STUDY FORMULA BOOKLET

Edexcel A Level Chemistry 9CH0 data booklet

The 9CH0 data booklet prints constants, IR and NMR data, electronegativities, indicators, electrode potentials and the periodic table; every calculation equation must be learned.

IN THE BOOKLET printed in the official booklet LEARN IT not printed: students must recall it

Based on the official **Pearson Edexcel Level 3 Advanced Level GCE in Chemistry (9CH0) Data Booklet, Issue 2, Summer 2017**, with what to learn and exam tips added by CuratedPrep.

Physical constants

Avogadro constant (L)	$L = 6.02 \times 10^{23}\ \text{mol}^{-1}$	IN THE BOOKLET
Elementary charge (e)	$e = 1.60 \times 10^{-19}\ \text{C}$	IN THE BOOKLET
Gas constant (R)	$R = 8.31\ \text{J mol}^{-1}\ \text{K}^{-1}$	IN THE BOOKLET
Molar volume of a gas at room temperature and pressure (r.t.p.) Use 24, not 22.4: the booklet gives the r.t.p. value only.	$V_\text{m} = 24\ \text{dm}^3\ \text{mol}^{-1}$	IN THE BOOKLET
Ionic product of water (Kw)	$K_\text{w} = 1.00 \times 10^{-14}\ \text{mol}^2\ \text{dm}^{-6}$	IN THE BOOKLET
Volume unit conversion	$1\ \text{dm}^3 = 1000\ \text{cm}^3 = 0.001\ \text{m}^3$	IN THE BOOKLET

Infrared spectroscopy

Correlation of infrared absorption wavenumbers with molecular structure. Each range is printed from the higher to the lower wavenumber.

Vibration	Group	Wavenumber range / cm^{-1}
C-H stretching	Alkane	2962 to 2853
C-H stretching	Alkene	3095 to 3010
C-H stretching	Alkyne	3300
C-H stretching	Arene	3030
C-H stretching	Aldehyde	2900 to 2820 and 2775 to 2700
C-H bending	Alkane	1485 to 1365
C-H bending	Arene, 5 adjacent hydrogen atoms	750 and 700
C-H bending	Arene, 4 adjacent hydrogen atoms	750
C-H bending	Arene, 3 adjacent hydrogen atoms	780
C-H bending	Arene, 2 adjacent hydrogen atoms	830
C-H bending	Arene, 1 isolated hydrogen atom	880
N-H stretching	Amine	3500 to 3300
N-H stretching	Amide	3500 to 3140
O-H stretching	Alcohols and phenols	3750 to 3200
O-H stretching	Carboxylic acids	3300 to 2500
C=C stretching	Isolated alkene	1669 to 1645
C=C stretching	Arene	1600, 1580, 1500, 1450
C=O stretching	Aldehydes, saturated alkyl	1740 to 1720
C=O stretching	Ketones, alkyl	1720 to 1700

Vibration	Group	Wavenumber range / cm^{-1}
C=O stretching	Ketones, aryl	1700 to 1680
C=O stretching	Carboxylic acids, alkyl	1725 to 1700
C=O stretching	Carboxylic acids, aryl	1700 to 1680
C=O stretching	Carboxylic acid anhydrides	1850 to 1800 and 1790 to 1740
C=O stretching	Acyl halides, chlorides	1795
C=O stretching	Acyl halides, bromides	1810
C=O stretching	Esters, saturated	1750 to 1735
C=O stretching	Amides	1700 to 1630
Triple bond stretching	C≡N	2260 to 2215
Triple bond stretching	C≡C	2260 to 2100

1H nuclear magnetic resonance chemical shifts relative to TMS

The booklet prints this as a chart of boxes on a scale from 12.0 to 0.0 ppm, with no numbers on the boxes. The ranges here were measured from the box edges against the printed scale and rounded to the nearest 0.5 ppm, so treat them as approximate: the chart is a guide, and its own reference marks sit up to 0.3 ppm from the scale. The bold H in the booklet marks the proton described.

Proton environment	Type of compound	δ / ppm (about)
COO-H	carboxylic acid	10.0 to 12.0
-C-H (O=C-H)	aldehyde	9.0 to 10.0
CON-H	amide	5.0 to 9.0
Ar-H	arene ring	6.5 to 8.5
Ar-O-H	phenol	4.0 to 7.5
H-C=C	alkene	4.5 to 6.5
Ar-N-H	phenylamines	3.0 to 5.0
H-C-O-	alcohol, ether, ester	3.0 to 4.0
H-C-N	amine, amide	2.5 to 3.5
-O-H	alcohol	2.0 to 4.0
H-C-halogen	halogenoalkane (R2CHF > R2CHCl > R2CHBr > R2CHI)	2.0 to 4.0
C-N-H	amine	0.5 to 3.0
H-C-C=O	aldehyde, ketone, ester, amide, acid	1.5 to 3.0
H-C-C=C	alkenes, arenes	1.5 to 3.0
H-C-C	alkane (R3CH > R2CH2 > RCH3)	0.0 to 1.5

1H NMR reference shifts printed on the chart

Four compounds are marked on the chart with their exact shift. TMS is the reference at 0.0 ppm.

Compound	δ / ppm
CH3OH	3.39
propanone	2.10
ethene	5.28
benzene	7.27

13C nuclear magnetic resonance chemical shifts relative to TMS

Again a chart of boxes, here on a scale from 220 to -40 ppm. The ranges were read from the box edges, rounded to the nearest 5 ppm, so treat them as approximate. The bold C in the booklet marks the carbon described.

Carbon environment	Type of compound	Approximate chemical shift δ / ppm
C-C-C with C=O	ketone	195 to 220

Carbon environment	Type of compound	Approximate chemical shift δ / ppm
C-C-H with C=O	aldehyde	195 to 220
-C-O with C=O	carboxylic acid, ester	165 to 185
-C-N with C=O	amide	165 to 185
C-C (arene)	arene ring	110 to 160
C=C	alkene	115 to 140
C-OH	alcohol	55 to 70
C-Cl, C-Br	halogenoalkane	30 to 70
C-N	amine	35 to 60
C-C	alkane chain	5 to 55

Pauling electronegativities

Pauling electronegativity index, laid out by period (row) and group (column, numbered 1 to 18). No value is printed for the noble gases helium to radon, so only the symbol is shown. Lanthanum (La) sits in group 3.

Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	H 2.1																	He
2	Li 1.0	Be 1.5											B 2.0	C 2.5	N 3.0	O 3.5	F 4.0	Ne
3	Na 0.9	Mg 1.2											Al 1.5	Si 1.9	P 2.1	S 2.5	Cl 3.0	Ar
4	K 0.8	Ca 1.0	Sc 1.3	Ti 1.5	V 1.6	Cr 1.6	Mn 1.5	Fe 1.8	Co 1.8	Ni 1.8	Cu 1.9	Zn 1.6	Ga 1.6	Ge 2.0	As 2.0	Se 2.4	Br 2.8	Kr
5	Rb 0.8	Sr 1.0	Y 1.2	Zr 1.3	Nb 1.6	Mo 2.1	Tc 1.9	Ru 2.2	Rh 2.2	Pd 2.2	Ag 1.9	Cd 1.6	In 1.7	Sn 1.9	Sb 1.9	Te 2.1	I 2.5	Xe
6	Cs 0.7	Ba 0.9	La 1.1	Hf 1.3	Ta 1.5	W 2.3	Re 1.9	Os 2.2	Ir 2.2	Pt 2.2	Au 2.5	Hg 2.0	Tl 1.6	Pb 1.8	Bi 1.9	Po 2.0	At 2.2	Rn

Indicators

The pKin values are at 298 K. No pKin is printed for litmus. The booklet shows a gap after bromocresol green, which separates the indicators that change below pH 5 from the rest.

No.	Indicator	$\mathrm{p}K_{\mathrm{in}}$ (at 298 K)	Colour in acid	pH range	Colour in alkaline
1	Thymol blue (acid)	1.7	red	1.2 to 2.8	yellow
2	Screened methyl orange	3.7	purple	3.2 to 4.2	green
3	Methyl orange	3.7	red	3.2 to 4.4	yellow
4	Bromophenol blue	4.0	yellow	2.8 to 4.6	blue
5	Bromocresol green	4.7	yellow	3.8 to 5.4	blue
6	Methyl red	5.1	red	4.2 to 6.3	yellow
7	Litmus		red	5.0 to 8.0	blue
8	Bromothymol blue	7.0	yellow	6.0 to 7.6	blue
9	Phenol red	7.9	yellow	6.8 to 8.4	red
10	Phenolphthalein (in ethanol)	9.3	colourless	8.2 to 10.0	red (or pink)

Standard electrode potentials

Standard electrode potential of the aqueous system at 298 K: the standard e.m.f. of a cell with the hydrogen half-cell as the left-hand electrode system. The right-hand electrode system is written as a reduction, and the list runs from the most negative to the most positive value.

No.	Right-hand electrode system	$E^{\ominus}$ / V
1	$\mathrm{Na^{+} + e^{-} \rightleftharpoons Na}$	−2.71
2	$\mathrm{Mg^{2+} + 2e^{-} \rightleftharpoons Mg}$	−2.37
3	$\mathrm{Al^{3+} + 3e^{-} \rightleftharpoons Al}$	−1.66

No.	Right-hand electrode system	$E^{\ominus}$ / V
4	$V^{2+} + 2e^- \rightleftharpoons V$	−1.18
5	$Zn^{2+} + 2e^- \rightleftharpoons Zn$	−0.76
6	$Cr^{3+} + 3e^- \rightleftharpoons Cr$	−0.74
7	$Fe^{2+} + 2e^- \rightleftharpoons Fe$	−0.44
8	$Cr^{3+} + e^- \rightleftharpoons Cr^{2+}$	−0.41
9	$V^{3+} + e^- \rightleftharpoons V^{2+}$	−0.26
10	$Ni^{2+} + 2e^- \rightleftharpoons Ni$	−0.25
11	$H^+ + e^- \rightleftharpoons \frac{1}{2}H_2$	0.00
12	$S_4O_6^{2-} + 2e^- \rightleftharpoons 2S_2O_3^{2-}$	+0.09
13	$Cu^{2+} + e^- \rightleftharpoons Cu^+$	+0.15
14	$Cu^{2+} + 2e^- \rightleftharpoons Cu$	+0.34
15	$VO^{2+} + 2H^+ + e^- \rightleftharpoons V^{3+} + H_2O$	+0.34
16	$O_2 + 2H_2O + 4e^- \rightleftharpoons 4OH^-$	+0.40
17	$S_2O_3^{2-} + 6H^+ + 4e^- \rightleftharpoons 2S + 3H_2O$	+0.47
18	$Cu^+ + e^- \rightleftharpoons Cu$	+0.52
19	$I_2 + 2e^- \rightleftharpoons 2I^-$	+0.54
20	$O_2 + 2H^+ + 2e^- \rightleftharpoons H_2O_2$	+0.68
21	$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$	+0.77
22	$Ag^+ + e^- \rightleftharpoons Ag$	+0.80
23	$NO_3^- + 2H^+ + e^- \rightleftharpoons NO_2 + H_2O$	+0.80
24	$ClO^- + H_2O + 2e^- \rightleftharpoons Cl^- + 2OH^-$	+0.89
25	$VO_2^+ + 2H^+ + e^- \rightleftharpoons VO^{2+} + H_2O$	+1.00
26	$Br_2 + 2e^- \rightleftharpoons 2Br^-$	+1.09
27	$O_2 + 4H^+ + 4e^- \rightleftharpoons 2H_2O$	+1.23
28	$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	+1.33
29	$Cl_2 + 2e^- \rightleftharpoons 2Cl^-$	+1.36
30	$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	+1.51
31	$H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O$	+1.77

The periodic table of the elements

Groups 1 to 18 as printed (the booklet also numbers the main groups 1 to 7 and 0). Relative atomic masses exactly as printed: square brackets mean the mass of the most stable isotope. Elements with atomic numbers 112 to 116 have been reported but are not fully authenticated, so none is printed.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H hydrogen 1.0				Z Sym name A_r	atomic number · symbol · name · relative atomic mass												2 He helium 4.0
3 Li lithium 6.9	4 Be beryllium 9.0											5 B boron 10.8	6 C carbon 12.0	7 N nitrogen 14.0	8 O oxygen 16.0	9 F fluorine 19.0	10 Ne neon 20.2
11 Na sodium 23.0	12 Mg magnesium 24.3											13 Al aluminium 27.0	14 Si silicon 28.1	15 P phosphorus 31.0	16 S sulfur 32.1	17 Cl chlorine 35.5	18 Ar argon 39.9
19 K potassium 39.1	20 Ca calcium 40.1	21 Sc scandium 45.0	22 Ti titanium 47.9	23 V vanadium 50.9	24 Cr chromium 52.0	25 Mn manganese 54.9	26 Fe iron 55.8	27 Co cobalt 58.9	28 Ni nickel 58.7	29 Cu copper 63.5	30 Zn zinc 65.4	31 Ga gallium 69.7	32 Ge germanium 72.6	33 As arsenic 74.9	34 Se selenium 79.0	35 Br bromine 79.9	36 Kr krypton 83.8
37 Rb rubidium 85.5	38 Sr strontium 87.6	39 Y yttrium 88.9	40 Zr zirconium 91.2	41 Nb niobium 92.9	42 Mo molybdenum 95.9	43 Tc technetium [98]	44 Ru ruthenium 101.1	45 Rh rhodium 102.9	46 Pd palladium 106.4	47 Ag silver 107.9	48 Cd cadmium 112.4	49 In indium 114.8	50 Sn tin 118.7	51 Sb antimony 121.8	52 Te tellurium 127.6	53 I iodine 126.9	54 Xe xenon 131.3
55 Cs caesium 132.9	56 Ba barium 137.3	57 La lanthanum 138.9	72 Hf hafnium 178.5	73 Ta tantalum 180.9	74 W tungsten 183.8	75 Re rhenium 186.2	76 Os osmium 190.2	77 Ir iridium 192.2	78 Pt platinum 195.1	79 Au gold 197.0	80 Hg mercury 200.6	81 Tl thallium 204.4	82 Pb lead 207.2	83 Bi bismuth 209.0	84 Po polonium [209]	85 At astatine [210]	86 Rn radon [222]
87 Fr francium [223]	88 Ra radium [226]	89 Ac actinium [227]	104 Rf rutherfordium [261]	105 Db dubnium [262]	106 Sg seaborgium [266]	107 Bh bohrium [264]	108 Hs hassium [277]	109 Mt meitnerium [268]	110 Ds darmstadtium [271]	111 Rg roentgenium [272]							

			58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium [147]	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175	
			90 Th thorium 232	91 Pa protactinium [231]	92 U uranium 238	93 Np neptunium [237]	94 Pu plutonium [242]	95 Am americium [243]	96 Cm curium [247]	97 Bk berkelium [245]	98 Cf californium [251]	99 Es einsteinium [254]	100 Fm fermium [253]	101 Md mendelevium [256]	102 No nobelium [254]	103 Lr lawrencium [257]	

Amount of substance and solutions

Not printed in the booklet: it gives constants and data only.

Amount from mass
n in mol, m in g, M (molar mass) in g mol^{-1}.
$$n = \frac{m}{M}$$
LEARN IT

Concentration of a solution
c in mol dm^{-3}, V in dm^3. Divide cm^3 by 1000.
$$c = \frac{n}{V}$$
LEARN IT

Concentration in g dm^{-3}
Multiply the concentration in mol dm^{-3} by the molar mass.
$$\text{concentration (g dm}^{-3}) = c \times M$$
LEARN IT

Amount from a volume of solution in cm^3
Use for titration calculations; V in cm^3.
$$n = c \times \frac{V}{1000}$$
LEARN IT

Number of particles
L is the Avogadro constant (given).
$$N = nL$$
LEARN IT

Amount of gas from volume at r.t.p.
V in dm^3; 24 dm^3 mol^{-1} is the r.t.p. molar volume (given).
$$n = \frac{V}{24}$$
LEARN IT

Relative atomic mass from isotopes
Take the abundances from a mass spectrum or from the question.
$$A_\text{r} = \frac{\sum(\text{isotopic mass} \times \text{abundance})}{\sum \text{abundance}}$$
LEARN IT

Percentage yield
$$\text{percentage yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100\%$$
LEARN IT

Atom economy Written out in the specification, but not printed in the data booklet.	$\text{atom economy} = \dfrac{\text{molar mass of the desired product}}{\text{sum of the molar masses of all products}} \times 100\%$	LEARN IT
Percentage uncertainty Double the uncertainty of a single reading when two readings are subtracted, for example the start and end of a burette.	$\text{percentage uncertainty} = \dfrac{\text{absolute uncertainty}}{\text{measured value}} \times 100\%$	LEARN IT

Gases

Ideal gas equation p in Pa, V in m^3, T in K, R = 8.31 J mol^{-1} K^{-1} (given). Also used to find a molar mass.	$pV = nRT$	LEARN IT
Molar mass from a gas measurement Rearranged from pV = nRT with n = m/M.	$M = \dfrac{mRT}{pV}$	LEARN IT
Mole fraction	$x_{\mathrm{A}} = \dfrac{n_{\mathrm{A}}}{n_{\mathrm{total}}}$	LEARN IT
Partial pressure The partial pressures add up to the total pressure.	$p_{\mathrm{A}} = x_{\mathrm{A}} \times p_{\mathrm{total}}$	LEARN IT

Energetics and entropy

Heat energy transferred m in g of water or solution, c in J g^{-1} K^{-1} (the value is not printed in the booklet), Q in J.	$Q = mc\Delta T$	LEARN IT
Enthalpy change from an experiment n is the amount in mol of the limiting reagent. Convert J to kJ and give a sign and units (kJ mol^{-1}. Use minus when the temperature rises.	$\Delta H = -\dfrac{Q}{n}$	LEARN IT
Enthalpy change of reaction from formation data Hess's law; elements in their standard states have zero enthalpy of formation.	$\Delta_{\mathrm{r}}H = \sum \Delta_{\mathrm{f}}H(\text{products}) - \sum \Delta_{\mathrm{f}}H(\text{reactants})$	LEARN IT
Enthalpy change of reaction from combustion data	$\Delta_{\mathrm{r}}H = \sum \Delta_{\mathrm{c}}H(\text{reactants}) - \sum \Delta_{\mathrm{c}}H(\text{products})$	LEARN IT
Enthalpy change of reaction from mean bond enthalpies Gaseous species only. The booklet prints no bond enthalpy table: the values are given in the question.	$\Delta_{\mathrm{r}}H = \sum E(\text{bonds broken}) - \sum E(\text{bonds formed})$	LEARN IT
Enthalpy change of solution Lattice energy is defined from gaseous ions to the solid, so it is negative.	$\Delta_{\mathrm{sol}}H = -\Delta_{\mathrm{latt}}H + \Delta_{\mathrm{hyd}}H(\text{cation}) + \Delta_{\mathrm{hyd}}H(\text{anion})$	LEARN IT
Born-Haber cycle for a 1:1 ionic solid MX Add further ionisation energies or electron affinities for 2+ or 2- ions, and multiply atomisation terms as needed.	$\Delta_{\mathrm{f}}H = \Delta_{\mathrm{at}}H(\mathrm{M}) + \mathrm{IE}_1(\mathrm{M}) + \Delta_{\mathrm{at}}H(\mathrm{X}) + \mathrm{EA}_1(\mathrm{X}) + \Delta_{\mathrm{latt}}H$	LEARN IT
Entropy change of the system S in J K^{-1} mol^{-1}.	$\Delta S_{\mathrm{system}} = \sum S(\text{products}) - \sum S(\text{reactants})$	LEARN IT
Entropy change of the surroundings Convert ΔH to J mol^{-1}; T in K.	$\Delta S_{\mathrm{surroundings}} = -\dfrac{\Delta H}{T}$	LEARN IT

Total entropy change A reaction is feasible when ΔS(total) is positive.	$\Delta S_{\text{total}} = \Delta S_{\text{system}} + \Delta S_{\text{surroundings}}$	LEARN IT
Gibbs free energy change ΔG is negative for a feasible reaction. Use ΔH and TΔS in the same energy unit.	$\Delta G = \Delta H - T\Delta S_{\text{system}}$	LEARN IT
Temperature at which a reaction becomes feasible The temperature at which ΔG = 0.	$T = \dfrac{\Delta H}{\Delta S_{\text{system}}}$	LEARN IT
Free energy and the equilibrium constant R = 8.31 J mol^{-1} K^{-1} (given), so ΔG must be in J mol^{-1}. Feasible reactions have a large K.	$\Delta G = -RT \ln K$	LEARN IT

Equilibria and acid-base calculations

Kc expression For a A + b B ⇌ c C + d D, at equilibrium. Pure solids and liquids in heterogeneous systems are left out.	$K_{\text{c}} = \dfrac{[\text{C}]^c[\text{D}]^d}{[\text{A}]^a[\text{B}]^b}$	LEARN IT
Kp expression Equilibrium partial pressures in atm, as the specification states.	$K_{\text{p}} = \dfrac{p_{\text{C}}^c\, p_{\text{D}}^d}{p_{\text{A}}^a\, p_{\text{B}}^b}$	LEARN IT
pH Reverse: [H+] = 10^-pH.	$\text{pH} = -\log_{10}[\text{H}^+]$	LEARN IT
Acid dissociation constant Units mol dm^{-3}.	$K_{\text{a}} = \dfrac{[\text{H}^+][\text{A}^-]}{[\text{HA}]}$	LEARN IT
pKa	$\text{p}K_{\text{a}} = -\log_{10} K_{\text{a}}$	LEARN IT
Ionic product of water 1.00 × 10^{-14} mol^2 dm^{-6} (value given in the booklet).	$K_{\text{w}} = [\text{H}^+][\text{OH}^-]$	LEARN IT
pKw 14.00 when Kw = 1.00 × 10^{-14}.	$\text{p}K_{\text{w}} = -\log_{10} K_{\text{w}}$	LEARN IT
pH of a weak acid Assumes the acid is only slightly dissociated and [H+] = [A-].	$[\text{H}^+] = \sqrt{K_{\text{a}} \times c}$	LEARN IT
pH of a strong base Then take -log10 of [H+].	$[\text{H}^+] = \dfrac{K_{\text{w}}}{[\text{OH}^-]}$	LEARN IT
Buffer solution Take [A-] from the salt and [HA] from the unreacted weak acid. Equivalent: pH = pKa + log([A-]/[HA]).	$[\text{H}^+] = K_{\text{a}} \times \dfrac{[\text{HA}]}{[\text{A}^-]}$	LEARN IT
Ka from the half-neutralisation point On a weak acid and strong base titration curve, pH = pKa when half the acid has been neutralised.	$\text{pH} = \text{p}K_{\text{a}}$	LEARN IT

Electrochemistry

Standard cell potential Take both values from the electrode potential table (given). The right-hand system in a cell diagram is the positive electrode when the cell is feasible.	$E^{\ominus}_{\text{cell}} = E^{\ominus}_{\text{right}} - E^{\ominus}_{\text{left}}$	LEARN IT

Cell potential and total entropy change Also, E⊖cell is proportional to ln K. A positive E⊖cell means a feasible reaction.	$E^{\ominus}_{\text{cell}} \propto \Delta S_{\text{total}}$	LEARN IT
Amount in a redox titration Use the mole ratio from the half-equations, for example 1 MnO4^- : 5 Fe^{2}+ and 1 I2 : 2 S2O3^{2}-.	$n = c \times \dfrac{V}{1000}$	LEARN IT

Reaction kinetics

Rate equation m and n are 0, 1 or 2 and are found by experiment. The overall order is m + n.	$\text{rate} = k[\text{A}]^m[\text{B}]^n$	LEARN IT
Average rate of reaction Units mol dm^{-3} s^{-1}. For a rate at one time, draw a tangent and take its gradient.	$\text{rate} = \dfrac{\Delta[\text{concentration}]}{\Delta t}$	LEARN IT
Half-life of a first-order reaction A constant half-life shows a first-order reaction. The specification asks you to find the half-life from a graph; the link to k is the standard result.	$t_{\frac{1}{2}} = \dfrac{\ln 2}{k}$	LEARN IT
Arrhenius equation The specification says the Arrhenius equation will be given if needed. It is not printed in the data booklet. R = 8.31 J mol^{-1} K^{-1} (given).	$k = A\,e^{-E_a/RT}$	SEE NOTE
Arrhenius equation in straight-line form Plot ln k against 1/T: gradient = -Ea/R, so Ea = -gradient × R. Ea comes out in J mol^{-1}.	$\ln k = -\dfrac{E_a}{R} \times \dfrac{1}{T} + \ln A$	SEE NOTE

Analysis

Relative molecular mass from a mass spectrum The molecular ion is the peak with the highest m/z (ignoring small isotope peaks).	$M_r = m/z$ of the molecular ion M^+	LEARN IT
Rf value in chromatography Measure from the baseline to the centre of the spot.	$R_f = \dfrac{\text{distance moved by the spot}}{\text{distance moved by the solvent front}}$	LEARN IT
Peak area ratio in 1H NMR Use the integration trace or the ratio numbers given.	$\text{ratio of peak areas} = \text{ratio of hydrogen atoms in each environment}$	LEARN IT

Learn these: not in the booklet

Standard conditions

100 kPa and a specified temperature, usually 298 K (the specification wording). The booklet only prints the r.t.p. molar volume.

Specific heat capacity of water

4.18 J g^{-1} K^{-1}. The specification's list of constants prints it, but the data booklet itself does not, so learn it or use the value the question gives.

Temperature conversion

$T/\text{K} = \theta/^\circ\text{C} + 273$

Pressure conversion

$1\ \text{kPa} = 1000\ \text{Pa}$

Use pascals and cubic metres in pV = nRT.

Sub-atomic particles

Proton: relative mass 1, charge +1. Neutron: relative mass 1, charge 0. Electron: relative mass 1/1836, charge -1.

Oxidation numbers

Sum equals the charge on the species; H is +1 (-1 in metal hydrides); O is -2 (-1 in peroxides); fluorine is -1.

First ionisation energy

$\text{X(g)} \rightarrow \text{X}^+\text{(g)} + \text{e}^-$

Per mole of gaseous atoms; successive ionisation energies remove one more electron each time.

Standard enthalpy changes

Formation: one mole of a compound from its elements in their standard states. Combustion: one mole burnt completely in oxygen. Neutralisation: one mole of water formed from an acid and an alkali.

Mean bond enthalpy

The average energy to break one mole of a bond in the gaseous state, averaged over a range of compounds.

Kinetics: effect of temperature

A higher temperature gives more molecules with energy at or above the activation energy (Maxwell-Boltzmann curve), so the rate rises.

Mass spectrum of chlorine and bromine

Cl: M and M+2 peaks in a 3 : 1 ratio. Br: M and M+2 in a 1 : 1 ratio. Cl2 molecule ions at 70, 72 and 74 in the ratio 9 : 6 : 1.

pH + pOH at 298 K

$$\mathrm{pH} + \mathrm{pOH} = 14$$

From Kw = 1.00 × 10^{-14}.

Strong monoprotic acid

$$\mathrm{pH} = -\log_{10} c$$

Electron affinity

$$\mathrm{X(g)} + \mathrm{e^-} \rightarrow \mathrm{X^-(g)}$$

First electron affinity is exothermic for most non-metals.

Lattice energy (Edexcel definition)

$$\mathrm{M^+(g)} + \mathrm{X^-(g)} \rightarrow \mathrm{MX(s)}$$

Formed from gaseous ions, so the value is negative. It measures ionic bond strength.

Enthalpy change of atomisation

One mole of gaseous atoms formed from the element in its standard state.

Enthalpy changes of hydration and solution

Hydration: gaseous ion to aqueous ion. Solution: one mole of solute dissolved in water.

Entropy trends

Gas > liquid > solid; entropy rises with temperature, and when the number of moles of gas increases. Perfect crystals at 0 K have zero entropy.

Effect of temperature on K

Exothermic: K falls as T rises. Endothermic: K rises as T rises. Concentration, pressure and catalysts do not change K.

Standard hydrogen electrode

Platinum in 1.00 mol dm^{-3} H+(aq) with H2(g) at 100 kPa and 298 K; defined as 0.00 V.

Standard electrode potential conditions

298 K, 100 kPa for gases and 1.00 mol dm^{-3} for ions.

Kc units

Work them out from the expression; there are none if the powers cancel.

Rate constant units

Zero order: mol dm^{-3} s^{-1}. First order: s^{-1}. Second order: dm^3 mol^{-1} s^{-1}.

Choosing an indicator

Pick an indicator whose pH range lies inside the steep part of the titration curve. Phenolphthalein suits a strong or weak acid with a strong base; methyl orange suits a strong acid with a strong or weak base.

Proton NMR splitting (n + 1 rule)

A proton with n equivalent protons on the adjacent carbon gives n + 1 peaks: singlet, doublet, triplet, quartet.

Number of 13C signals

One signal for each different carbon environment.

Using the booklet in the exam

- The booklet holds tables only. Write every calculation equation from memory and take only the numbers from the tables.
- Use 24 dm^3 mol^{-1} for gas volumes at r.t.p. and R = 8.31 J mol^{-1} K^{-1} with pV = nRT: both are printed, and 22.4 is not.
- The NMR pages are charts of boxes with no printed ranges, so quote the environment and a sensible range, then match the peak you are given.
- Read each electrode half-equation as a reduction. Use E⊖cell = E⊖(right) − E⊖(left), and change the sign of E⊖ only if you reverse the equation (never multiply it by the coefficients).
- Choose an indicator from the table whose pH range sits on the steep part of the titration curve; the table does not tell you which to use.

Based on: Pearson Edexcel, Pearson Edexcel Level 3 Advanced Level GCE in Chemistry (9CH0) Data Booklet, Issue 2, Summer 2017 (the specification, Issue 3, lists the same constants and data tables). Statistical tables are calculated by CuratedPrep to the same layout. Updated 31 October 2026. Always practise with the version of the official booklet your exam uses. More free sheets and topic worksheets at curatedprep.com.