsten 74	184 W Tungsten 74	184 W Tungsten 74	184 W Tungsten 74	184 W Tungsten 74	27.0 Al Aluminium 13
181 Ta Tantalum 73	181 Ta Tantalum 73	181 Ta Tantalum 73	181 Ta Tantalum 73	181 Ta Tantalum 73	181 Ta Tantalum 73	181 Ta Tantalum 73	27.0 Al Aluminium 13
179 Hf Hafnium 72	179 Hf Hafnium 72	179 Hf Hafnium 72	179 Hf Hafnium 72	179 Hf Hafnium 72	179 Hf Hafnium 72	179 Hf Hafnium 72	27.0 Al Aluminium 13
139 La Lanthanum 57	139 La Lanthanum 57	139 La Lanthanum 57	139 La Lanthanum 57	139 La Lanthanum 57	139 La Lanthanum 57	139 La Lanthanum 57	27.0 Al Aluminium 13
(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	27.0 Al Aluminium 13

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

► Lanthanoid elements

►► Actinoid elements