



Pearson Edexcel Level 3
Advanced Level
GCE in Chemistry (9CH0)

Data Booklet

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Physical constants

Avogadro constant (L) $6.02 \times 10^{23} \text{ mol}^{-1}$

Elementary charge (e) $1.60 \times 10^{-19} \text{ C}$

Gas constant (R) $8.31 \text{ J mol}^{-1} \text{ K}^{-1}$

Molar volume of a gas
at room temperature
and pressure (r.t.p.): $24 \text{ dm}^3 \text{ mol}^{-1}$

Ionic product of water (K_w) $1.00 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$

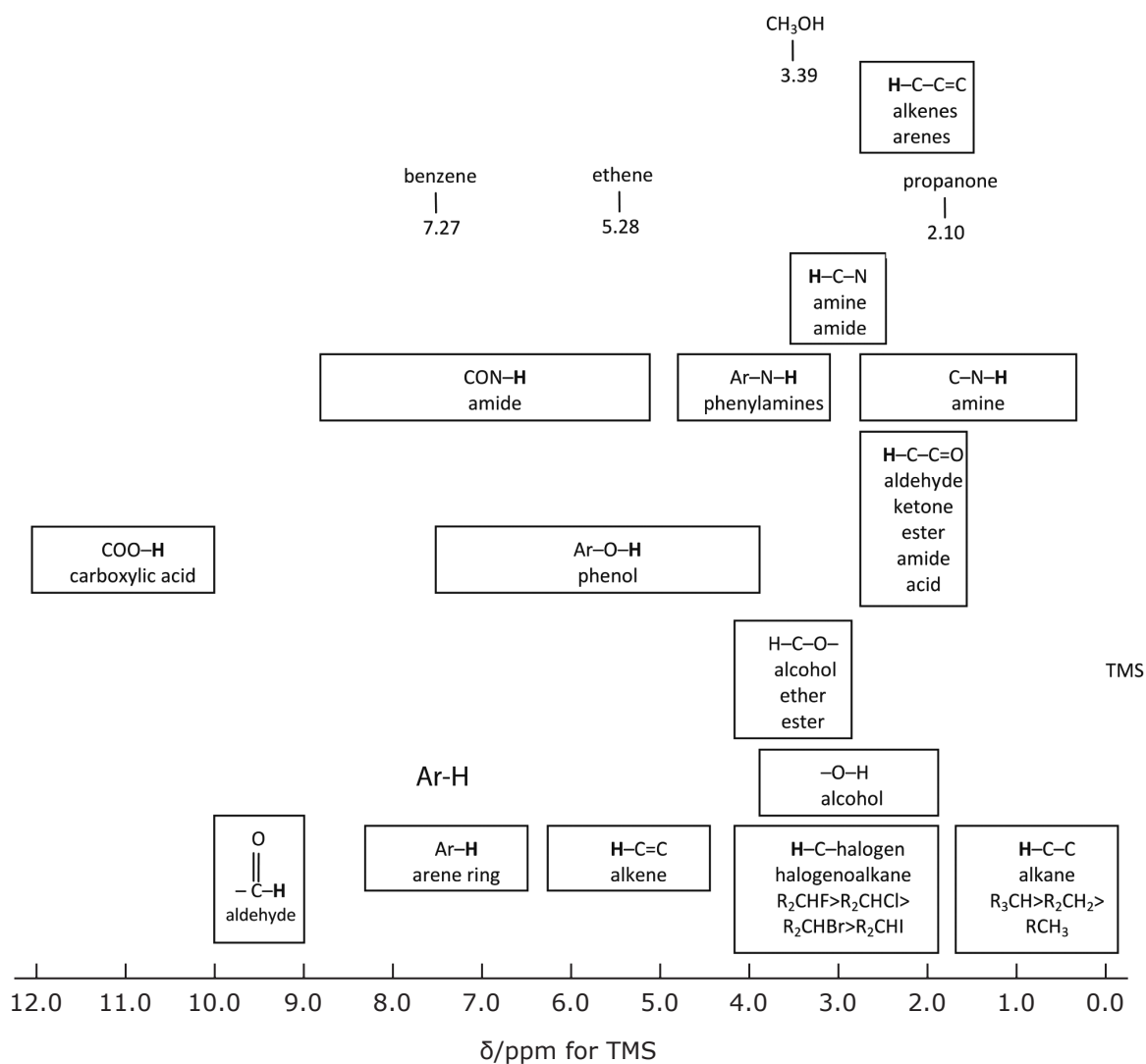
$1 \text{ dm}^3 = 1000 \text{ cm}^3 = 0.001 \text{ m}^3$

Infrared spectroscopy

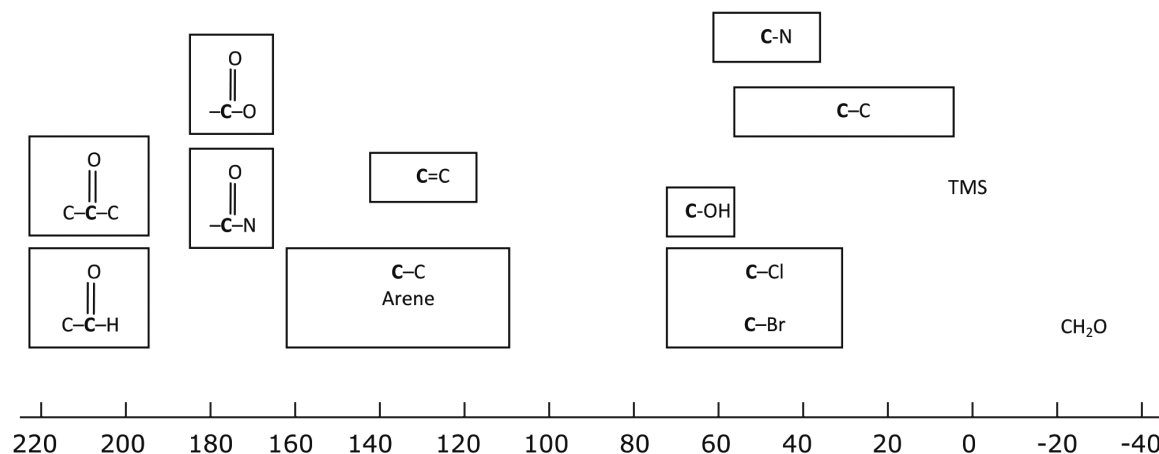
Correlation of infrared absorption wavenumbers with molecular structure

Group	Wavenumber range/cm ⁻¹
C-H stretching vibrations	
Alkane	2962-2853
Alkene	3095-3010
Alkyne	3300
Arene	3030
Aldehyde	2900-2820 and 2775-2700
C-H bending vibrations	
Alkane	1485-1365
Arene 5 adjacent hydrogen atoms	750 and 700
4 adjacent hydrogen atoms	750
3 adjacent hydrogen atoms	780
2 adjacent hydrogen atoms	830
1 isolated hydrogen atom	880
N-H stretching vibrations	
Amine	3500-3300
Amide	3500-3140
O-H stretching vibrations	
Alcohols and phenols	3750-3200
Carboxylic acids	3300-2500
C=C stretching vibrations	
Isolated alkene	1669-1645
Arene	1600, 1580, 1500, 1450
C=O stretching vibrations	
Aldehydes, saturated alkyl	1740-1720
Ketones, alkyl	1720-1700
Ketones, aryl	1700-1680
Carboxylic acids, alkyl	1725-1700
Carboxylic acids, aryl	1700-1680
Carboxylic acid, anhydrides	1850-1800 and 1790-1740
Acyl halides, chlorides	1795
Acyl halides, bromides	1810
Esters, saturated	1750-1735
Amides	1700-1630
Triple bond stretching vibrations	
C≡N	2260-2215
C≡C	2260-2100

¹H nuclear magnetic resonance chemical shifts relative to tetramethylsilane (TMS)



¹³C nuclear magnetic resonance chemical shifts relative to tetramethylsilane (TMS)



Pauling electronegativity index

Indicators

		pK_{in} (at 298 K)	acid	pH range	alkaline
1	Thymol blue (acid)	1.7	red	1.2–2.8	yellow
2	Screened methyl orange	3.7	purple	3.2–4.2	green
3	Methyl orange	3.7	red	3.2–4.4	yellow
4	Bromophenol blue	4.0	yellow	2.8–4.6	blue
5	Bromocresol green	4.7	yellow	3.8–5.4	blue
6	Methyl red	5.1	red	4.2–6.3	yellow
7	Litmus		red	5.0–8.0	blue
8	Bromothymol blue	7.0	yellow	6.0–7.6	blue
9	Phenol red	7.9	yellow	6.8–8.4	red
10	Phenolphthalein (in ethanol)	9.3	colourless	8.2–10.0	red

Standard electrode potentials

E^\ominus Standard electrode potential of aqueous system at 298 K, that is, standard emf of electrochemical cell in the hydrogen half-cell forms the left-hand side electrode system.

	Right-hand electrode system	E^\ominus / V
1	$\text{Na}^+ + \text{e}^- \rightleftharpoons \text{Na}$	-2.71
2	$\text{Mg}^{2+} + 2\text{e}^- \rightleftharpoons \text{Mg}$	-2.37
3	$\text{Al}^{3+} + 3\text{e}^- \rightleftharpoons \text{Al}$	-1.66
4	$\text{V}^{2+} + 2\text{e}^- \rightleftharpoons \text{V}$	-1.18
5	$\text{Zn}^{2+} + 2\text{e}^- \rightleftharpoons \text{Zn}$	-0.76
6	$\text{Cr}^{3+} + 3\text{e}^- \rightleftharpoons \text{Cr}$	-0.74
7	$\text{Fe}^{2+} + 2\text{e}^- \rightleftharpoons \text{Fe}$	-0.44
8	$\text{Cr}^{3+} + \text{e}^- \rightleftharpoons \text{Cr}^{2+}$	-0.41
9	$\text{V}^{3+} + \text{e}^- \rightleftharpoons \text{V}^{2+}$	-0.26
10	$\text{Ni}^{2+} + 2\text{e}^- \rightleftharpoons \text{Ni}$	-0.25
11	$\text{H}^+ + \text{e}^- \rightleftharpoons \frac{1}{2}\text{H}_2$	0.00
12	$\text{S}_4\text{O}_6^{2-} + 2\text{e}^- \rightleftharpoons 2\text{S}_2\text{O}_3^{2-}$	+0.09
13	$\text{Cu}^{2+} + \text{e}^- \rightleftharpoons \text{Cu}^+$	+0.15
14	$\text{Cu}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cu}$	+0.34
15	$\text{VO}^{2+} + 2\text{H}^+ + \text{e}^- \rightleftharpoons \text{V}^{3+} + \text{H}_2\text{O}$	+0.34
16	$\text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^- \rightleftharpoons 4\text{OH}^-$	+0.40
17	$\text{S}_2\text{O}_3^{2-} + 6\text{H}^+ + 4\text{e}^- \rightleftharpoons 2\text{S} + 3\text{H}_2\text{O}$	+0.47
18	$\text{Cu}^+ + \text{e}^- \rightleftharpoons \text{Cu}$	+0.52
19	$\text{I}_2 + 2\text{e}^- \rightleftharpoons 2\text{I}^-$	+0.54
20	$\text{O}_2 + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2\text{O}_2$	+0.68
21	$\text{Fe}^{3+} + \text{e}^- \rightleftharpoons \text{Fe}^{2+}$	+0.77
22	$\text{Ag}^+ + \text{e}^- \rightleftharpoons \text{Ag}$	+0.80
23	$\text{NO}_3^- + 2\text{H}^+ + \text{e}^- \rightleftharpoons \text{NO}_2 + \text{H}_2\text{O}$	+0.80
24	$\text{ClO}^- + \text{H}_2\text{O} + 2\text{e}^- \rightleftharpoons \text{Cl}^- + 2\text{OH}^-$	+0.89
25	$\text{VO}_2^+ + 2\text{H}^+ + \text{e}^- \rightleftharpoons \text{VO}^{2+} + \text{H}_2\text{O}$	+1.00
26	$\text{Br}_2 + 2\text{e}^- \rightleftharpoons 2\text{Br}^-$	+1.09
27	$\text{O}_2 + 4\text{H}^+ + 4\text{e}^- \rightleftharpoons 2\text{H}_2\text{O}$	+1.23
28	$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e}^- \rightleftharpoons 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	+1.33
29	$\text{Cl}_2 + 2\text{e}^- \rightleftharpoons 2\text{Cl}^-$	+1.36
30	$\text{MnO}_4^- + 8\text{H}^+ + 5\text{e}^- \rightleftharpoons \text{Mn}^{2+} + 4\text{H}_2\text{O}$	+1.51
31	$\text{H}_2\text{O}_2 + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons 2\text{H}_2\text{O}$	+1.77

[illegible]

* Lanthanide series

* Actinide series

Elements with atomic numbers 112-116 have been reported but not fully authenticated