STUDY FORMULA BOOKLET

Edexcel International A Level Chemistry data booklet and equations

The Edexcel IAL booklet prints constants, IR and NMR data, electronegativities, indicators, electrode potentials and the periodic table; every calculation equation, such as pV = nRT, you must learn.

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

Based on the official **Pearson Edexcel International Advanced Subsidiary/Advanced Level in Chemistry, Specification Issue 1, September 2017, Appendix 9: Data booklet (pages 100 to 105)**, 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.)	$V_\text{m} = 24\ \text{dm}^3\ \text{mol}^{-1}$	IN THE BOOKLET
Ionic product of water (Kw) At 298 K.	$K_\text{w} = 1.00 \times 10^{-14}\ \text{mol}^2\ \text{dm}^{-6}$	IN THE BOOKLET
Volume 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

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 tetramethylsilane (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 as labelled	δ / ppm (about)
C**H** in $R_3CH > R_2CH_2 > RCH_3$	alkane, H-C-C	0.0 to 1.5
H-C=C	alkene	4.5 to 6.5
Ar-**H**	arene ring	6.5 to 8.5
−CO-**H**	aldehyde	9.0 to 10.0
H-C-halogen ($R_2CHF > R_2CHCl > R_2CHBr > R_2CHI$)	halogenoalkane	2.0 to 4.0
H-C-O-	alcohol, ether, ester	3.0 to 4.0
−O-**H**	alcohol	2.0 to 4.0
COO-**H**	carboxylic acid	10.0 to 12.0
Ar-O-**H**	phenol	4.0 to 7.5
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-N	amine, amide	2.5 to 3.5
Ar-N-**H**	phenylamines	3.0 to 5.0
C-N-**H**	amine	0.5 to 3.0
CON-**H**	amide	5.0 to 9.0

1H NMR: reference peaks marked on the chart

These four values are printed exactly on the chart; TMS is the zero of the scale.

Compound	δ / ppm
CH_3OH	3.39
benzene	7.27
ethene	5.28
propanone	2.10
TMS (reference)	0

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

The booklet prints this as a chart with boxes on a δ / ppm axis (220 to -40), not as a table of numbers. The ranges below are read off the chart to the nearest 5 ppm and are approximate; use the chart in your booklet for the exact edges. The bold C is the carbon described.

Carbon	Environment as labelled	δ / ppm (about)
C-**C**	C-C	5 to 55
C-N	C-N	35 to 60
C-OH	C-OH	55 to 70
C-Cl, **C**-Br	halogenoalkane	30 to 70
C=C	alkene	115 to 140
C-C in an arene	arene	110 to 160
−**C**(=O)-O	acid, ester carbonyl	165 to 185
−**C**(=O)-N	amide carbonyl	165 to 185
C-**C**(=O)-C	ketone carbonyl	195 to 220
C-**C**(=O)-H	aldehyde carbonyl	195 to 220
TMS (reference)		0

Pauling electronegativities (Pauling electronegativity index)

Columns are groups 1 to 18. Each cell gives the element and its value; the noble gases have no value printed. Hydrogen is printed above the middle of the table and is shown here under group 1. La is shown under 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

pKin is given at 298 K. No pKin value is printed for litmus.

No.	Indicator	pKin	Colour in acid	pH range	Colour in alkali
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

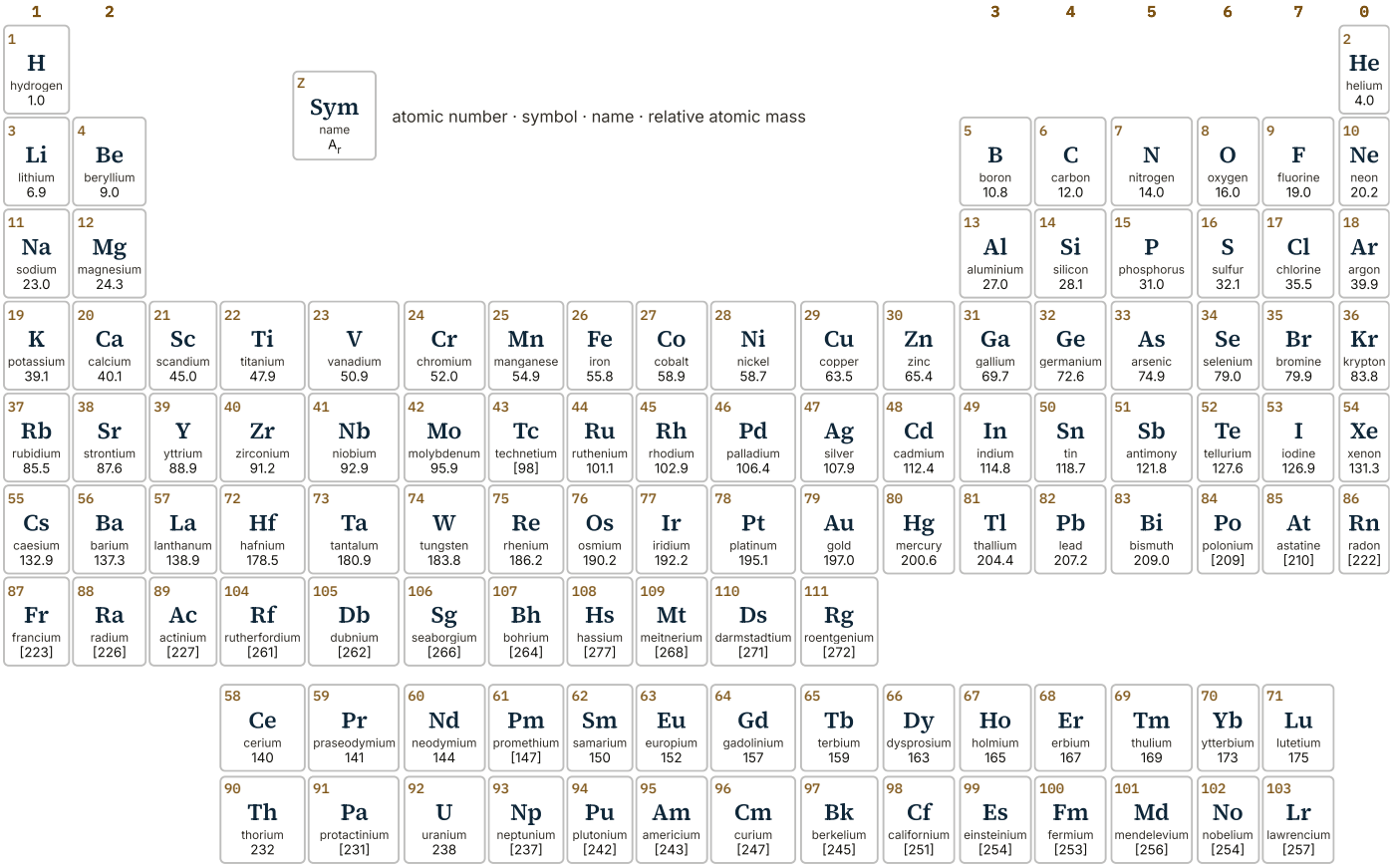
Standard electrode potentials

E⊖ is the standard electrode potential of the aqueous system at 298 K, that is, the standard emf of the electrochemical cell in which the hydrogen half-cell forms the left-hand side electrode system. The half-equations are the right-hand electrode systems.

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

Groups are numbered 1 to 7 and 0 (8), with the group numbers (1) to (18) as printed. Elements with atomic numbers 112 to 116 have been reported but not fully authenticated (as printed). Masses in square brackets are as printed; lanthanide and actinide masses are whole numbers as printed.



Amount of substance and solutions

None of these is printed in the booklet. Spec topic 1.

Amount from mass n in mol, m in g, M (molar mass) in g mol^{-1}.	$n = \frac{m}{M}$	LEARN IT
Number of particles L is printed in the booklet (6.02 × 10^{23} mol^{-1}.	$N = n \times L$	LEARN IT
Concentration c in mol dm^{-3}, V in dm^3. For g dm^{-3}, multiply c by M.	$c = \frac{n}{V}$	LEARN IT
Amount of a gas at r.t.p. V in dm^3, using the printed molar volume 24 dm^3 mol^{-1}.	$n = \frac{V}{24}$	LEARN IT
Dilution Keep both volumes in the same unit.	$c_1V_1 = c_2V_2$	LEARN IT
Relative atomic mass from isotopes Use the mass spectrum abundances (spec topic 2).	$A_\mathrm{r} = \frac{\sum(\text{abundance} \times \text{isotopic mass})}{\sum \text{abundance}}$	LEARN IT
Percentage yield Compare moles with moles or mass with mass.	$\%\ \text{yield} = \frac{\text{actual amount of product}}{\text{theoretical amount of product}} \times 100$	LEARN IT
Percentage atom economy Edexcel IAL divides by the sum of all products, using the balanced equation.	$\%\ \text{atom economy} = \frac{\text{molar mass of the desired product}}{\text{sum of the molar masses of all products}} \times 100$	LEARN IT

Parts per million Used for gases in the atmosphere (spec topic 1).	$\text{ppm} = \dfrac{\text{mass of component}}{\text{total mass}} \times 10^6$	LEARN IT

Gases

Ideal gas equation p in Pa, V in m^3, n in mol, T in K. R is printed ($8.31\ J\ mol^{-1}\ K^{-1}$. $1\ dm^3 = 0.001\ m^3$ is printed.	$pV = nRT$	LEARN IT
Molar mass of a volatile liquid From pV = nRT with n = m/M; spec 1.8 covers gases and volatile liquids.	$M = \dfrac{mRT}{pV}$	LEARN IT

Energetics

Spec topic 6.

Energy transferred m in g, c in $J\ g^{-1}\ °C^{-1}$ (given in the question), ΔT in °C, q in J.	$q = mc\Delta T$	LEARN IT
Enthalpy change of an experiment Convert q to kJ (divide by 1000) so ΔH is in $kJ\ mol^{-1}$. n is the amount of the limiting reagent.	$\Delta H = -\dfrac{q}{n}$	LEARN IT
Hess's law with formation data Multiply each value by its coefficient. Elements in their standard states have ΔfH = 0.	$\Delta_r H = \sum \Delta_f H(\text{products}) - \sum \Delta_f H(\text{reactants})$	LEARN IT
Hess's law with combustion data Note the order is reversed compared with formation data.	$\Delta_r H = \sum \Delta_c H(\text{reactants}) - \sum \Delta_c H(\text{products})$	LEARN IT
Enthalpy change from bond enthalpies Bond enthalpies are means, so the answer is approximate (spec 6.9).	$\Delta H = \sum(\text{bonds broken}) - \sum(\text{bonds formed})$	LEARN IT
Mean bond enthalpy from ΔH Spec 6.10: work back from an enthalpy change of reaction.	$\text{mean bond enthalpy} = \dfrac{\text{total enthalpy to break the bonds}}{\text{number of bonds}}$	LEARN IT

Entropy and energetics

Spec topic 12.

Total entropy change A reaction is feasible when ΔStotal is positive.	$\Delta S_{\text{total}} = \Delta S_{\text{system}} + \Delta S_{\text{surroundings}}$	LEARN IT
Entropy change of the system Units $J\ K^{-1}\ mol^{-1}$.	$\Delta S_{\text{system}} = \sum S(\text{products}) - \sum S(\text{reactants})$	LEARN IT
Entropy change of the surroundings Convert ΔH from kJ to J first, and T in K, to give $J\ K^{-1}\ mol^{-1}$.	$\Delta S_{\text{surroundings}} = -\dfrac{\Delta H}{T}$	LEARN IT
Temperature at which a reaction becomes feasible Set ΔStotal = 0 and rearrange; check the units of ΔS.	$T = \dfrac{\Delta H}{\Delta S_{\text{system}}}$	LEARN IT
Gibbs free-energy change Optional in the Edexcel IAL specification (spec 12.9), but accepted in answers. Feasible if ΔG is negative.	$\Delta G = \Delta H - T\Delta S_{\text{system}}$	LEARN IT

Born-Haber cycle for a 1:1 ionic solid MX Lattice energy here is the exothermic formation of one mole of solid from gaseous ions. Use Hess's law with the cycle (spec 12.13).	$\Delta_{\mathrm{f}}H = \Delta_{\mathrm{at}}H(\mathrm{M}) + \Delta_{\mathrm{IE}}H(\mathrm{M}) + \Delta_{\mathrm{at}}H(\mathrm{X}) + \Delta_{\mathrm{EA}}H(\mathrm{X}) + \Delta_{\mathrm{latt}}H$	LEARN IT
Enthalpy change of solution Sum the enthalpies of hydration of the cation and the anion (spec 12.17).	$\Delta_{\mathrm{sol}}H = -\Delta_{\mathrm{latt}}H + \sum \Delta_{\mathrm{hyd}}H$	LEARN IT

Reaction kinetics

Spec topics 9 and 11.

Rate from time taken Used for clock reactions (spec 9.3).	$\mathrm{rate} = \dfrac{1}{\mathrm{time}}$	LEARN IT
Rate equation m and n are 0, 1 or 2, found by experiment. Overall order = m + n.	$\mathrm{rate} = k[\mathrm{A}]^m[\mathrm{B}]^n$	LEARN IT
Half-life of a first-order reaction A constant half-life shows a first-order reaction (spec 11.2). The relationship with k is standard but not printed in the specification text.	$k = \dfrac{\ln 2}{t_{1/2}}$	LEARN IT
Arrhenius equation The Arrhenius equation will be given if needed (spec 11.10). E_a in J mol^{-1}, T in K.	$k = Ae^{-E_{\mathrm{a}}/RT}$	LEARN IT
Logarithmic form of the Arrhenius equation Plot ln k (y) against 1/T (x): gradient = -Ea/R. Convert Ea to kJ mol^{-1} at the end.	$\ln k = -\dfrac{E_{\mathrm{a}}}{R} \cdot \dfrac{1}{T} + \ln A$	LEARN IT

Equilibria

Spec topic 13. For aA + bB ⇌ cC + dD at a fixed temperature.

Kc expression Equilibrium concentrations in mol dm^{-3}. Work out the units from the expression. Heterogeneous systems leave out solids.	$K_{\mathrm{c}} = \dfrac{[\mathrm{C}]^c[\mathrm{D}]^d}{[\mathrm{A}]^a[\mathrm{B}]^b}$	LEARN IT
Kp expression Partial pressures in atm in this specification (spec 13.2).	$K_{\mathrm{p}} = \dfrac{p_{\mathrm{C}}^c\, p_{\mathrm{D}}^d}{p_{\mathrm{A}}^a\, p_{\mathrm{B}}^b}$	LEARN IT
Mole fraction Moles of the gas divided by the total moles of gas.	$x_{\mathrm{A}} = \dfrac{n_{\mathrm{A}}}{n_{\mathrm{total}}}$	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

Acids, bases and buffers

Spec topic 14.

pH Convert back with [H+] = 10^-pH. For a strong monoprotic acid, [H+] equals the acid concentration.	$\mathrm{pH} = -\log_{10}[\mathrm{H}^+]$	LEARN IT
Ionic product of water Value printed: 1.00 × 10^{-14} mol^2 dm^{-6} (298 K). For a strong base [H+] = Kw / [OH-].	$K_{\mathrm{w}} = [\mathrm{H}^+][\mathrm{OH}^-]$	LEARN IT

pKw So pH + pOH = pKw (14 at 298 K).	$\mathrm{p}K_\mathrm{w} = -\log_{10} K_\mathrm{w}$	LEARN IT
Acid dissociation constant Units mol dm^{-3}. Written for HA ⇌ H+ + A-.	$K_\mathrm{a} = \dfrac{[\mathrm{H^+}][\mathrm{A^-}]}{[\mathrm{HA}]}$	LEARN IT
pKa Convert back with Ka = 10^-pKa.	$\mathrm{p}K_\mathrm{a} = -\log_{10} K_\mathrm{a}$	LEARN IT
pH of a weak acid Assume [H+] = [A-] and that [HA] equals the starting concentration; state both assumptions.	$[\mathrm{H^+}] = \sqrt{K_\mathrm{a}[\mathrm{HA}]}$	LEARN IT
Acidic buffer Take -log10 to get the pH. Equivalent: pH = pKa + log10([A-]/[HA]).	$[\mathrm{H^+}] = K_\mathrm{a} \times \dfrac{[\mathrm{HA}]}{[\mathrm{A^-}]}$	LEARN IT
Titration Find moles from c × V of the known solution, then use the equation ratio.	$n(\mathrm{A}) = \dfrac{\text{coefficient of A}}{\text{coefficient of B}} \times n(\mathrm{B})$	LEARN IT

Electrode potentials and chromatography

Spec topics 15 and 16.

Standard emf of a cell The same as E(positive) - E(negative). Take the E values from the printed table, using the electrode potential as printed (reduction) for each half-cell. Spec 16.7.	$E^\ominus_\mathrm{cell} = E^\ominus_\mathrm{right} - E^\ominus_\mathrm{left}$	LEARN IT
Cell diagram Negative electrode on the left, positive on the right (spec 16.8). The double line is the salt bridge.	$\mathrm{Pt} \mid \mathrm{Fe^{2+}}, \mathrm{Fe^{3+}} \mid\mid \mathrm{Ag^+} \mid \mathrm{Ag}$	LEARN IT
Rf value Measure from the baseline (spec 15.22).	$R_\mathrm{f} = \dfrac{\text{distance moved by the solute}}{\text{distance moved by the solvent front}}$	LEARN IT

Learn these: not in the booklet

Standard conditions
100 kPa and a specified temperature, usually 298 K (spec 6.1). Standard electrode potentials use 298 K and 1 mol dm^{-3} solutions.

Temperature conversion
$T/\mathrm{K} = \theta/^\circ\mathrm{C} + 273$

Pressure conversion
$1\ \mathrm{kPa} = 1000\ \mathrm{Pa}$
Use pascals and cubic metres in pV = nRT.

Standard enthalpy change of formation
One mole of a compound formed from its elements in their standard states, under standard conditions.

Standard enthalpy change of combustion
One mole of a substance burned completely in oxygen under standard conditions.

Enthalpy changes in a cycle
Atomisation, ionisation energy, electron affinity, lattice energy, hydration and solution: know each definition and its sign.

Units of the rate constant k
Zero order: mol dm^{-3} s^{-1}. First order: s^{-1}. Second order: mol^{-1} dm^3 s^{-1}.

Units of Kc and Kp
Work them out from the expression; there are no units if the powers cancel. Kp uses atm.

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

Standard hydrogen electrode
Platinum in 1 mol dm^{-3} H+(aq) with H2(g) at 100 kPa and 298 K; E = 0.00 V by definition.

Link between E⊖ and thermodynamics
E⊖cell is directly proportional to ΔStotal and to ln K; the equations are not required.

Using the booklet in the exam

- The booklet prints no equations. Write each equation from memory first, then take only the constants and data from the booklet.
- Use the printed values exactly: R = 8.31, L = 6.02 × 10^{23}, e = 1.60 × 10^{-19} C and the molar volume 24 dm^3 mol^{-1} at r.t.p.

- Read the electrode potential table as reductions. To combine two half-cells, subtract: E(cell) = E(right) - E(left), and do not multiply E by the electron count.
- For NMR, use the chart boxes to see which environments overlap, and use the TMS = 0 line and the marked reference peaks to anchor your reading.
- Convert before you substitute: cm^3 to dm^3, dm^3 to m^3 for pV = nRT, and J to kJ when combining ΔH and TΔS.

Based on: Pearson Edexcel International A Level Chemistry (YCH11), Specification Issue 1, September 2017, Appendix 9: Data booklet (pages 100 to 105). 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.