GCE A LEVEL

1410U50-1G

S24-1410U50-1G

FRIDAY, 10 MAY 2024 – MORNING

CHEMISTRY – A2 unit 5

Practical Methods and Analysis Task

Data Booklet

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

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

1 dm^3 = 1000 cm^3
1 m^3 = 1000 dm^3
1 tonne = 1000 kg
1 atm = 1.01×10^5 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

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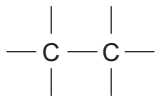
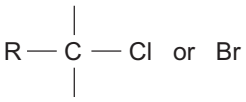
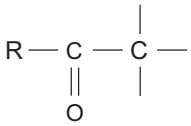
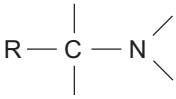
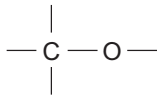
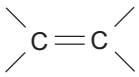
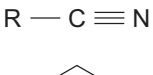
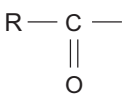
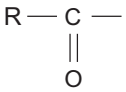
Infrared absorption values

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

^{13}C 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
 (carboxylic acid / ester)	160 to 185
 (aldehyde / ketone)	190 to 220

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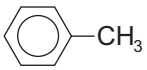
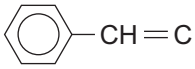
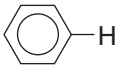
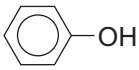
^{1}H NMR chemical shifts relative to TMS = 0

Type of proton	Chemical shift, δ (ppm)
$-CH_3$	0.1 to 2.0
$R-CH_3$	0.9
$R-CH_2-R$	1.3
$CH_3-C\equiv N$	2.0
$CH_3-C(=O)-$	2.0 to 2.5
$-CH_2-C(=O)-$	2.0 to 3.0
	2.2 to 2.3
$HC-Cl$ or $HC-Br$	3.1 to 4.3
$HC-O$	3.3 to 4.3
$R-OH$	4.5 *
$-C=CH$	4.5 to 6.3
$-C=CH-CO$	5.8 to 6.5
	6.5 to 7.5
	6.5 to 8.0
	7.0 *
$R-C(=O)-H$	9.8 *
$R-C(=O)-OH$	11.0 *

*variable figure dependent on concentration and solvent

THE PERIODIC TABLE

Key

A_r	relative atomic mass
Symbol	
Name	
Z	atomic number

Group

s block: Groups 1 and 2 · d block · p block: Groups 3 to 0 · f block

Period	1	2	3	4	5	6	7	0
1	1.01 H Hydrogen 1							4.00 He Helium 2
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
3	23.0 Na Sodium 11	24.3 Mg Magnesium 12	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
4	39.1 K Potassium 19	40.1 Ca Calcium 20	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	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						
5	85.5 Rb Rubidium 37	87.6 Sr Strontium 38	88.9 Y Yttrium 39	91.2 Zr Zirconium 40	92.9 Nb Niobium 41	95.9 Mo Molybdenum 42	98.9 Tc Technetium 43	101 Ru Ruthenium 44
	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52
	127 I Iodine 53	131 Xe Xenon 54						
6	133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 ▸	179 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76
	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	(222) Rn Radon 86						
7	(223) Fr Francium 87	(226) Ra Radium 88	(227) Ac Actinium 89 ▸▸					

▸ Lanthanoid 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

▸▸ Actinoid elements

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

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