

Chemistry B (Salters)

Advanced GCE

Unit **F335**: Chemistry by Design

Mark Scheme for June 2012

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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Annotations used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
✓	separates marking points
NOT	answers which are not worthy of credit and which will CON a correct answer
IGNORE	statements which are irrelevant and will NOT 'CON' a correct answer
ALLOW	answers that can be accepted
()	words which are not essential to gain credit
<u> </u>	underlined words must be present in answer to score a mark
ecf	error carried forward
AW	alternative wording (replaces the old 'or words to that effect')
ORA	or reverse argument

Annotations used in scoris:

Annotation	Meaning
✓	correct response
✗	incorrect response
bod	benefit of the doubt
nbod	benefit of the doubt not given
ECF	error carried forward
^	information omitted
	ignore
sf	Refers to the use of significant figures

Subject-specific Marking Instructions that apply across the whole question paper:

Accept minor mis-spellings where the 'sound' is right (eg alcahol), except:

- QWC mark
- where it changes a technical term (eg alkene/alkane)

If the answer on the answer line (or in box) differs from a previous answer (copying error), mark the answer on the answer line (or in box). If the answer line (or box) is blank, reward the answer elsewhere if possible.

In calculations, rounding errors should not be rewarded, unless the Mark Scheme indicates otherwise (eg 3(g))

If it says 'mark separately' marks can be awarded even if the answer does not hang together well without the other mark. However, if the later marking point has words in brackets before it, the mark should only be awarded in the context of those words.

Formulae must have correct brackets and subscripts to score. Element symbols must have small second letters (eg not BA). These errors and the use of a wrong symbol should, if possible, only result in the loss of ONE mark in a part (rather than more marks).

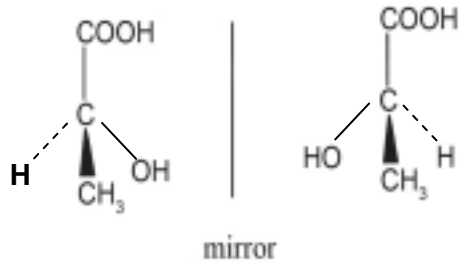
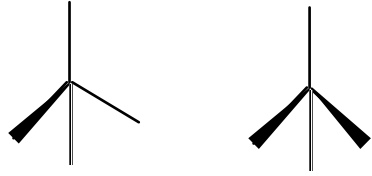
Multiples of equations are acceptable (including halves) unless specified otherwise.

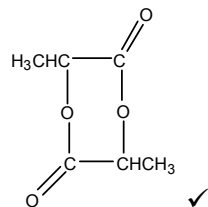
Allow the omission of *one* plus sign in an equation if the species are still well separated.

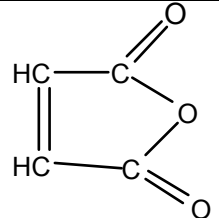
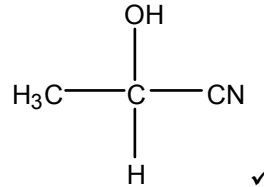
Question			Answer	Mark	Guidance
1	(a)	(i)	0 ✓, +2 ✓	2	NOT 2+
1	(a)	(ii)	nitrogen(IV) oxide ✓	1	ACCEPT nitrogen dioxide (or with no gap between words) or nitrogen(IV) dioxide (with or without gaps) ALLOW nitrogen (IV) oxide ALLOW without brackets round 'IV'
1	(b)		brown (gas) (formed) ✓	1	IGNORE 'colourless' as starting colour
1	(c)		<i>advantage</i> : nitrogen is fixed OR it (enters the soil and) benefits plants (AW) ✓ <i>disadvantage</i> : Acid rain OR an effect of acid rain eg buildings corroded / increasing acidity of soil / kills trees, increasing acidity of lakes (or rivers) / kills fish OR toxic OR causes respiratory problems OR (tropospheric) ozone formed OR contributes to <u>photochemical</u> smog ✓	2	idea of benefit to plants (eg: needed by plants / help plants grow / fertiliser / provides nutrients <u>to soil</u> , etc) needed for the 'or' version of the mark IGNORE 'harmful'/'polluting' for last two points must have idea of <i>giving rise to</i> ozone or photochemical smog IGNORE 'greenhouse gas'
1	(d)	(i)	0.2/24 ✓ OR $8.3 \times 10^{-3} \times 24 = 0.2$ AND comment that this is the fraction of oxygen in air 0.033(2) or 0.033333 (to 2 or more sf) ✓ [or standard form]	2	Numbers 0.2 (or 1/5) and divided by 24 must be there OR 1/120 OR 2/240 8.3 x 10 ⁻³ alone obviously does not score ie do not accept '0.03' Answer alone scores the mark. Working alone does not score ALLOW standard form eg 3.3×10^{-2} ACCEPT recurring decimal NOT rounding errors watch out for 3.3×10^{-3} (incorrect)
1	(d)	(ii)	$[\text{NO}_2]^2 / [\text{N}_2][\text{O}_2]^2$ ✓	1	MUST have square brackets NOT 'p' (even if with square brackets) ALLOW $[\text{N}_2] \times [\text{O}_2]^2$ or $[\text{N}_2].[O_2]^2$ NOT $[\text{N}_2] + [\text{O}_2]^2$ ALLOW '(g)' as state symbols. Others are CON

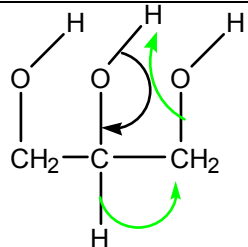
Question			Answer	Mark	Guidance
1	(d)	(iii)	$\sqrt{\{\text{ans for } [N_2] \text{ from d(i)}\} \times (8.3 \times 10^{-3})^2 \times 4 \times 10^{-19}} \checkmark$ OR $\sqrt{[N_2] \times [O_2]^2 \times K_{(c)}}$ OR part numbers part symbols evaluation (eg $[N_2] = 0.033$ gives $9.5(4) \times 10^{-13}$) \checkmark (0.0332 gives $9.56/9.6 \times 10^{-13}$) one sig fig (eg 1×10^{-12}) \checkmark	3	correct evaluation of correct expression (even if expression is not written down) scores 2 No ecf from d(ii); no ecf for evaluating an incorrect expression, except that omission of the square root and then correctly evaluated (eg $9(.1) \times 10^{-25}$) or omission of square on O_2 (eg $1(.1) \times 10^{-11}$) score one mark. <i>A spreadsheet is available for other answers from (d)(i)</i> Mark sf separately, awarding the mark for <i>any</i> number to one sf. <i>So proceed as follows:</i> <ul style="list-style-type: none"> • check for the three possible answers (with ecf if necessary using spreadsheet) One is worth two, others are worth one • If no matching answer is present, look for square root expression and award 1 if it is correct • Award sf mark if relevant
1	(d)	(iv)	K_c larger \checkmark (Forward) reaction endothermic OR right is endothermic direction ORA \checkmark <u>Equilibrium position</u> moves to right/towards products \checkmark	3	Mark separately No ecf from second marking point incorrect IGNORE references to rates must mention 'position' in connection with equilibrium
1	(d)	(v)	Equilibrium (position) moves to right/products \checkmark More <u>molecules/moles</u> on left-hand side/reactants ORA \checkmark	2	<i>Incorrect</i> effects on K_c are CON of first mark (IGNORE 'no effect') ALLOW 'it' for 'equilibrium position' IGNORE 'favours the right-hand side' ALLOW 'particles' instead of 'molecules' IGNORE 'more reactants than products' (ie without mention of moles etc) <i>Mark separately</i>
1	(e)	(i)	$HNO_3 \rightarrow H^+ + NO_3^-$ or $HNO_3 + H_2O \rightarrow H_3O^+ + NO_3^-$ \checkmark for correct species \checkmark for correct species with arrow (not equm sign)	2	IGNORE state symbols ALLOW $HNO_3 + aq \rightarrow H^+ + NO_3^-$ $HNO_3 \rightarrow H_3O^+ + NO_3^-$ scores 1 overall Correct species in square brackets can just score the arrow mark

Question			Answer	Mark	Guidance
1	(e)	(ii)	$-\log(0.015) \checkmark = 1.82(391) \checkmark$	2	ALLOW 1.8 or more sf. ALLOW 'lg' Answer alone scores 2 marks No ecf from first mark
1	(f)	(i)	$\text{H}_2\text{SO}_4 + \text{HNO}_3 \rightarrow \text{NO}_2^+ + \text{H}_2\text{O} + \text{HSO}_4^-$ $\text{NO}_2^+ \checkmark$ rest correct \checkmark	2	ALLOW $2\text{H}_2\text{SO}_4 + \text{HNO}_3 \rightarrow \text{NO}_2^+ + \text{H}_3\text{O}^+ + 2\text{HSO}_4^-$ 'rest correct' means all other species correct with ' NO_2 ' (incorrect sign or no sign) IGNORE state symbols
1	(f)	(ii)	hydrogensulfate(VI) \checkmark	1	Mark separately from f(i) IGNORE formula ALLOW 'hydrogen sulfate' and 'hydrogensulfate' (i.e. no '(VI)') ALLOW 'sulphate' replacing 'sulfate'
1	(f)	(iii)	nitration OR nitrating (benzene/aromatics) OR making nitrobenzene \checkmark	1	ALLOW 'electrophilic substitution <u>of arene</u> '
Total				25	

Question			Answer	Mark	Guidance
2	(a)	(i)	CO ₂ / carbon dioxide ✓	1	
2	(a)	(ii)	2-hydroxypropanoic acid ✓	1	ALLOW errors in gaps, commas, dashes ALLOW '2-hydroxylpropanoic acid'
2	(b)	(i)	 <p>one correct 3d representation shown ✓</p> <p>two correct mirror images of 3d structures and <i>either</i> line between them <i>or</i> the words 'mirror images' ✓</p>	2	ALLOW groups on any carbons ambiguous attachments (eg COOH connected through O)  <p>structures drawn as (but where two lines in the plane are shown (eg left-hand diagram here), they must not be at 90 or 180 degrees to each other)</p> <p>ALLOW for ———</p> <p>ALLOW skeletal (or mixed) formulae</p> <p>ALLOW structures breaking the 'two lines in the plane' rule above for <i>second</i> mark</p> <p>NOT flat structures</p>
2	(b)	(ii)	1/ one ✓	1	
2	(c)	(i)	it has two: (carboxylic) acid / carboxyl groups / COOH groups ✓	1	ALLOW 'dicarboxylic' and 'diprotic'
2	(c)	(ii)	lactic acid/it has a higher pK _a value / lower K _a / 3.86 is higher (ORA for malic acid) ✓	2	<i>Mark separately</i> IGNORE references to 5.13/larger value for malic acid
			higher pH / lower concentration (or fewer) <u>H⁺ ions</u> / less dissociation into <u>H⁺</u> ORA ✓		IGNORE 'less acidic' (which is in the stem) <i>must refer to H⁺ or pH</i>

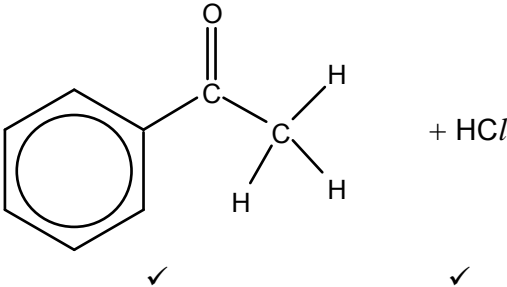
Question			Answer	Mark	Guidance
2	(d)	(i)	$C_3H_6O_3 \rightleftharpoons C_3H_5O_3^- + H^+ \checkmark$	1	ALLOW $C_3H_6O_3 + H_2O \rightleftharpoons C_3H_5O_3^- + H_3O^+$ OR $C_3H_6O_3 + aq \rightleftharpoons C_3H_5O_3^- + H^+$ IGNORE lactic acid shown as a structural formula IGNORE state symbols watch out for incorrect anion formula
2	(d)	(ii)	$K_a = 10^{-3.86} / pK_a = -\log K_a$ OR $-\log 1.4 \times 10^{-4} = 3.86 \checkmark$	1	No marks obviously for 1.4×10^{-4} ALLOW 'inv(erse) log -3.86' or 'log ⁻¹ (-3.86)' ALLOW 'lg' for 'log'
2	(d)	(iii)	$[H^+] = \sqrt{(1.4 \times 10^{-4} \times 0.1)} (= 3.74 \times 10^{-3}) \checkmark$ pH = 2.43 \checkmark	2	First mark is for working* or correct evaluation Allow ecf for second mark* (if $[H^+]$ is smaller than 1×10^{-2}) ALLOW 2.4 or more sf Correct pH value alone scores two marks * provided working shows ' $H^+ = \dots$ ' or ' $[H^+] = \dots$ '
2	(d)	(iv)	$[salt]/[acid] = K_a / [H^+]$ OR $[salt]/[acid] = 1.4 \times 10^{-4} / (1 \times 10^{-3}) \checkmark$ $= 1.4 \times 10^{-4} / 1 \times 10^{-3} = 0.14 \checkmark$	2	Correct answer (to 2 or more sf) scores both marks without working. Allow ecf for second mark for inverse only (7.1429 [to 2 or more sf] or 50/7). This scores one mark even if no working. ALLOW 1/7.1 OR 7/50
2	(e)		C=O present <u>in ester</u> \checkmark no OH/ alcohol (groups) / no alkene \checkmark 	3	Both C=O and ester must be mentioned IGNORE references to other groups any unambiguous indication of the structure scores Any additional incorrect structures are CON NOT $CH_2=CHCOOCH(CH_3)COOH$ since alkene C-H is 3000 up NOT ring with ether and anhydride as it is not an ester

Question		Answer	Mark	Guidance
2	(f)	 <p>acid anhydride ✓ rest ✓</p>	2	<p>Any unambiguous indication of the structure scores marks</p> <p>Any additional incorrect structures are CON ALLOW any acid anhydride or just the anhydride group for the first mark ALLOW (-)CO-O-CO(-) for anhydride part of formula</p>
2	(g) (i)	ethanal ✓	1	
2	(g) (ii)	 <p>✓</p>	1	<p>Any unambiguous representation of structure scores mark allow ambiguous attachment of any group</p> <p>ALLOW anion formed at OH group / O⁻ Na⁺ (or any Group I cation)</p>
2	(g) (iii)	nucleophilic ✓ addition ✓	2	<p>ALLOW any unambiguous indication of the words (eg circling) <i>Mark separately</i> Any extra words CON correct answers</p>
2	(g) (iv)	ammonium ion / NH ₄ ⁺ ✓✓	2	ammonia/ NH ₃ scores one mark
2	(h) (i)	orange/yellow to blue/green ✓ CH ₃ COOH ✓	2	<p>ALLOW any combinations of these colours but no others should be mentioned ALLOW a more displayed or skeletal formula</p>
2	(h) (ii)	OH / (secondary) alcohol / hydroxyl (group) (in lactic acid) ✓ (lactic acid) reacts with reagent/acidified (potassium) dichromate gives same reaction / same colour change / same result / can be oxidised ✓	2	<p>'primary/tertiary alcohol' is CON to first mark <i>mark separately</i> ALLOW 'both have a colour change'</p>
Total			29	

Question		Answer	Mark	Guidance
3	(a)	propane-1,2-diol ✓	1	ALLOW errors in dashes, gaps and commas ACCEPT propan-1,2-diol
3	(b) (i)	co-product is formed in the <u>reaction</u> that produces the (main) product OR co-product is another substance (AW) that appears in the main <u>reaction/equation</u> ✓ by-product is formed by side/other/unwanted reactions ✓	2	must imply that co-product is <i>another</i> product of the <i>reaction</i> IGNORE 'process' (instead of 'reaction') IGNORE usefulness in either mark
3	(b) (ii)	hydrolysis ✓	1	ALLOW 'saponification'
3	(c)	water is only (other) product / water and no other product OR glycerin is made from a renewable/carbon-neutral/sustainable substance OR no toxic products ✓	1	must imply that it is only water IGNORE 'as a by-product' ALLOW 'high atom economy' (but IGNORE 100%) IGNORE references to energy consumption IGNORE harmful/ 'no pollutants'
3	(d)	increases rate of reaction / faster reaction (AW) ✓ more frequent collisions (AW) ✓	2	IGNORE references to equilibrium IGNORE what is colliding NOT just 'more collisions' IGNORE 'chance of collisions'
3	(e) (i)		1	Arrow must start and end on bonds (or do so if the lines are continued with the same curvature) Any other arrows <i>on the glycerin structure</i> are 'CON'

Question			Answer	Mark	Guidance
3	(e)	(ii)	elimination ✓	1	
3	(e)	(iii)	(primary) alcohol / hydroxyl ✓ ketone / carbonyl ✓	2	'secondary' or 'tertiary' CON the alcohol mark Any extra groups CON a correct answer
3	(e)	(iv)	<p>a IR: acetol has peak at 1705 – 1725 ✓ b C=O / ketone ✓</p> <p>c NMR: acetol has peaks of height/area/ratio 3:2:1 (any order) OR acetol has a peak at 2.0 – 2.7 OR two from the following:</p> <ul style="list-style-type: none"> • acetol has 3 peaks • glycerin has 4 peaks • glycerin has a doublet or triplet at 3.3 – 4.8 ✓ <p>d linking no. of peaks with <u>proton/hydrogen environments</u> in either compound ✓</p> <p>e all singlets/single peaks/unsplit/splitting of 1 ✓</p> <p>f the neighbouring <u>carbons</u> have no hydrogens/protons ✓</p>	6	<p>Please place ticks where points scored check it is the correct numerical range</p> <p>IGNORE references to other peaks</p> <p>c must mention peaks for this mark.</p> <p>IGNORE any extra material even if wrong</p> <p>d (QWC mark linking environments with no. of peaks) ALLOW if hydrogen environments described rather than number given (eg acetol has CH₃, CH₂ and OH) Number of peaks must be stated for either compound and be the same as the number of environments for this mark to be awarded</p> <p>e must imply all peaks are unsplit</p> <p>f must actually say 'no hydrogens' not just state the rule references to any split peaks loses e but f can be scored if it is made for any peak</p>
3	(f)	(i)	+3 ✓	1	NOT 3+

Question			Answer	Mark	Guidance
3	(f)	(ii)	no effect ✓ catalyst affects the rate of/speeds up forward and back reactions (equally) OR affects/speeds up rate of attainment of equilibrium (AW) ✓	2	ALLOW 'only temperature affects K_c ' ALLOW 'provides a route of lower activation enthalpy/energy' IGNORE 'affects rate' without qualification <i>mark separately</i>
3	(g)		calculation of both M_r values correctly ✓ (glycerin 92, prop glycol 76) $\% = (9/76) \times (92/15) \times 100 = 73\%$ ✓	2	ALLOW 92.0 and 76.0 Answer on its own scores marks without reference to working ALLOW two or more sig figs allow any answer between 72 and 73 (intermediate rounding) ALLOW ecf from incorrect M_r values (if clearly indicated as such or by working)
Total				22	

Question			Answer	Mark	Guidance								
4	(a)	(i)		2	ALLOW -CH_3 ALLOW H atoms on benzene carbons IGNORE anything written over arrow								
4	(a)	(ii)	ethanoyl chloride ✓	1	ALLOW without gap between words								
4	(a)	(iii)	electrophilic ✓ substitution ✓	2	Mark separately ALLOW mis-spellings that sound like 'electrophilic' IGNORE 'acylation / acetylation / ethanoylation' Other words are CON to correct marks								
4	(b)		Aluminium (compounds) are toxic OR HCl is a toxic/corrosive/acidic (gas) / lowers pH of rivers/lakes (etc) ✓	1	must name a product to score ALLOW aluminium chloride giving HCl with consequences of this								
4	(c)	(i)	<table border="1" data-bbox="336 909 1052 981"> <tbody> <tr> <td>$(\text{C}_2\text{H}_5)_4\text{N}^+$</td> <td>4</td> <td>tetrahedral</td> <td>107 – 110</td> </tr> <tr> <td>PF_6^-</td> <td>6</td> <td>octahedral</td> <td>90</td> </tr> </tbody> </table> ✓✓ for each row; two if all correct, one if one error	$(\text{C}_2\text{H}_5)_4\text{N}^+$	4	tetrahedral	107 – 110	PF_6^-	6	octahedral	90	4	No ecf ALLOW 'tetrahedron' and/or 'octahedron'
$(\text{C}_2\text{H}_5)_4\text{N}^+$	4	tetrahedral	107 – 110										
PF_6^-	6	octahedral	90										
4	(c)	(ii)	small/weak (AW): electrostatic attraction / attraction between <u>ions</u> / force between <u>ions</u> / <u>ion-ion</u> bonds / <u>ionic</u> bonds ✓ small amount of <u>energy</u> required: to separate (ions) / break/overcome forces of attraction (or bonds) ✓	2	IGNORE 'intermolecular', named imb, 'ion-dipole' for first mark IGNORE answers that discuss removing electrons from ions <i>first mark is for describing bonds between ions and implying they are weak</i> ALLOW breaking of any imb for second mark, provided energy is mentioned. <i>second mark is for saying that little energy is required to break attraction/bonds AW</i> <i>mark separately</i>								

Question			Answer	Mark	Guidance
4	(d)	(i)	CHCl ₃ or more displayed ✓	1	ALLOW CHBr ₃ ALLOW triphenylmethane structure with one or two benzene rings replaced by Cl or Br (eg CHCl (C ₆ H ₅) ₂ or C ₁₃ H ₁₁ Cl or C ₇ H ₆ Cl ₂)
4	(d)	(ii)	<p>a <u>electrons</u> excited/move up ✓</p> <p>b to (higher) <u>energy level</u> ✓ <i>electron movement</i></p> <p>c <u>difference</u> in levels related to frequency / $\Delta E = hv$ ✓ <i>relation between energy and frequency</i></p> <p>d ΔE/energy gap or frequency is lower the greater the delocalisation / larger the chromophore OR OR comparison of size of energy gap (eg 'bigger gap for benzene' or 'big gap for benzene and small gap for dye') ✓ <i>comparison of benzene and dyes in terms of ΔE</i></p> <p>e more delocalisation/larger chromophore for dyes than benzene OR ✓ <i>reason: difference in delocalisation</i></p> <p>f uv has: high frequency/low wavelength/more energy (than visible) OR OR benzene absorbs higher frequency than visible OR ✓ <i>difference between uv and visible</i></p>	6	<p>Please place ticks where points scored</p> <p>'electrons move to higher energy levels' scores both a and b QWC: only award point b if marking point a has been scored IGNORE references to d-orbitals and ligands</p> <p>c ALLOW $E = hv$ but only in context of energy <u>gaps</u> ALLOW 'f' for 'v' in $E = hv$</p> <p>d ALLOW in terms of excitation energies (eg 'it takes more energy to excite benzene's electrons')</p> <p>ALLOW 'conjugated system' for 'chromophore/delocalisation' in d and e</p> <p>e ALLOW comment just for benzene or dyes, provided it is a comparison (eg 'benzene has less delocalisation'). Award for eg 'dyes big delocalisation, benzene small' in different parts of answer</p> <p>If electrons dropping down and emission of light mentioned, max 2 out of 6</p> <p>Please place cross where 'emission' (AW) is mentioned</p>

Question		Answer	Mark	Guidance
4	(e)	<p>a (Kekule structure would form) $C_6H_6Br_2$ or $C_6H_6Br_4$ or $C_6H_6Br_6$ or their structures ✓</p> <p>b (Actual product is) C_6H_5Br or its structure ✓</p> <p>c substitution AND addition mentioned correctly ✓</p> <p>d benzene/delocalised structure is stable / addition removes stability ✓</p> <p>e benzene has delocalisation/ has delocalised electrons ✓</p>	5	<p>Please place ticks where points scored</p> <p>a and b ACCEPT structures without specific reference to where they come from</p> <p>ALLOW skeletal structures</p> <p>ALLOW correct names (1,2-dibromocyclohexa-(3,5)-diene, (1,2,3,4,5,6-)hexabromocyclohexane; bromobenzene) but IGNORE names if structures given</p> <p>ALLOW full descriptions (eg 'one bromine added on each end of one double bond')</p> <p>c IGNORE type of addition/substitution</p> <p>e 'delocalisation'/'delocalised' must be spelled correctly at least once (QWC)</p>
		Total	24	

Question		Answer	Mark	Guidance
5	(a)	$3d^{10} 4s^2$ ✓	1	ALLOW either order ALLOW upper case letters but numbers must be superscripts
5	(b) (i)	$Zn^{2+}(g) \rightarrow Zn^{3+}(g) + e^{-}$ ✓	1	IGNORE any state symbol on the electron ALLOW $Zn^{2+}(g) - e^{-} \rightarrow Zn^{3+}(g)$ Zn symbol must be correct to score
5	(b) (ii)	d^{10} / full (3)d ✓	1	'd' must be stated
5	(b) (iii)	$ZnSO_4$ ✓	1	
5	(c)	$ZnCl_2 \cdot 2H_2O \rightarrow ZnCl(OH) + HCl + H_2O$ ✓	1	IGNORE state symbols ALLOW $Zn(OH)Cl$ or either without brackets (but must be OH not HO) ALLOW the zinc salt product hydrated with one water (correctly represented as '· H ₂ O') eg ' $ZnCl(OH) \cdot H_2O$ ' ALLOW $ZnCl^+ + OH^-$ for salt
5	(d) (i)	lattice enthalpy/energy (of zinc chloride) ✓	1	ALLOW 'lattice formation energy/enthalpy' ALLOW 'enthalpy change of lattice (energy/enthalpy)', 'lattice' for 'lattice' IGNORE ΔH_{LE} etc IGNORE signs
5	(d) (ii)	(Sum of enthalpy changes of hydration) = - 2772 ✓ Expression: (Sum of enthalpy changes of hydration) + 2734 ✓ evaluation of answer (-38) (with ecf) ✓	3	correctly evaluated <i>look to see if marked on diagram</i> expression or correct evaluation ALLOW -(-2734) -38 scores three overall*; (+38) scores two overall* +325 scores two overall* -5506 scores two overall* +685 scores two overall* 325 or -325 score one overall* * whether any working shown or not

Question			Answer	Mark	Guidance
5	(d)	(iii)	broken: hydrogen bonds (in water) ✓ ionic bonds / electrostatic forces / ion-ion bonds (in lattice) ✓ made: ion-(permanent) dipole bonds/forces ✓	3	Extra wrong bonds mentioned are CON to correct bonds IGNORE the species linked by the bonds (eg 'Zn and Cl')
5	(e)		a Entropy is a measure of disorder OR entropy (implies) more ways of arrangement OR entropy measures number of ways of arrangement ✓ b (Particles in) solution (often) more disordered / have more ways of arrangement (than solids) ✓ c Ca ions: have large numbers of/more water molecules clustered round/ OR attract large numbers of/more water molecules OR are greatly/strongly hydrated OR have strong attraction to water molecules ✓ d Entropy loss of water / more order in water ✓	4	Please place ticks where points scored a If 'disorder' or 'ways of arrangement' are qualified it must be by plural 'particles', 'ions', 'molecules', or '(quanta of) energy' NOT singular 'particle' etc, 'compound', 'atoms' or 'element' which CON correct words IGNORE 'substance' b IGNORE 'liquid' for 'solution'; must imply dissolving ALLOW 'molecules' or 'ions' or 'solute' for 'particles' NOT just 'higher entropy' c 'Ca' can be implied eg 'small highly charged ions' must say 'many' water molecules or 'strongly' hydrated d must refer to water
5	(f)		a (Solubility) increase ✓ b $\Delta S_{\text{tot}} = \Delta S_{\text{sys}} - \Delta H/T$ ✓ c $\Delta H/T$ gets smaller as T gets bigger (AW) ✓ d ΔS_{tot} gets more positive / less negative / increases ✓	4	Please place ticks where points scored b ALLOW $\Delta S_{\text{tot}} = \Delta S_{\text{sys}} + \Delta S_{\text{surr}}$ and $\Delta S_{\text{surr}} = -\Delta H/T$ look out for this in any part of the answer c ALLOW '- $\Delta H/T/\Delta S_{\text{surr}}$ gets less negative' / ' ΔS_{surr} increases' / '- ΔS_{surr} decreases' IGNORE ' ΔS_{surr} decreases' '- $\Delta H/T$ decreases' d ALLOW 'total entropy gets...' IGNORE just 'entropy gets...'
			Total	20	

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