STUDY FORMULA BOOKLET

Cambridge AS and A Level Chemistry 9701 data booklet

The 9701 data section prints constants, ionisation and bond energies, electrode potentials, NMR and IR data and the periodic table; every equation must be learned.

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

Based on the official **Cambridge International AS & A Level Chemistry 9701 syllabus for 2025, 2026 and 2027, Data section (pages 80 to 91)**, with what to learn and exam tips added by CuratedPrep.

1 Important values, constants and standards

Molar gas constant	$R = 8.31\ \text{J K}^{-1}\ \text{mol}^{-1}$	IN THE BOOKLET
Faraday constant	$F = 9.65 \times 10^{4}\ \text{C mol}^{-1}$	IN THE BOOKLET
Avogadro constant	$L = 6.022 \times 10^{23}\ \text{mol}^{-1}$	IN THE BOOKLET
Electronic charge	$e = -1.60 \times 10^{-19}\ \text{C}$	IN THE BOOKLET
Molar volume of gas at s.t.p. s.t.p. is 101 kPa and 273 K.	$V_\text{m} = 22.4\ \text{dm}^3\ \text{mol}^{-1}$	IN THE BOOKLET
Molar volume of gas at room conditions	$V_\text{m} = 24.0\ \text{dm}^3\ \text{mol}^{-1}$	IN THE BOOKLET
Ionic product of water At 298 K (25 °C).	$K_\text{w} = 1.00 \times 10^{-14}\ \text{mol}^2\ \text{dm}^{-6}$	IN THE BOOKLET
Specific heat capacity of water	$c = 4.18\ \text{kJ kg}^{-1}\ \text{K}^{-1}\ (4.18\ \text{J g}^{-1}\ \text{K}^{-1})$	IN THE BOOKLET

2 Ionisation energies of selected elements

First to fourth ionisation energies in kJ mol^{-1}. Elements not listed in the booklet are left out.

Element	Proton number	1st	2nd	3rd	4th
H	1	1310			
He	2	2370	5250		
Li	3	519	7300	11800	
Be	4	900	1760	14800	21000
B	5	799	2420	3660	25000
C	6	1090	2350	4610	6220
N	7	1400	2860	4590	7480
O	8	1310	3390	5320	7450
F	9	1680	3370	6040	8410
Ne	10	2080	3950	6150	9290
Na	11	494	4560	6940	9540
Mg	12	736	1450	7740	10500
Al	13	577	1820	2740	11600
Si	14	786	1580	3230	4360
P	15	1060	1900	2920	4960
S	16	1000	2260	3390	4540
Cl	17	1260	2300	3850	5150
Ar	18	1520	2660	3950	5770

Element	Proton number	1st	2nd	3rd	4th
K	19	418	3070	4600	5860
Ca	20	590	1150	4940	6480
Sc	21	632	1240	2390	7110
Ti	22	661	1310	2720	4170
V	23	648	1370	2870	4600
Cr	24	653	1590	2990	4770
Mn	25	716	1510	3250	5190
Fe	26	762	1560	2960	5400
Co	27	757	1640	3230	5100
Ni	28	736	1750	3390	5400
Cu	29	745	1960	3350	5690
Zn	30	908	1730	3828	5980
Ga	31	577	1980	2960	6190
Br	35	1140	2080	3460	4850
Rb	37	403	2632	3900	5080
Sr	38	548	1060	4120	5440
Ag	47	731	2074	3361	5000
I	53	1010	1840	3000	4030
Cs	55	376	2420	3300	4400
Ba	56	502	966	3390	4700

3(a) Bond energies in diatomic molecules: homonuclear

These are exact values.

Bond	Energy / kJ mol^{-1}
H-H	436
N≡N	944
O=O	496
P≡P	485
S=S	425
F-F	158
Cl-Cl	242
Br-Br	193
I-I	151

3(a) Bond energies in diatomic molecules: heteronuclear

These are exact values.

Bond	Energy / kJ mol^{-1}
H-F	562
H-Cl	431
H-Br	366
H-I	299
C≡O	1077

3(b) Bond energies in polyatomic molecules: homonuclear

These are average values.

Bond	Energy / kJ mol^{-1}
C-C	350
C=C	610
C≡C	840
C-C in benzene (aromatic)	520
N-N	160
N=N	410
O-O	150
Si-Si	225
P-P	200
S-S	265

3(b) Bond energies in polyatomic molecules: heteronuclear

These are average values.

Bond	Energy / kJ mol^{-1}
C-H	410
C-Cl	340
C-Br	280
C-I	240
C-N	305
C=N	610
C≡N	890
C-O	360
C=O	740
C=O in CO_2	805
N-H	390
N-Cl	310
O-H	460
Si-Cl	360
Si-H	320
Si-O (in SiO_2(s))	460
Si=O (in SiO_2(g))	640
P-H	320
P-Cl	330
P-O	340
P=O	540
S-H	340
S-Cl	250
S-O	360
S=O	500

4 Standard electrode (reduction) potentials at 298 K (25 °C)

Standard electrode potentials in alphabetical order of the species. All ionic states refer to aqueous ions but other state symbols have been omitted.

Electrode reaction	$E^{\ominus}$ / V
$Ag^{+} + e^{-} \rightleftharpoons Ag$	+0.80
$Al^{3+} + 3e^{-} \rightleftharpoons Al$	−1.66
$Ba^{2+} + 2e^{-} \rightleftharpoons Ba$	−2.90
$Br_2 + 2e^{-} \rightleftharpoons 2Br^{-}$	+1.07
$Ca^{2+} + 2e^{-} \rightleftharpoons Ca$	−2.87
$Cl_2 + 2e^{-} \rightleftharpoons 2Cl^{-}$	+1.36
$2HOCl + 2H^{+} + 2e^{-} \rightleftharpoons Cl_2 + 2H_2O$	+1.64
$ClO^{-} + H_2O + 2e^{-} \rightleftharpoons Cl^{-} + 2OH^{-}$	+0.89
$Co^{2+} + 2e^{-} \rightleftharpoons Co$	−0.28
$Co^{3+} + e^{-} \rightleftharpoons Co^{2+}$	+1.82
$[Co(NH_3)_6]^{2+} + 2e^{-} \rightleftharpoons Co + 6NH_3$	−0.43
$Cr^{2+} + 2e^{-} \rightleftharpoons Cr$	−0.91
$Cr^{3+} + 3e^{-} \rightleftharpoons Cr$	−0.74
$Cr^{3+} + e^{-} \rightleftharpoons Cr^{2+}$	−0.41
$Cr_2O_7^{2-} + 14H^{+} + 6e^{-} \rightleftharpoons 2Cr^{3+} + 7H_2O$	+1.33
$Cu^{+} + e^{-} \rightleftharpoons Cu$	+0.52
$Cu^{2+} + 2e^{-} \rightleftharpoons Cu$	+0.34
$Cu^{2+} + e^{-} \rightleftharpoons Cu^{+}$	+0.15
$[Cu(NH_3)_4]^{2+} + 2e^{-} \rightleftharpoons Cu + 4NH_3$	−0.05
$F_2 + 2e^{-} \rightleftharpoons 2F^{-}$	+2.87
$Fe^{2+} + 2e^{-} \rightleftharpoons Fe$	−0.44
$Fe^{3+} + 3e^{-} \rightleftharpoons Fe$	−0.04
$Fe^{3+} + e^{-} \rightleftharpoons Fe^{2+}$	+0.77
$[Fe(CN)_6]^{3-} + e^{-} \rightleftharpoons [Fe(CN)_6]^{4-}$	+0.36
$Fe(OH)_3 + e^{-} \rightleftharpoons Fe(OH)_2 + OH^{-}$	−0.56
$2H^{+} + 2e^{-} \rightleftharpoons H_2$	0.00
$2H_2O + 2e^{-} \rightleftharpoons H_2 + 2OH^{-}$	−0.83
$I_2 + 2e^{-} \rightleftharpoons 2I^{-}$	+0.54
$K^{+} + e^{-} \rightleftharpoons K$	−2.92
$Li^{+} + e^{-} \rightleftharpoons Li$	−3.04
$Mg^{2+} + 2e^{-} \rightleftharpoons Mg$	−2.38
$Mn^{2+} + 2e^{-} \rightleftharpoons Mn$	−1.18
$Mn^{3+} + e^{-} \rightleftharpoons Mn^{2+}$	+1.49
$MnO_2 + 4H^{+} + 2e^{-} \rightleftharpoons Mn^{2+} + 2H_2O$	+1.23
$MnO_4^{-} + e^{-} \rightleftharpoons MnO_4^{2-}$	+0.56
$MnO_4^{-} + 4H^{+} + 3e^{-} \rightleftharpoons MnO_2 + 2H_2O$	+1.67
$MnO_4^{-} + 8H^{+} + 5e^{-} \rightleftharpoons Mn^{2+} + 4H_2O$	+1.52
$NO_3^{-} + 2H^{+} + e^{-} \rightleftharpoons NO_2 + H_2O$	+0.81
$NO_3^{-} + 3H^{+} + 2e^{-} \rightleftharpoons HNO_2 + H_2O$	+0.94
$NO_3^{-} + 10H^{+} + 8e^{-} \rightleftharpoons NH_4^{+} + 3H_2O$	+0.87
$Na^{+} + e^{-} \rightleftharpoons Na$	−2.71

Electrode reaction	$E^{\ominus}$ / V
$Ni^{2+} + 2e^- \rightleftharpoons Ni$	−0.25
$[Ni(NH_3)_6]^{2+} + 2e^- \rightleftharpoons Ni + 6NH_3$	−0.51
$H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O$	+1.77
$HO_2^- + H_2O + 2e^- \rightleftharpoons 3OH^-$	+0.88
$O_2 + 4H^+ + 4e^- \rightleftharpoons 2H_2O$	+1.23
$O_2 + 2H_2O + 4e^- \rightleftharpoons 4OH^-$	+0.40
$O_2 + 2H^+ + 2e^- \rightleftharpoons H_2O_2$	+0.68
$O_2 + H_2O + 2e^- \rightleftharpoons HO_2^- + OH^-$	−0.08
$Pb^{2+} + 2e^- \rightleftharpoons Pb$	−0.13
$Pb^{4+} + 2e^- \rightleftharpoons Pb^{2+}$	+1.69
$PbO_2 + 4H^+ + 2e^- \rightleftharpoons Pb^{2+} + 2H_2O$	+1.47
$SO_4^{2-} + 4H^+ + 2e^- \rightleftharpoons SO_2 + 2H_2O$	+0.17
$S_2O_8^{2-} + 2e^- \rightleftharpoons 2SO_4^{2-}$	+2.01
$S_4O_6^{2-} + 2e^- \rightleftharpoons 2S_2O_3^{2-}$	+0.09
$Sn^{2+} + 2e^- \rightleftharpoons Sn$	−0.14
$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}$	+0.15
$V^{2+} + 2e^- \rightleftharpoons V$	−1.20
$V^{3+} + e^- \rightleftharpoons V^{2+}$	−0.26
$VO^{2+} + 2H^+ + e^- \rightleftharpoons V^{3+} + H_2O$	+0.34
$VO_2^+ + 2H^+ + e^- \rightleftharpoons VO^{2+} + H_2O$	+1.00
$VO_3^- + 4H^+ + e^- \rightleftharpoons VO^{2+} + 2H_2O$	+1.00
$Zn^{2+} + 2e^- \rightleftharpoons Zn$	−0.76

5 Pauling electronegativity values

Columns are groups 1 to 17 as printed in the periodic table; each cell shows the element and its value.

Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	H 2.1																
2	Li 1.0	Be 1.6											B 2.0	C 2.5	N 3.0	O 3.5	F 4.0
3	Na 0.9	Mg 1.3											Al 1.5	Si 1.9	P 2.2	S 2.6	Cl 3.0
4	K 0.8	Ca 1.0	Sc 1.4	Ti 1.5	V 1.6	Cr 1.7	Mn 1.5	Fe 1.8	Co 1.9	Ni 1.9	Cu 1.9	Zn 1.6	Ga 1.8	Ge 2.0	As 2.2	Se 2.6	Br 2.6

6 Typical proton (1H) NMR chemical shift values (δ) relative to TMS = 0

The bold H is the proton described. δ values for O-H and N-H protons can vary depending on solvent and concentration. Ar represents an aromatic ring.

Environment of proton	Example	Chemical shift range δ / ppm
alkane	$-C\mathbf{H}_3$, $-C\mathbf{H}_2-$, $>C\mathbf{H}-$	0.9 to 1.7
alkyl next to C=O	$C\mathbf{H}_3-C{=}O$, $-C\mathbf{H}_2-C{=}O$, $>C\mathbf{H}-C{=}O$	2.2 to 3.0
alkyl next to aromatic ring	$C\mathbf{H}_3-Ar$, $-C\mathbf{H}_2-Ar$, $>C\mathbf{H}-Ar$	2.3 to 3.0
alkyl next to electronegative atom	$C\mathbf{H}_3-O$, $-C\mathbf{H}_2-O$, $-C\mathbf{H}_2-Cl$	3.2 to 4.0
attached to alkene	$=C\mathbf{H}R$	4.5 to 6.0
attached to aromatic ring	$\mathbf{H}-Ar$	6.0 to 9.0
aldehyde	$\mathbf{H}COR$	9.3 to 10.5
alcohol	$RO\mathbf{H}$	0.5 to 6.0
phenol	$Ar-O\mathbf{H}$	4.5 to 7.0

Environment of proton	Example	Chemical shift range δ / ppm
carboxylic acid	$\mathrm{RCOO\mathbf{H}}$	9.0 to 13.0
alkyl amine	$\mathrm{R-N\mathbf{H}-}$	1.0 to 5.0
aryl amine	$\mathrm{Ar-N\mathbf{H}_2}$	3.0 to 6.0
amide	$\mathrm{RCON\mathbf{H}R}$	5.0 to 12.0

7 Typical carbon-13 (13C) NMR chemical shift values (δ) relative to TMS = 0

The bold C is the carbon described.

Hybridisation of the carbon atom	Environment of carbon atom	Example	Chemical shift range δ / ppm
sp^3	alkyl	$\mathbf{C}\mathrm{H_3}-$, $\mathbf{C}\mathrm{H_2}-$, $-\mathbf{C}\mathrm{H}<$, $>\mathbf{C}<$	0 to 50
sp^3	next to alkene/arene	$-\mathbf{C}-\mathrm{C{=}C}$, $-\mathbf{C}-\mathrm{Ar}$	25 to 50
sp^3	next to carbonyl/carboxyl	$\mathbf{C}-\mathrm{COR}$, $\mathbf{C}-\mathrm{O_2R}$	30 to 65
sp^3	next to halogen	$\mathbf{C}-\mathrm{X}$	30 to 60
sp^3	next to oxygen	$\mathbf{C}-\mathrm{O}$	50 to 70
sp^2	alkene or arene	$>\mathbf{C}=\mathbf{C}<$, or a carbon in a benzene ring	110 to 160
sp^2	carboxyl	$\mathrm{R}-\mathbf{C}\mathrm{OOH}$, $\mathrm{R}-\mathbf{C}\mathrm{OOR}$	160 to 185
sp^2	carbonyl	$\mathrm{R}-\mathbf{C}\mathrm{HO}$, $\mathrm{R}-\mathbf{C}\mathrm{O}-\mathrm{R}$	190 to 220
sp	nitrile	$\mathrm{R}-\mathbf{C}\equiv\mathrm{N}$	100 to 125

8 Characteristic infrared absorption frequencies for some selected bonds

Bond	Functional groups containing the bond	Characteristic infrared absorption range (wavenumbers) / cm^{-1}
C-O	hydroxy, ester	1040 to 1300
C=C	aromatic compound, alkene	1500 to 1680
C=O	amide	1640 to 1690
C=O	carbonyl, carboxyl	1670 to 1740
C=O	ester	1710 to 1750
C≡N	nitrile	2200 to 2250
C-H	alkane	2850 to 2950
N-H	amine, amide	3300 to 3500
O-H	carboxyl	2500 to 3000
O-H	hydroxy	3200 to 3600

9 The periodic table of elements

Groups 1 to 18 as printed. A dash means no relative atomic mass is printed in the booklet.

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 -	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		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 -	85 At astatine -	86 Rn radon -
87 Fr francium -	88 Ra radium -		104 Rf rutherfordium -	105 Db dubnium -	106 Sg seaborgium -	107 Bh bohrium -	108 Hs hassium -	109 Mt meitnerium -	110 Ds darmstadtium -	111 Rg roentgenium -	112 Cn copernicium -	113 Nh nihonium -	114 Fl flerovium -	115 Mc moscovium -	116 Lv livermorium -	117 Ts tennessine -	118 Og oganesson -

		57 La lanthanum 138.9	58 Ce cerium 140.1	59 Pr praseodymium 140.9	60 Nd neodymium 144.4	61 Pm promethium -	62 Sm samarium 150.4	63 Eu europium 152.0	64 Gd gadolinium 157.3	65 Tb terbium 158.9	66 Dy dysprosium 162.5	67 Ho holmium 164.9	68 Er erbium 167.3	69 Tm thulium 168.9	70 Yb ytterbium 173.1	71 Lu lutetium 175.0	
		89 Ac actinium -	90 Th thorium 232.0	91 Pa protactinium 231.0	92 U uranium 238.0	93 Np neptunium -	94 Pu plutonium -	95 Am americium -	96 Cm curium -	97 Bk berkelium -	98 Cf californium -	99 Es einsteinium -	100 Fm fermium -	101 Md mendelevium -	102 No nobelium -	103 Lr lawrencium -	

Amount of substance and solutions

Not printed in the booklet: the booklet gives 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

Dilution
Use the same volume unit on both sides.
$$c_1V_1 = c_2V_2$$
LEARN IT

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

Amount of gas from volume
Vm is 22.4 dm^3 mol^{-1} at s.t.p. or 24.0 dm^3 mol^{-1} at room conditions (both given).
$$n = \frac{V}{V_m}$$
LEARN IT

Density
$$\rho = \frac{m}{V}$$
LEARN IT

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

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

Gases

Ideal gas equation
p in Pa, V in m^3, T in K, R = 8.31 J K^{-1} mol^{-1} (given).
$$pV = nRT$$
LEARN IT

Relative molecular mass from a gas Rearranged from pV = nRT with n = m/Mr.	$M_\mathrm{r} = \dfrac{mRT}{pV}$	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

Chemical energetics

Heat energy transferred m in g (of water or solution), c = 4.18 J g^{-1} K^{-1} (given), 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.	$\Delta H = -\dfrac{mc\Delta T}{n}$	LEARN IT
Enthalpy change of reaction from formation data	$\Delta H_\mathrm{r}^\ominus = \sum \Delta H_\mathrm{f}^\ominus(\text{products}) - \sum \Delta H_\mathrm{f}^\ominus(\text{reactants})$	LEARN IT
Enthalpy change of reaction from combustion data	$\Delta H_\mathrm{r}^\ominus = \sum \Delta H_\mathrm{c}^\ominus(\text{reactants}) - \sum \Delta H_\mathrm{c}^\ominus(\text{products})$	LEARN IT
Enthalpy change of reaction from bond energies Bond energies are in the data tables (given).	$\Delta H_\mathrm{r} = \sum E(\text{bonds broken}) - \sum E(\text{bonds formed})$	LEARN IT
Enthalpy change of solution Lattice energy is defined from gaseous ions to solid, so it is negative.	$\Delta H_\mathrm{sol} = -\Delta H_\mathrm{latt} + \Delta H_\mathrm{hyd}(\text{cation}) + \Delta H_\mathrm{hyd}(\text{anion})$	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.	$\Delta H_\mathrm{f} = \Delta H_\mathrm{at}(\mathrm{M}) + \mathrm{IE}_1(\mathrm{M}) + \Delta H_\mathrm{at}(\mathrm{X}) + \mathrm{EA}_1(\mathrm{X}) + \Delta H_\mathrm{latt}$	LEARN IT
Entropy change of a reaction S in J K^{-1} mol^{-1}.	$\Delta S^\ominus = \sum S^\ominus(\text{products}) - \sum S^\ominus(\text{reactants})$	LEARN IT
Gibbs free energy change Convert ΔS to kJ K^{-1} mol^{-1} before using it with ΔH in kJ mol^{-1}.	$\Delta G^\ominus = \Delta H^\ominus - T\Delta S^\ominus$	LEARN IT
Feasibility temperature Temperature at which ΔG = 0.	$T = \dfrac{\Delta H^\ominus}{\Delta S^\ominus}$	LEARN IT

Equilibria

Kc expression For a A + b B ⇌ c C + d D, at equilibrium concentrations.	$K_\mathrm{c} = \dfrac{[\mathrm{C}]^c[\mathrm{D}]^d}{[\mathrm{A}]^a[\mathrm{B}]^b}$	LEARN IT
Kp expression Partial pressures at equilibrium.	$K_\mathrm{p} = \dfrac{p_\mathrm{C}^c\, p_\mathrm{D}^d}{p_\mathrm{A}^a\, p_\mathrm{B}^b}$	LEARN IT
pH Equivalent: [H+] = 10^-pH.	$\mathrm{pH} = -\log_{10}[\mathrm{H}^+]$	LEARN IT
Acid dissociation constant	$K_\mathrm{a} = \dfrac{[\mathrm{H}^+][\mathrm{A}^-]}{[\mathrm{HA}]}$	LEARN IT
pKa	$\mathrm{p}K_\mathrm{a} = -\log_{10} K_\mathrm{a}$	LEARN IT
Ionic product of water 1.00 × 10^{-14} mol^2 dm^{-6} at 298 K (value given).	$K_\mathrm{w} = [\mathrm{H}^+][\mathrm{OH}^-]$	LEARN IT

Weak acid pH Assumes the acid is only slightly dissociated and [H+] = [A-].	$[\mathrm{H}^+] = \sqrt{K_\mathrm{a} \times c}$	LEARN IT
Buffer solution (acidic) Take [A-] from the salt and [HA] from the unreacted weak acid.	$[\mathrm{H}^+] = K_\mathrm{a} \times \dfrac{[\mathrm{HA}]}{[\mathrm{A}^-]}$	LEARN IT
Solubility product of a sparingly soluble salt Units depend on the expression.	$K_\mathrm{sp} = [\mathrm{A}^{y+}]^x[\mathrm{B}^{x-}]^y$	LEARN IT
Stability constant of a complex [H2O] is not included.	$K_\mathrm{stab} = \dfrac{[\mathrm{ML}_n]}{[\mathrm{M}][\mathrm{L}]^n}$	LEARN IT
Partition coefficient Same physical state of the solute in both solvents.	$K_\mathrm{pc} = \dfrac{[\mathrm{X}]_\mathrm{solvent\ 1}}{[\mathrm{X}]_\mathrm{solvent\ 2}}$	LEARN IT

Electrochemistry

Charge passed in electrolysis Q in C, I in A, t in s.	$Q = It$	LEARN IT
Faraday constant L is the Avogadro constant and e the charge on the electron (both given).	$F = Le$	LEARN IT
Amount of electrons passed	$n(\mathrm{e}^-) = \dfrac{Q}{F}$	LEARN IT
Standard cell potential Use the electrode potentials from the data table (given).	$E^\ominus_\mathrm{cell} = E^\ominus_\mathrm{positive} - E^\ominus_\mathrm{negative}$	LEARN IT
Nernst equation at 298 K z is the number of electrons in the half-equation.	$E = E^\ominus + \dfrac{0.059}{z}\log_{10}\dfrac{[\mathrm{oxidised\ species}]}{[\mathrm{reduced\ species}]}$	LEARN IT
Gibbs free energy and cell potential n is the number of electrons transferred; ΔG in J mol^{-1}.	$\Delta G^\ominus = -nE^\ominus_\mathrm{cell}F$	LEARN IT

Reaction kinetics

Rate equation m and n are 0, 1 or 2. Overall order = m + n.	$\mathrm{rate} = k[\mathrm{A}]^m[\mathrm{B}]^n$	LEARN IT
Rate of reaction Units mol dm^{-3} s^{-1}.	$\mathrm{rate} = \dfrac{\Delta[\mathrm{concentration}]}{\Delta t}$	LEARN IT
Half-life of a first-order reaction Independent of concentration.	$t_{\frac{1}{2}} = \dfrac{\ln 2}{k}$	LEARN IT
Rate constant from half-life First-order reactions only.	$k = \dfrac{0.693}{t_{\frac{1}{2}}}$	LEARN IT

Analysis

Rf value in chromatography Measure from the baseline.	$R_\mathrm{f} = \dfrac{\mathrm{distance\ moved\ by\ the\ solute}}{\mathrm{distance\ moved\ by\ the\ solvent\ front}}$	LEARN IT
Carbon atoms from the M+1 peak	$n = \dfrac{100 \times \mathrm{abundance\ of\ [M+1]^+\ ion}}{1.1 \times \mathrm{abundance\ of\ M^+\ ion}}$	LEARN IT
Percentage error Maximum uncertainty is half the smallest division, doubled when two readings are subtracted.	$\mathrm{percentage\ error} = \dfrac{\mathrm{maximum\ uncertainty}}{\mathrm{measurement}} \times 100\%$	LEARN IT

Learn these: not in the booklet

Standard conditions in this syllabus

298 K and 101 kPa; standard enthalpy changes are marked ⊖.

Temperature conversion

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

Volume conversion

$$1\ \mathrm{dm}^3 = 1000\ \mathrm{cm}^3 = 10^{-3}\ \mathrm{m}^3$$

Pressure conversion

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

Use pascals and cubic metres in pV = nRT.

pOH at 298 K

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

From Kw = 1.00 × 10^{-14} (printed).

Strong monoprotic acid

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

Strong alkali, e.g. NaOH

$$[\mathrm{H}^+] = \frac{K_\mathrm{w}}{[\mathrm{OH}^-]}$$

Buffer pH from the same data

$$\mathrm{pH} = \mathrm{p}K_\mathrm{a} + \log_{10}\frac{[\mathrm{A}^-]}{[\mathrm{HA}]}$$

First ionisation energy

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

Per mole of gaseous atoms; each further ionisation removes one more electron from the gaseous ion.

Standard enthalpy change of formation

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

Lattice energy (as defined in 9701)

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

Gaseous ions to solid lattice, so the value is negative.

First electron affinity

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

Enthalpy change of atomisation

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

Enthalpy change of hydration and solution

Hydration: gaseous ion to aqueous ion. Solution: one mole of solute dissolved to infinite dilution.

Gibbs free energy and feasibility

A reaction is feasible when ΔG is negative; changing T changes the sign when ΔH and ΔS have the same sign.

Standard hydrogen electrode

Platinum in 1.00 mol dm^{-3} H+(aq) with H2(g) at 101 kPa and 298 K; defined as 0.00 V.

Standard electrode potential

The e.m.f. of a half-cell against the standard hydrogen electrode under standard conditions (298 K, 1 mol dm^{-3}, 101 kPa).

Rate constant units

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

Kc and Kp units

Work them out from the expression; no units if the powers cancel.

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.

Proton NMR splitting (n + 1 rule)

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

Number of 13C signals

One signal for each different carbon environment.

D2O exchange

O-H and N-H peaks disappear from the proton NMR spectrum after shaking with D2O.

[M + 2] peak

A pair at M and M+2 in a 1 : 1 ratio shows bromine; 3 : 1 shows chlorine.

Entropy trends

Gas > liquid > solid; entropy rises with temperature and when the number of gas molecules increases.

Electrolysis products

Cathode: the species with the more positive E⊖ is reduced (H2 is formed from water if the metal is more reactive than hydrogen). Anode: halide ions in concentrated solution, otherwise oxygen from water.

Using the booklet in the exam

- The data section holds tables only. Write each calculation equation from memory and take only the numbers from the tables.
- Check the units of the data: bond energies and ionisation energies are in kJ mol^{-1}, while R is in J K^{-1} mol^{-1}.
- Bond energies in the diatomic table are exact; the polyatomic table gives averages. Say 'average bond energy' when you use the second kind.
- For electrode potentials, read the electrode reaction as printed (reduction) and reverse the sign if you reverse the reaction.
- Give NMR and IR answers as ranges from the table: pick the row for the environment, then compare with the peak you are given.

Based on: Cambridge International, Cambridge International AS & A Level Chemistry 9701 syllabus 2025 to 2027 (Data section). 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.