



GCE A LEVEL

1410U30-1A



S24-1410U30-1A

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	$c = 3.00 \times 10^8 \text{ ms}^{-1}$
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 ($^{\circ}\text{C}$) + 273

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

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

1 tonne = 1000 kg

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

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

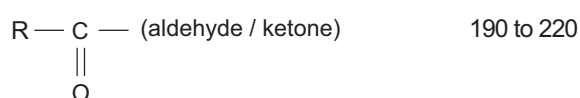
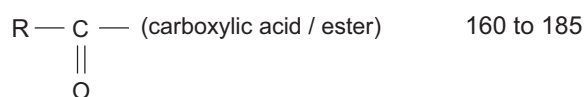
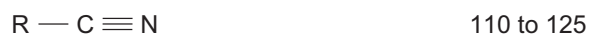
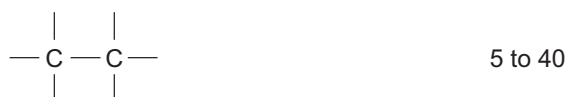
Multiple	Prefix	Symbol
10^3	kilo	k
10^6	mega	M
10^9	giga	G

Infrared absorption values

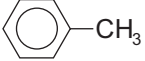
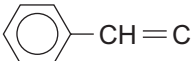
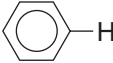
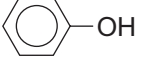
Bond	Wavenumber / cm^{-1}
C—Br	500 to 600
C—Cl	650 to 800
C—O	1000 to 1300
C=C	1620 to 1670
C=O	1650 to 1750
C≡N	2100 to 2250
C—H	2800 to 3100
O—H (carboxylic acid)	2500 to 3200 (very broad)
O—H (alcohol / phenol)	3200 to 3550 (broad)
N—H	3300 to 3500

 ^{13}C NMR chemical shifts relative to TMS = 0

Type of carbon	Chemical shift, δ (ppm)
----------------	--------------------------------



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

Group 1 2 3 4 5 6 7 0

Period 1 2 3 4 5 6 7

Period	1	2	s block										p block																																																																																																																																																																																																																															
1	1.01 H Hydrogen 1												4.00 He Helium 2																																																																																																																																																																																																																															
2	6.94 Li Lithium 3	9.01 Be Beryllium 4											20.2 Ne Neon 10																																																																																																																																																																																																																															
3	23.0 Na Sodium 11	24.3 Mg Magnesium 12											40.0 Ar Argon 18																																																																																																																																																																																																																															
4	39.1 K Potassium 19	40.1 Ca Calcium 20											83.8 Kr Krypton 36																																																																																																																																																																																																																															
5	85.5 Rb Rubidium 37	87.6 Sr Strontium 38											131 Xe Xenon 54																																																																																																																																																																																																																															
6	133 Cs Caesium 55	137 Ba Barium 56											(222) Rn Radon 86																																																																																																																																																																																																																															
7	(223) Fr Francium 87	(226) Ra Radium 88																																																																																																																																																																																																																																										
													d block										f block																																																																																																																																																																																																																					
													<table border="1"> <tr> <td>65.4</td><td>Zn</td><td>Zinc</td><td>30</td> <td>63.5</td><td>Cu</td><td>Copper</td><td>29</td> <td>58.7</td><td>Ni</td><td>Nickel</td><td>28</td> <td>58.9</td><td>Co</td><td>Cobalt</td><td>27</td> <td>55.8</td><td>Fe</td><td>Iron</td><td>26</td> <td>54.9</td><td>Mn</td><td>Manganese</td><td>25</td> <td>52.0</td><td>Cr</td><td>Chromium</td><td>24</td> <td>50.9</td><td>V</td><td>Vanadium</td><td>23</td> <td>47.9</td><td>Ti</td><td>Titanium</td><td>22</td> <td>45.0</td><td>Sc</td><td>Scandium</td><td>21</td> </tr> <tr> <td>112</td><td>Cd</td><td>Cadmium</td><td>48</td> <td>108</td><td>Ag</td><td>Silver</td><td>47</td> <td>106</td><td>Pd</td><td>Palladium</td><td>46</td> <td>103</td><td>Rh</td><td>Rhodium</td><td>45</td> <td>101</td><td>Ru</td><td>Ruthenium</td><td>44</td> <td>98.9</td><td>Tc</td><td>Technetium</td><td>43</td> <td>95.9</td><td>Mo</td><td>Molybdenum</td><td>42</td> <td>92.9</td><td>Nb</td><td>Niobium</td><td>41</td> <td>91.2</td><td>Zr</td><td>Zirconium</td><td>40</td> <td>88.9</td><td>Y</td><td>Yttrium</td><td>39</td> </tr> <tr> <td>201</td><td>Hg</td><td>Mercury</td><td>80</td> <td>197</td><td>Au</td><td>Gold</td><td>79</td> <td>195</td><td>Pt</td><td>Platinum</td><td>78</td> <td>192</td><td>Ir</td><td>Iridium</td><td>77</td> <td>190</td><td>Os</td><td>Osmium</td><td>76</td> <td>186</td><td>Re</td><td>Rhenium</td><td>75</td> <td>184</td><td>W</td><td>Tungsten</td><td>74</td> <td>181</td><td>Ta</td><td>Tantalum</td><td>73</td> <td>179</td><td>Hf</td><td>Hafnium</td><td>72</td> <td>139</td><td>La</td><td>Lanthanum</td><td>57</td> <td>(227)</td><td>Ac</td><td>Actinium</td><td>89</td> </tr> </table>										65.4	Zn	Zinc	30	63.5	Cu	Copper	29	58.7	Ni	Nickel	28	58.9	Co	Cobalt	27	55.8	Fe	Iron	26	54.9	Mn	Manganese	25	52.0	Cr	Chromium	24	50.9	V	Vanadium	23	47.9	Ti	Titanium	22	45.0	Sc	Scandium	21	112	Cd	Cadmium	48	108	Ag	Silver	47	106	Pd	Palladium	46	103	Rh	Rhodium	45	101	Ru	Ruthenium	44	98.9	Tc	Technetium	43	95.9	Mo	Molybdenum	42	92.9	Nb	Niobium	41	91.2	Zr	Zirconium	40	88.9	Y	Yttrium	39	201	Hg	Mercury	80	197	Au	Gold	79	195	Pt	Platinum	78	192	Ir	Iridium	77	190	Os	Osmium	76	186	Re	Rhenium	75	184	W	Tungsten	74	181	Ta	Tantalum	73	179	Hf	Hafnium	72	139	La	Lanthanum	57	(227)	Ac	Actinium	89	<table border="1"> <tr> <td>165</td><td>Ho</td><td>Holmium</td><td>67</td> <td>163</td><td>Dy</td><td>Dysprosium</td><td>66</td> <td>159</td><td>Tb</td><td>Terbium</td><td>65</td> <td>157</td><td>Gd</td><td>Gadolinium</td><td>64</td> <td>(153)</td><td>Eu</td><td>Europium</td><td>63</td> <td>150</td><td>Sm</td><td>Samarium</td><td>62</td> <td>(147)</td><td>Pm</td><td>Promethium</td><td>61</td> <td>144</td><td>Nd</td><td>Neodymium</td><td>60</td> <td>141</td><td>Pr</td><td>Praseodymium</td><td>59</td> <td>140</td><td>Ce</td><td>Cerium</td><td>58</td> </tr> <tr> <td>(254)</td><td>No</td><td>Nobelium</td><td>102</td> <td>(253)</td><td>Fm</td><td>Fermium</td><td>100</td> <td>(256)</td><td>Md</td><td>Mendelevium</td><td>101</td> <td>(255)</td><td>Lr</td><td>Lawrencium</td><td>103</td> <td>(254)</td><td>No</td><td>Nobelium</td><td>102</td> <td>(253)</td><td>Fm</td><td>Fermium</td><td>100</td> <td>(256)</td><td>Md</td><td>Mendelevium</td><td>101</td> <td>(257)</td><td>Lr</td><td>Lawrencium</td><td>103</td> <td>(254)</td><td>No</td><td>Nobelium</td><td>102</td> <td>(253)</td><td>Fm</td><td>Fermium</td><td>100</td> </tr> </table>										165	Ho	Holmium	67	163	Dy	Dysprosium	66	159	Tb	Terbium	65	157	Gd	Gadolinium	64	(153)	Eu	Europium	63	150	Sm	Samarium	62	(147)	Pm	Promethium	61	144	Nd	Neodymium	60	141	Pr	Praseodymium	59	140	Ce	Cerium	58	(254)	No	Nobelium	102	(253)	Fm	Fermium	100	(256)	Md	Mendelevium	101	(255)	Lr	Lawrencium	103	(254)	No	Nobelium	102	(253)	Fm	Fermium	100	(256)	Md	Mendelevium	101	(257)	Lr	Lawrencium	103	(254)	No	Nobelium	102	(253)	Fm	Fermium	100
65.4	Zn	Zinc	30	63.5	Cu	Copper	29	58.7	Ni	Nickel	28	58.9	Co	Cobalt	27	55.8	Fe	Iron	26	54.9	Mn	Manganese	25	52.0	Cr	Chromium	24	50.9	V	Vanadium	23	47.9	Ti	Titanium	22	45.0	Sc	Scandium	21																																																																																																																																																																																																					
112	Cd	Cadmium	48	108	Ag	Silver	47	106	Pd	Palladium	46	103	Rh	Rhodium	45	101	Ru	Ruthenium	44	98.9	Tc	Technetium	43	95.9	Mo	Molybdenum	42	92.9	Nb	Niobium	41	91.2	Zr	Zirconium	40	88.9	Y	Yttrium	39																																																																																																																																																																																																					
201	Hg	Mercury	80	197	Au	Gold	79	195	Pt	Platinum	78	192	Ir	Iridium	77	190	Os	Osmium	76	186	Re	Rhenium	75	184	W	Tungsten	74	181	Ta	Tantalum	73	179	Hf	Hafnium	72	139	La	Lanthanum	57	(227)	Ac	Actinium	89																																																																																																																																																																																																	
165	Ho	Holmium	67	163	Dy	Dysprosium	66	159	Tb	Terbium	65	157	Gd	Gadolinium	64	(153)	Eu	Europium	63	150	Sm	Samarium	62	(147)	Pm	Promethium	61	144	Nd	Neodymium	60	141	Pr	Praseodymium	59	140	Ce	Cerium	58																																																																																																																																																																																																					
(254)	No	Nobelium	102	(253)	Fm	Fermium	100	(256)	Md	Mendelevium	101	(255)	Lr	Lawrencium	103	(254)	No	Nobelium	102	(253)	Fm	Fermium	100	(256)	Md	Mendelevium	101	(257)	Lr	Lawrencium	103	(254)	No	Nobelium	102	(253)	Fm	Fermium	100																																																																																																																																																																																																					
													▶ Lanthanoid elements										▶▶ Actinoid elements																																																																																																																																																																																																																					

