

HSC chemistry: NESA's formulae sheet and data sheet, annotated

Four pages printed in every HSC Chemistry paper since 2019, unchanged: the formulae sheet with the constants and solubility constants, the spectroscopy data, the standard potentials, and the periodic table.

Page 1: the nine formulas and six constants

Formula	For	Constant	Value
$n = m / MM$	moles from mass	Avogadro constant	$6.022 \times 10^{23} \text{ mol}^{-1}$
$c = n / V$	concentration	Volume of 1 mol of ideal gas at 100 kPa	22.71 L at 0 C; 24.79 L at 25 C
$PV = nRT$	ideal gas	Gas constant	$8.314 \text{ J mol}^{-1} \text{ K}^{-1}$
$q = mc \Delta T$	calorimetry	K_w at 25 C	1.0×10^{-14}
$\Delta G = \Delta H - T \Delta S$	spontaneity	Specific heat capacity of water	$4.18 \times 10^3 \text{ J kg}^{-1} \text{ K}^{-1}$
$\text{pH} = -\log[\text{H}^+]$; $\text{pK}_a = -\log K_a$	acids		
$A = \epsilon c l$; $c = \log(I_0 / I)$	Beer-Lambert		

Solubility constants at 25 C for 32 compounds: the carbonates, hydroxides, phosphates and sulfates of barium, calcium, copper(II), iron(II) and (III), lead(II), magnesium and silver, and the silver and lead halides; from barium hydroxide 2.55×10^{-4} to lead(II) phosphate 8.0×10^{-43} . The K_{sp} expressions are not given.

Page 2: spectroscopy data

Table	What is given
Infrared absorption	N-H amines 3300-3500; O-H alcohols 3230-3550 (broad); C-H 2850-3300; O-H acids 2500-3000 (very broad); C triple-bond N 2220-2260; C=O 1680-1750; C=C 1620-1680; C-O 1000-1300; C-C 750-1100 cm^{-1}
Carbon-13 NMR shifts	alkane C 5-40; C-Cl or C-Br 10-70; C next to C=O 20-50; C-N 25-60; C-O (alcohols, ethers, esters) 50-90; C=C 90-150; nitrile 110-125; aromatic 110-160; ester or acid C=O 160-185; aldehyde or ketone C=O 190-220 ppm
UV absorption (approximate)	C-H 122; C-C 135; C=C 162; alkyne 173-222; C-Cl 173; C-Br 208 nm. Proton NMR data is not on the sheet; it is given in the question

Page 3: standard potentials (31 reductions)

$\text{K}^+ -2.94 \text{ V}$; $\text{Ba}^{2+} -2.91$; $\text{Ca}^{2+} -2.87$; $\text{Na}^+ -2.71$; $\text{Mg}^{2+} -2.36$; $\text{Al}^{3+} -1.68$; $\text{Mn}^{2+} -1.18$; water to $\text{H}_2 + \text{OH}^- -0.83$; $\text{Zn}^{2+} -0.76$; $\text{Fe}^{2+} -0.44$; $\text{Ni}^{2+} -0.24$; $\text{Sn}^{2+} -0.14$; $\text{Pb}^{2+} -0.13$; $\text{H}^+ 0.00$; sulfate to $\text{SO}_2 0.16$; $\text{Cu}^{2+} 0.34$; $\text{O}_2 + \text{water to OH}^- 0.40$; $\text{Cu}^+ 0.52$; $\text{I}_2(\text{s}) 0.54$; $\text{I}_2(\text{aq}) 0.62$; $\text{Fe}^{3+} \text{ to Fe}^{2+} 0.77$; $\text{Ag}^+ 0.80$; $\text{Br}_2(\text{l}) 1.08$; $\text{Br}_2(\text{aq}) 1.10$; $\text{O}_2 + \text{H}^+ \text{ to water } 1.23$; $\text{Cl}_2(\text{g}) 1.36$; dichromate 1.36; $\text{Cl}_2(\text{aq}) 1.40$; permanganate 1.51; $\text{F}_2 2.89$. The rule $E_{\text{cell}} = E_{\text{cathode}} - E_{\text{anode}}$ and the choice of the stronger oxidant (more positive) are not written on the sheet. Page 4: the periodic table with atomic weights to four significant figures (Cl 35.45, Cu 63.55, S 32.07, Ca 40.08).

Not on the sheet: the memorise list, and exam habits

Module	Memorise or know
Equilibrium and acid reactions	K_{eq} and Q expressions; what a large or small K means; Le Chatelier's reasoning; the K_{sp} expression for each salt type and the ion-product test; the common-ion effect
Acid and base reactions	Arrhenius and Bronsted-Lowry; strong and weak acids and bases by name; K_a and K_b expressions, $K_a \times K_b = K_w$; $pH + pOH = 14$ at 25 °C; titration calculations and indicator choice; buffers; $c_1 V_1 = c_2 V_2$; enthalpy of neutralisation
Energy (Year 11, assumed)	molar enthalpy $\Delta H = -q / n$; Hess's law and enthalpies of formation; bond energy reasoning; the sign of ΔH and ΔS by reaction type
Organic chemistry	IUPAC naming to C8 with functional groups; the reactions and conditions (addition, substitution, esterification with conc. H_2SO_4 and reflux, oxidation of alcohols with acidified dichromate or permanganate, fermentation, saponification); property trends; addition and condensation polymers
Applying chemical ideas	flame colours (Na, K, Ca, Ba, Cu); precipitate tests for chloride, sulfate, carbonate, hydroxide and the separation sequence; tests for organic groups; how AAS, colorimetry, IR, NMR and mass spectrometry are read; fragment logic
Everywhere	percentage yield and atom economy; percentage composition and the empirical formula; gas calculations at non-standard conditions; significant figures and units

Exam habits

- [] Know what is given (K_w , the molar volumes, R , Avogadro) and what is not (every expression form), so nothing is re-derived under pressure
- [] The specific heat of water is in J per kg per K: convert grams, or use 4.18 J per g per K
- [] Read the potentials as reductions; reverse the anode's half-equation yourself; the more negative potential is the anode in a galvanic cell
- [] Check IR and NMR peaks against the sheet's tables, not from memory; the question's peaks are chosen to fit the sheet
- [] Use the sheet's atomic weights (Cl 35.45, Cu 63.55), because the marking guidelines do

My checklist

Expressions I must write from memory (K_{eq} , K_a , K_{sp} types): _____

Reaction conditions I confuse: _____

Tests for ions I need to drill: _____

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