



Pearson

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

**Data Booklet**

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Centres can make additional fresh copies by printing the Data Booklet from our website. Candidates must use an unmarked copy of the Data Booklet in examinations.

### **Acknowledgement of source**

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# Introduction

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This Data Booklet is for use with the Pearson Edexcel Level 3 Advanced Level GCE in Chemistry (9CH0) assessments for papers 1, 2 and 3.

Students will be provided with a clean copy of this Data Booklet for these assessments, which should be kept under the same conditions as the assessment papers.

Students may have a copy of this Data Booklet for their personal use in lessons and for homework, to allow them to become familiar with how to use it.

## 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 ( $K_w$ )  $1.00 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$

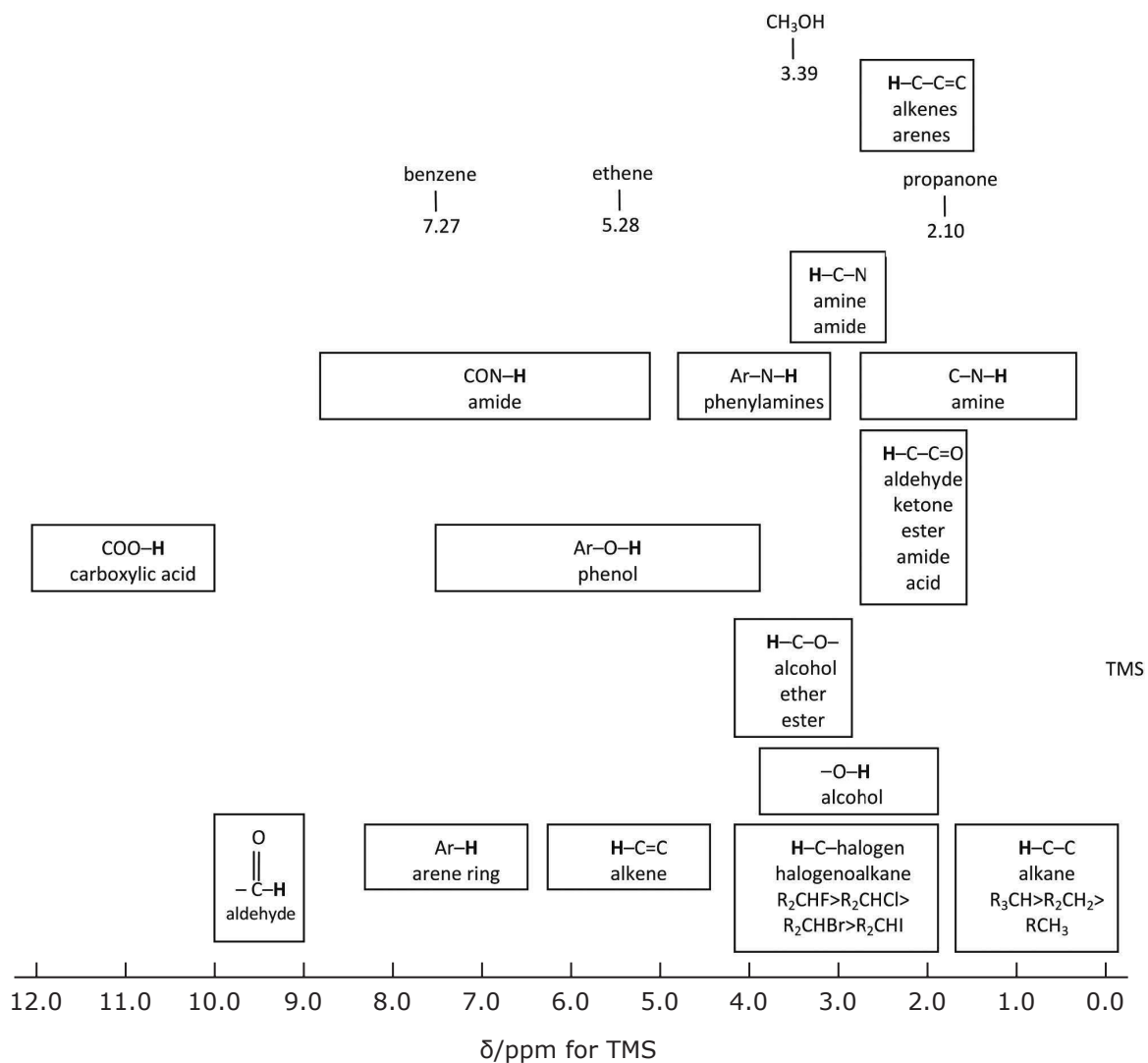
$1 \text{ dm}^3 = 1000 \text{ cm}^3 = 0.001 \text{ m}^3$

## Infrared spectroscopy

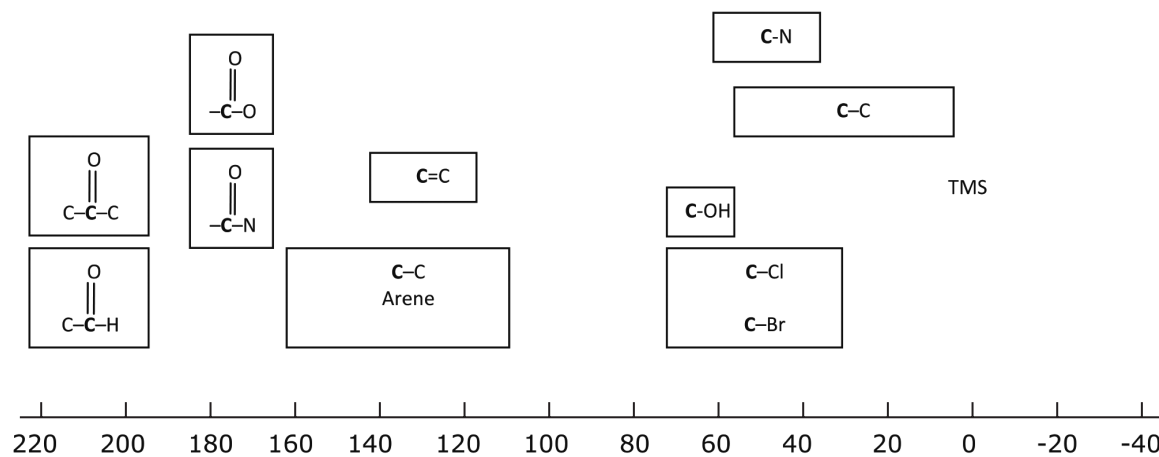
### Correlation of infrared absorption wavenumbers with molecular structure

Group	Wavenumber range/cm <sup>-1</sup>
<b>C-H stretching vibrations</b>	
Alkane	2962-2853
Alkene	3095-3010
Alkyne	3300
Arene	3030
Aldehyde	2900-2820 and 2775-2700
<b>C-H bending vibrations</b>	
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
<b>N-H stretching vibrations</b>	
Amine	3500-3300
Amide	3500-3140
<b>O-H stretching vibrations</b>	
Alcohols and phenols	3750-3200
Carboxylic acids	3300-2500
<b>C=C stretching vibrations</b>	
Isolated alkene	1669-1645
Arene	1600, 1580, 1500, 1450
<b>C=O stretching vibrations</b>	
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
<b>Triple bond stretching vibrations</b>	
C≡N	2260-2215
C≡C	2260-2100

**<sup>1</sup>H nuclear magnetic resonance chemical shifts relative to tetramethylsilane (TMS)**



**<sup>13</sup>C nuclear magnetic resonance chemical shifts relative to tetramethylsilane (TMS)**



## Pauling electronegativities

### Pauling electronegativity index

								H										He
								2.1										
Li	Be												B	C	N	O	F	Ne
1.0	1.5												2.0	2.5	3.0	3.5	4.0	
Na	Mg												Al	Si	P	S	Cl	Ar
0.9	1.2												1.5	1.9	2.1	2.5	3.0	
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br		Kr
0.8	1.0	1.3	1.5	1.6	1.6	1.5	1.8	1.8	1.8	1.9	1.6	1.6	2.0	2.0	2.4	2.8		
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I		Xe
0.8	1.0	1.2	1.3	1.6	2.1	1.9	2.2	2.2	2.2	1.9	1.6	1.7	1.9	1.9	2.1	2.5		
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At		Rn
0.7	0.9	1.1	1.3	1.5	2.3	1.9	2.2	2.2	2.2	2.5	2.0	1.6	1.8	1.9	2.0	2.2		

## Indicators

		<b>pK<sub>in</sub></b> <b>(at 298 K)</b>	<b>acid</b>	<b>pH range</b>	<b>alkaline</b>
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*

\* or pink



## 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

# The Periodic Table of Elements

1	2	3	4	5	6	7	0 (8) (18)																																							
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)																													
6.9 <b>Li</b> lithium 3	9.0 <b>Be</b> beryllium 4	23.0 <b>Na</b> sodium 11	24.3 <b>Mg</b> magnesium 12	39.1 <b>K</b> potassium 19	40.1 <b>Ca</b> calcium 20	87.6 <b>Sr</b> strontium 38	132.9 <b>Cs</b> caesium 55	[223] <b>Fr</b> francium 87	[226] <b>Ra</b> radium 88	[227] <b>Ac*</b> actinium 89	[261] <b>Rf</b> rutherfordium 104	[262] <b>Db</b> dubnium 105	[266] <b>Sg</b> seaborgium 106	[264] <b>Bh</b> bohrium 107	[277] <b>Hs</b> hassium 108	[268] <b>Mt</b> meitnerium 109	[271] <b>Ds</b> darmstadtium 110	[272] <b>Rg</b> roentgenium 111	140 <b>Ce</b> cerium 58	141 <b>Pr</b> praseodymium 59	144 <b>Nd</b> neodymium 60	147 <b>Pm</b> promethium 61	150 <b>Sm</b> samarium 62	152 <b>Eu</b> europium 63	157 <b>Gd</b> gadolinium 64	159 <b>Tb</b> terbium 65	163 <b>Dy</b> dysprosium 66	165 <b>Ho</b> holmium 67	167 <b>Er</b> erbium 68	169 <b>Tm</b> thulium 69	173 <b>Yb</b> ytterbium 70	175 <b>Lu</b> lutetium 71	232 <b>Th</b> thorium 90	[231] <b>Pa</b> protactinium 91	238 <b>U</b> uranium 92	[237] <b>Np</b> neptunium 93	[242] <b>Pu</b> plutonium 94	[243] <b>Am</b> americium 95	[247] <b>Cm</b> curium 96	[245] <b>Bk</b> berkelium 97	[251] <b>Cf</b> californium 98	[254] <b>Es</b> einsteinium 99	[253] <b>Fm</b> fermium 100	[256] <b>Md</b> mendelevium 101	[254] <b>No</b> nobelium 102	[257] <b>Lr</b> lawrencium 103
1.0 <b>H</b> hydrogen 1	4.0 <b>He</b> helium 2	10.8 <b>B</b> boron 5	12.0 <b>C</b> carbon 6	14.0 <b>N</b> nitrogen 7	16.0 <b>O</b> oxygen 8	19.0 <b>F</b> fluorine 9	20.2 <b>Ne</b> neon 10	27.0 <b>Al</b> aluminium 13	28.1 <b>Si</b> silicon 14	31.0 <b>P</b> phosphorus 15	32.1 <b>S</b> sulfur 16	35.5 <b>Cl</b> chlorine 17	39.9 <b>Ar</b> argon 18	55.8 <b>Fe</b> iron 26	58.9 <b>Co</b> cobalt 27	59.0 <b>V</b> vanadium 23	50.9 <b>Cr</b> chromium 24	52.0 <b>Mn</b> manganese 25	54.9 <b>Ni</b> nickel 28	58.7 <b>Cu</b> copper 29	63.5 <b>Zn</b> zinc 30	65.4 <b>Ga</b> gallium 31	72.6 <b>Ge</b> germanium 32	74.9 <b>As</b> arsenic 33	79.0 <b>Se</b> selenium 34	79.9 <b>Br</b> bromine 35	83.8 <b>Kr</b> krypton 36	114.8 <b>In</b> indium 49	118.7 <b>Sn</b> tin 50	121.8 <b>Sb</b> antimony 51	127.6 <b>Te</b> tellurium 52	126.9 <b>I</b> iodine 53	131.3 <b>Xe</b> xenon 54	200.6 <b>Hg</b> mercury 80	204.4 <b>Tl</b> thallium 81	207.2 <b>Pb</b> lead 82	209.0 <b>Bi</b> bismuth 83	209.0 <b>Po</b> polonium 84	210 <b>At</b> astatine 85	222 <b>Rn</b> radon 86						
																		Elements with atomic numbers 112-116 have been reported but not fully authenticated																												
																		* Lanthanide series																												
																		* Actinide series																												

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