

1410U30-1A

MONDAY, 10 JUNE 2024 – MORNING

CHEMISTRY – A2 unit 3

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	=	$6.63 \times 10^{-34} \text{ Js}$
speed of light	c	=	$3.00 \times 10^8 \text{ m s}^{-1}$
density of water	d	=	1.00 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 ($^{\circ}\text{C}$) + 273

$1 \text{ dm}^3 = 1000 \text{ cm}^3$

$1 \text{ m}^3 = 1000 \text{ dm}^3$

$1 \text{ tonne} = 1000 \text{ kg}$

$1 \text{ atm} = 1.01 \times 10^5 \text{ Pa}$

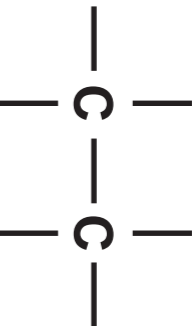

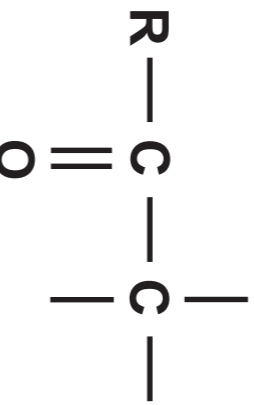
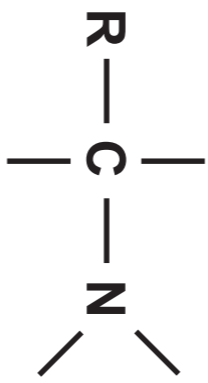
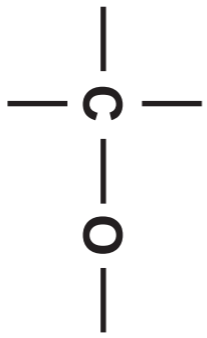
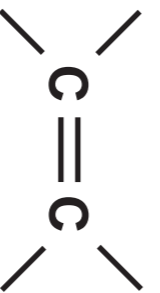




Multiple	Prefix	Symbol
10^{-9}	nano	n
10^{-6}	micro	μ
10^{-3}	milli	m

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≡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)
	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

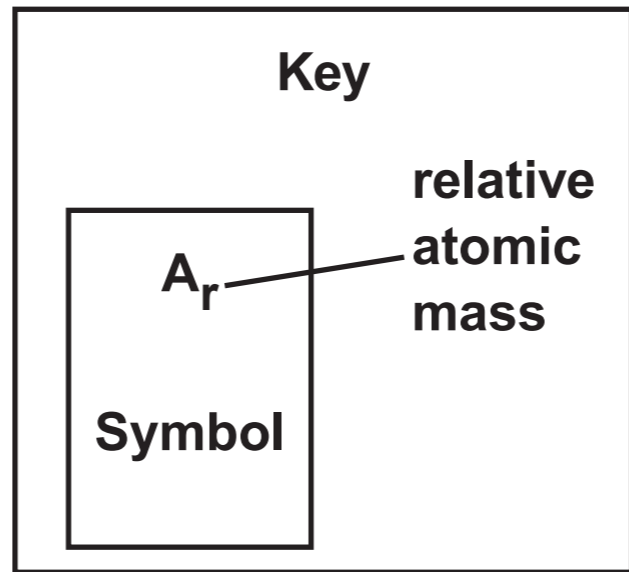
¹H NMR CHEMICAL SHIFTS RELATIVE TO TMS = 0

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
 $-\text{CH}_3$	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
 $-\text{H}$	6.5 to 8.0
 $-\text{OH}$	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

		Group																		
		1	2											3	4	5	6	7	0	
Period	1	s Block												p Block						
	1	1.01 H																		4.00 He
	2	6.94 Li	9.01 Be											10.8 B	12.0 C	14.0 N	16.0 O	19.0 F	20.2 Ne	
	3	23.0 Na	24.3 Mg	d Block										27.0 Al	28.1 Si	31.0 P	32.1 S	35.5 Cl	40.0 Ar	
	4	39.1 K	40.1 Ca	45.0 Sc	47.9 Ti	50.9 V	52.0 Cr	54.9 Mn	55.8 Fe	58.9 Co	58.7 Ni	63.5 Cu	65.4 Zn	69.7 Ga	72.6 Ge	74.9 As	79.0 Se	79.9 Br	83.8 Kr	
	5	85.5 Rb	87.6 Sr	88.9 Y	91.2 Zr	92.9 Nb	95.9 Mo	98.9 Tc	101 Ru	103 Rh	106 Pd	108 Ag	112 Cd	115 In	119 Sn	122 Sb	128 Te	127 I	131 Xe	
	6	133 Cs	137 Ba	139 La	179 Hf	181 Ta	184 W	186 Re	190 Os	192 Ir	195 Pt	197 Au	201 Hg	204 Tl	207 Pb	209 Bi	(210) Po	(210) At	(222) Rn	
7	(223) Fr	(226) Ra	(227) Ac																	



f Block

▶Lanthanoid elements	140 Ce	141 Pr	144 Nd	(147) Pm	150 Sm	(153) Eu	157 Gd	159 Tb	163 Dy	165 Ho	167 Er	169 Tm	173 Yb	175 Lu
▶Actinoid elements	232 Th	(231) Pa	238 U	(237) Np	(242) Pu	(243) Am	(247) Cm	(245) Bk	(251) Cf	(254) Es	(253) Fm	(256) Md	(254) No	(257) Lr

THE PERIODIC TABLE – KEY
ATOMIC NUMBER – SYMBOL – NAME

1	H - Hydrogen	38	Sr - Strontium	75	Re - Rhenium
2	He - Helium	39	Y - Yttrium	76	Os - Osmium
3	Li - Lithium	40	Zr - Zirconium	77	Ir - Iridium
4	Be - Beryllium	41	Nb - Niobium	78	Pt - Platinum
5	B - Boron	42	Mo - Molybdenum	79	Au - Gold
6	C - Carbon	43	Tc - Technetium	80	Hg - Mercury
7	N - Nitrogen	44	Ru - Ruthenium	81	Tl - Thallium
8	O - Oxygen	45	Rh - Rhodium	82	Pb - Lead
9	F - Fluorine	46	Pd - Palladium	83	Bi - Bismuth
10	Ne - Neon	47	Ag - Silver	84	Po - Polonium
11	Na - Sodium	48	Cd - Cadmium	85	At - Astatine
12	Mg - Magnesium	49	In - Indium	86	Rn - Radon
13	Al - Aluminium	50	Sn - Tin	87	Fr - Francium
14	Si - Silicon	51	Sb - Antimony	88	Ra - Radium
15	P - Phosphorus	52	Te - Tellurium	89	Ac - Actinium
16	S - Sulfur	53	I - Iodine	90	Th - Thorium
17	Cl - Chlorine	54	Xe - Xenon	91	Pa - Protactinium
18	Ar - Argon	55	Cs - Caesium	92	U - Uranium
19	K - Potassium	56	Ba - Barium	93	Np - Neptunium
20	Ca - Calcium	57	La - Lanthanum	94	Pu - Plutonium
21	Sc - Scandium	58	Ce - Cerium	95	Am - Americium
22	Ti - Titanium	59	Pr - Praseodymium	96	Cm - Curium
23	V - Vanadium	60	Nd - Neodymium	97	Bk - Berkelium
24	Cr - Chromium	61	Pm - Promethium	98	Cf - Californium
25	Mn - Manganese	62	Sm - Samarium	99	Es - Einsteinium
26	Fe - Iron	63	Eu - Europium	100	Fm - Fermium
27	Co - Cobalt	64	Gd - Gadolinium	101	Md - Mendeleevium
28	Ni - Nickel	65	Tb - Terbium	102	No - Nobelium
29	Cu - Copper	66	Dy - Dysprosium	103	Lr - Lawrencium
30	Zn - Zinc	67	Ho - Holmium		
31	Ga - Gallium	68	Er - Erbium		
32	Ge - Germanium	69	Tm - Thulium		
33	As - Arsenic	70	Yb - Ytterbium		
34	Se - Selenium	71	Lu - Lutetium		
35	Br - Bromine	72	Hf - Hafnium		
36	Kr - Krypton	73	Ta - Tantalum		
37	Rb - Rubidium	74	W - Tungsten		