2008 Chemistry

Advanced Higher

Finalised Marking Instructions

Advanced Higher Chemistry

General information for markers

The general comments given below should be considered during all marking.

1 Marks should **not** be deducted for incorrect spelling or loose language as long as the meaning of the word(s) is conveyed.

Example: Answers like 'distilling' (for 'distillation') and 'it gets hotter' (for 'the temperature rises') should be accepted.

2 A right answer followed by a wrong answer should be treated as a cancelling error and no marks should be given.

Example: What is the colour of universal indicator in acid solution?

The answer 'red, blue' gains no marks.

3 If a right answer is followed by additional information which does not conflict, the additional information should be ignored, whether correct or not.

Example: Why can the tube not be made of copper?

If the correct answer is related to a low melting point, and the candidate's answer is 'It has a low melting point and is coloured grey' this would **not** be treated as a cancelling error.

4 Full marks should be awarded for the correct answer to a calculation on its own whether or not the various steps are shown **unless the question is structured or working is specifically asked for.**

5 A mark should be deducted in a calculation for each arithmetic slip **unless stated otherwise in the marking scheme.** No marks should be deducted for incorrect or missing units at intermediate stages in a calculation.

6 A mark should be deducted for incorrect or missing units **unless stated otherwise in the marking scheme**. Please note, for example, that KJ mol^{-1} is not acceptable for kJ mol^{-1} and a mark should be deducted.

7 Where a wrong numerical answer (already penalised) is carried forward to another step, no further penalty is incurred provided the result is used correctly.

8 No mark is given for the solution of an equation which is based on a wrong principle.

Example: Use the information in the table to calculate the standard entropy change for the reaction:

$$C_2H_2 + 2HCl \longrightarrow CH_2ClCH_2Cl$$

Compound	**S^o/J K^{-1} mol^{-1}**
C_2H_2	201
HCl	187
CH_2ClCH_2Cl	208

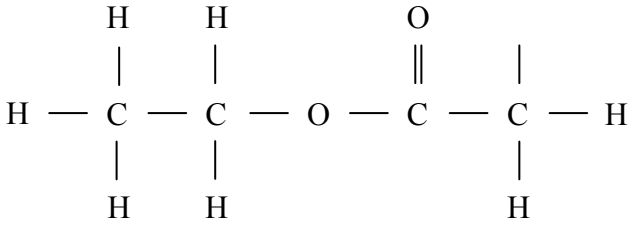
Using $\Delta S^o = S^o_{\text{reactants}} - S^o_{\text{products}}$ would gain zero marks.

9 No marks are given for the description of the wrong experiment.

10 Full marks should be given for correct information conveyed by a sketch or diagram in place of a written description or explanation.

11 In a structural formula, if one hydrogen atom is missing but the bond is shown, no marks are deducted.

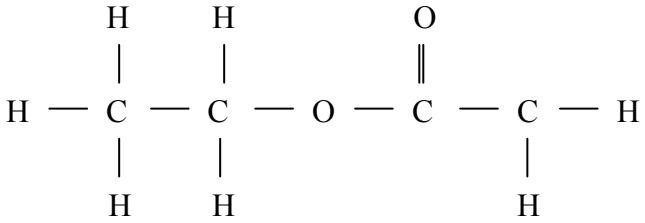
Examples:



Would not be penalised as the structural formula for ethyl ethanoate.

If the bond is also missing, then zero marks should be awarded.

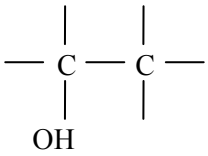
Example:



12 If a structural formula is asked for, CH_3– and CH_3CH_2 – are acceptable as methyl and ethyl groups respectively.

13 With structures involving an – OH or an – NH_2 group, no mark should be awarded if the 'O' or 'N' are not bonded to a carbon, ie OH – CH_2 and NH_2–CH_2.

14 When drawing structural formulae, no mark should be awarded if the bond points to the 'wrong' atom, eg



15 A symbol or correct formula should be accepted in place of a name **unless stated otherwise in the marking scheme**.

16 When formulae of ionic compounds are given as answers it will only be necessary to show ion charges if these have been specifically asked for. However, if ion charges are shown, they must be correct. If incorrect charges are shown, no marks should be awarded.

17 If an answer comes directly from the text of the question, no marks should be given.

Example: A student found that 0·05 mol of propane, C_3H_8 burned to give 82·4 kJ of energy.

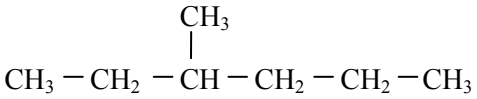
$$C_3H_8(g) + 5O_2(g) \longrightarrow 3CO_2(g) + 4H_2O(\ell)$$

Name the kind of enthalpy change which the student measured.

No marks should be given for 'burning' since the word 'burned' appears in the text.

18 A guiding principle in marking is to give credit for (partially) correct chemistry rather than to look for reasons not to give marks.

Example 1: The structure of a hydrocarbon found in petrol is shown below.



Name the hydrocarbon.

Although not completely correct, the answer, '3, methyl-hexane' would gain the full mark ie wrong use of commas and dashes.

Example 2: A student measured the pH of four carboxylic acids to find out how their strength is related to the number of chlorine atoms in the molecule. The results are shown.

Structural formula	**pH**
CH_3COOH	1·65
$CH_2ClCOOH$	1·27
$CHCl_2COOH$	0·90
CCl_3COOH	0·51

How is the strength of the acids related to the number of chlorine atoms in the molecule?

Again, although not completely correct, an answer like 'the more Cl_2, the stronger the acid' should gain the full mark.

Example 3: Why does the (catalytic) converter have a honeycomb structure?

A response like 'to make it work' may be correct but it is not a chemical answer and the mark should not be given.

2008 Chemistry Advanced Higher

Marking scheme

Section A

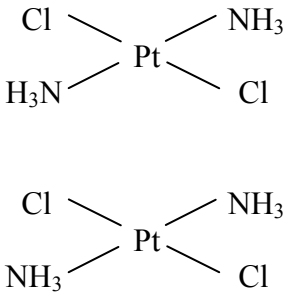
1.	D	21.	D
2.	D	22.	B
3.	B	23.	A
4.	C	24.	A
5.	B	25.	C
6.	A	26.	D
7.	D	27.	B
8.	C	28.	A
9.	A	29.	C
10.	C	30.	C
11.	B	31.	D
12.	D	32.	B
13.	D	33.	D
14.	C	34.	D
15.	B	35.	A
16.	C	36.	B
17.	A	37.	A
18.	A	38.	C
19.	B	39.	D
20.	A	40.	C

Section B

Question	Acceptable Answer	Mark	Unacceptable Answer
1 (a)	Octahedral/square bipyramidal 5 bonded pairs and 1 lone pair	**1**	
(b)	NF_3 has 4 electron pairs, BF_3 has 3 electron pairs NF_3 tetrahedral arrangement of electron pairs, BF_3 trigonal planar arrangement of electron pairs NF_3 has an extra electron pair, N has an extra pair	**1**	NF_3 has lone pair Lone pair on N NF_3 has extra pair**s** } But not cancelling

Question	Acceptable Answer	Mark	Unacceptable Answer
2 (a)	Green	**1**	
(b) (i)	+3 or 3+ or 3 or III or Three	**1**	-3
(ii)	Tetraamminedichlorocobalt(III) (follow through from (b)(i)) Dichlorotetraamminecobalt (III) Accept 'a' instead of 'aa'	**1**	Tetraaminedichlorocobalt(III) Tetraamminedichlorocobaltate(III) …ate amine instead of ammine
(iii)	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^6$ (again, follow through from (b)(i))	**1**	[Ar] $3d^6$

Question	Acceptable Answer	Mark	Unacceptable Answer
3 (a)	(Excited) electrons emitting energy as they fall (back) down to lower energy levels	1	d → d transitions
(b)	Wavelength of emitted light is outwith the visible part of the spectrum or Temperature too low Emission in U.V. or I.R. Flame not hot enough	1	No d electrons Mg has full 2s shell
(c)	$E = \frac{Lhc}{\lambda} = \frac{6 \cdot 02 \times 10^{23} \times 6 \cdot 63 \times 10^{-34} \times 3 \times 10^{8}}{671 \times 10^{-9} \times 10^{3}}$ = 178.45 (kJ mol^{-1}) (or 178) 2.96×10^{-22} = 1 mark only 178450 or 178000 = 1 mark only	1 1	2.96×10^{-19} = 0 marks

Question	Acceptable Answer	Mark	Unacceptable Answer
4 (a) (i)	It coordinates through 2 sites to the platinum Forms 2 bonds to the Pt Pt is attached to 2 parts of the DNA Forms 2 dative bonds to the Pt	**1**	Has 2 lone pairs
(ii)	Lone pairs of electrons Non bonded pairs Unbonded pairs Free electron pairs	**1**	Electron pairs Free electrons Unpaired electrons
(b)		**1**	Tetrahedral diagram

<table>
<tr><th colspan="2">Question</th><th>Acceptable Answer</th><th>Mark</th><th>Unacceptable Answer</th></tr>
<tr><td>5 (a)</td><td>(i)</td><td>$\Delta H^o = \Sigma H^o_{products} - \Sigma H^o_{reactants}$
$= (4 \times -286) -1140 - (-1806)$
$= -478$ kJ mol^{-1}</td><td>1</td><td></td></tr>
<tr><td></td><td>(ii)</td><td>$\Delta S^o = \Sigma S^o_{products} - \Sigma S^o_{reactants}$
$= 192 + (4 \times 70) + 81 - 336$
$= 217$ J K^{-1} mol^{-1}</td><td>1</td><td></td></tr>
<tr><td></td><td>(iii)</td><td>$\Delta G^o = \Delta H^o - T\Delta S^o$
$= -478 - (298 \times 217)/1000$
$= -542.7$ kJ mol^{-1} or -543 kJ mol^{-1}

(Follow through from incorrect answers)
(See below for combinations of follow through possibilities)

<table>
<tr><th>ΔH^o kJ mol^{-1}</th><th>ΔS^o J K^{-1} mol^{-1}</th><th>ΔG^o kJ mol^{-1}</th><th></th></tr>
<tr><td>-478</td><td>+217</td><td>-542.7</td><td>Correct</td></tr>
<tr><td>-478</td><td>+7 *</td><td>-480.1</td><td>ΔS wrong</td></tr>
<tr><td>+380 *</td><td>+7 *</td><td>+377.9</td><td>$\Delta H/\Delta S$ wrong</td></tr>
<tr><td>+380 *</td><td>+217</td><td>+315.3</td><td>ΔH wrong</td></tr>
</table>
* omitted $4 \times H_2O$</td><td>1

1</td><td></td></tr>
<tr><td></td><td>(b)</td><td>-570 kJ mol^{-1}</td><td>1</td><td></td></tr>
</table>

Penalise once only in question 5 for wrong or missing units

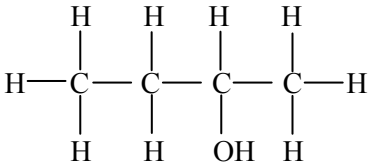
Question	Acceptable Answer	Mark	Unacceptable Answer
6 (a)	Number of moles of $S_2O_3^{2-} = 0.0205 \times 0.1 = 0.00205$ or 2.05×10^{-3} Number of moles of iodine which reacted = 0.001025 or 1.025×10^{-3} 1.02×10^{-3} 1.03×10^{-3} 1.0×10^{-3}	**1**	1×10^{-3} 0.001
(b)	Moles of ClO^- in 25 cm^3 of bleach solution = 1.025×10^{-3} So moles of ClO^- in 250 cm^3 of bleach solution = 1.025×10^{-2} Original concentration in 10.0 cm^3 of bleach = n/V = $1.025 \times \frac{10^{-2}}{0.01}$ = 1.025 (mol l^{-1}) 1.02 1.03 1.0 Accept correct follow through from (a)	**1** **1**	

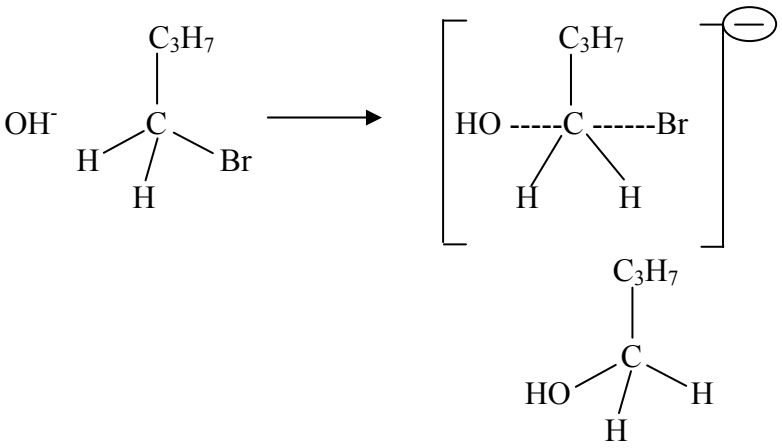
Question	Acceptable Answer	Mark	Unacceptable Answer
7 (a)	Step **X** = 77 kJ or 77 kJ mol^{-1} Step **Y** = 382 kJ or 382 kJ mol^{-1}	**1** **1**	Lose maximum of 1 mark if no units given in one or both answers
(b)	Lattice enthalpy Lattice Lattice formation	**1**	
(c)	$\Delta H_{formation}$ = 77 + 77.5 + 382 – 328 – 744 = -535.5 (kJ mol^{-1}) -536 -535 Correct follow through from (a) [-994.5 + X + Y calculated correctly = 1 mark]	**1**	

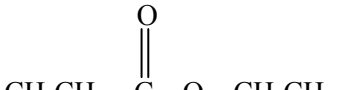
Question	Acceptable Answer	Mark	Unacceptable Answer
8 (a)	Starch solution Starch iotec	**1**	
(b) (i)	moles of thiosulphate = $0.0188 \times 0.025 = 0.00047$ or 4.7×10^{-4} So moles of $I_2 = 0.000235$ or 2.35×10^{-4} $[I_2]_{cyclohexane} = 2.35 \times 10^{-4}/0.01 = 2.35 \times 10^{-2}$ mol l^{-1} (or 0.0235 mol l^{-1}) 0.024	**1**	
(ii)	Moles thiosulphate = $0.0105 \times 0.05 = 0.000525$ or 5.25×10^{-4} So moles of $I_2 = 2.625 \times 10^{-4}$ $[I_2]_{aqueous} = 2.625 \times 10^{-4}/ 0.01 = 2.625 \times 10^{-2}$ mol l^{-1} or 0.02625 mol l^{-1} or $= 2.63 \times 10^{-2}$ mol l^{-1} or 0.0263 mol l^{-1} 0.026	**1**	

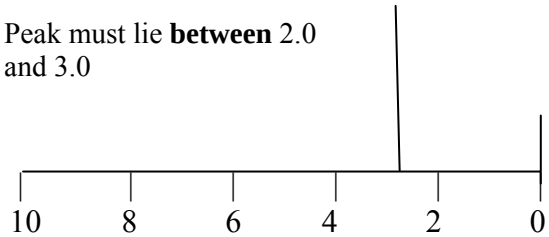
Question	Acceptable Answer	Mark	Unacceptable Answer
(c)	$K = \frac{[I_2]_{cyclohexane}}{[I_2]_{aqueous}}$ $= \frac{0.0235}{0.0263}$ = 0.894 (or 0.895 if 0.02625 used) 0.9 b(i) / b(ii) } correct follow through	**1**	Any units given Answer to b(ii) / Answer to b(i)
(d) (i)	It decreases Any indication that value goes down	**1**	Changed/increased
(ii)	It would stay the same No change No effect	**1**	Little change

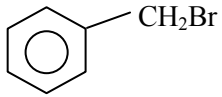
Question	Acceptable Answer	Mark	Unacceptable Answer
9 (a)	$K_a = \frac{[H_3O^+(aq)] \times [F^-(aq)]}{[HF(aq)]}$ $\frac{[H^+][F^-]}{[HF]}$	**1**	$\frac{[H^+][F^-]}{[HF][H_20]}$
(b)	From the graph, $pK_a = 3.8$ or 3.75 (or any number between 3.75 and 3.80) $pK_a = -\log K_a = 3.8$, therefore $K_a = 1.58 \times 10^{-4}$ or $pK_a = -\log K_a = 3.75$, therefore $K_a = 1.78 \times 10^{-4}$ Accept $(1.58 - 1.80) \times 10^{-4}$ $3.75 \rightarrow 1.78 \times 10^{-4}$ $3.76 \rightarrow 1.73 \times 10^{-4}$ $3.77 \rightarrow 1.70 \times 10^{-4}$ $3.78 \rightarrow 1.66 \times 10^{-4}$ $3.79 \rightarrow 1.62 \times 10^{-4}$	**1** **1**	$pK_a = 3.17$ which is the value given in the Data Booklet. $K_a = 6.8 \times 10^{-4}$ which is the Data Booklet value Any units given, lose 1 mark
(c)	Sodium fluoride or NaF or Na^+F^- or F^- Salt of HF Soluble ionic fluoride	**1**	
(d)	Cresol red/alizarin red Accept either or both	**1**	

Question	Acceptable Answer	Mark	Unacceptable Answer
10 (a)	Elimination	**1**	Nucleophilic elimination
(b) (i)	sp^2 hybridisation is a mixing of one s orbital and two p orbitals, (hybridising of one s orbital and two p orbitals)	**1**	A 1s orbital…
(ii)	Sigma bonds – end on overlap of (atomic) orbitals Pi bonds – sideways overlap of (atomic) orbitals 2 correct diagrams	**1**	Overlap between 2 carbons
(c)	 or $CH_3CH_2CHOHCH_3$	**1**	

Question	Acceptable Answer	Mark	Unacceptable Answer
(d) (i)	2nd order	**1**	
(ii)	Rate = k[OH^-][1-bromobutane] k = $\frac{3\cdot3\times10^{-6}}{0\cdot1\times0\cdot25}$ = 1.32×10^{-4} or 1.3×10^{-4} Units = *l* mol^{-1} s^{-1} Correct units = 1 mark Accept correct follow through from (d) (i) (see below for follow through) [1 bromobutane] | [OH^-] | k 0.25 | 0.10 | 1.32×10^{-4} 1 $mol^{-1}s^{-1}$ $(0.25)^2$ | 0.10 | 5.28×10^{-4} 1^2 $mol^{-2}s^{-1}$ 0.25 | $(0.10)^2$ | 1.32×10^{-3} 1^2 $mol^{-2}s^{-1}$ $(0.25)^2$ | $(0.10)^2$ | 5.28×10^{-3} 1^3 $mol^{-3}s^{-1}$	**1** **1** **1**	
(iii)	 – ve charge must be given outside the brackets or on the C (in the transition state)	**1** **1**	$C_4 H_9 Br$ $C_4 H_9 OH$

Question	Acceptable Answer	Mark	Unacceptable Answer
11 (a) (i)	Sodium metal or any reactive metal Any Gp 1 metal and Ba	**1**	Mg NaOH Ca
(ii)	(Hot) copper (II) oxide or acidified dichromate or acidified permanganate or correct formulae H^+/MnO_4^- $H^+/Cr_2O_7^{2-}$ Copper oxide Acidified chromate	**1**	Tollens Benedict's/Fehlings } reagents H^+/MnO_4 H^+/Cr_2O_7
(b)	Ethoxypropane or ethylpropylether	**1**	Propoxyethane Propylethylether Do not accept formulae
(c)	 $CH_3CH_2COOCH_2CH_3$ $C_2H_5COOC_2H_5$	**1**	

Question	Acceptable Answer	Mark	Unacceptable Answer
12 (a)	Condensation or addition + elimination	**1**	
(b) (i)	By recrystallisation/crystallisation	**1**	Evaporate off the water
(ii)	Measure melting point of derivative and compare with literature values/expected value/data book value/known value	**1**	Boiling point instead of MP Measure melting point
(c) (i)	Fehling's solution and blue to orange/brown with the isomer (propanal) or Benedict's → orange/red/green Tollens' reagent and silver mirror with the isomer Acidified dichromate and orange to green with the isomer Acidified permanganate and purple to colourless with the isomer (Hot) copper (II) oxide and black to brown with the isomer 3 points – Aldehyde/reagent/result (final) or – Ketone/reagent/result	**1**	Cancelling errors eg propanone instead of propanal
(ii)	Peak must lie **between** 2.0 and 3.0  	**1**	Line on 3.0
(iii)	A = CH_3^+ Charges not needed B = CH_3CO^+ or $C_2H_3O^+$	**1**	Negative charges Labels A and B wrong way round

Question	Acceptable Answer	Mark	Unacceptable Answer
13 (a)	Electrophilic substitution	**1**	Nucleophilic substitution
(b)	Br_2 and $FeBr_3$/$FeCl_3$/$AlBr_3$/Fe/$AlCl_3$ Correct answers in words rather than formulae	**1**	
(c)	Sulphuric acid and nitric acid H_2SO_4 and HNO_3 Concentrated/fuming H_2SO_4 + HNO_3	**1**	Dilute H_2SO_4 and HNO_3
(d)	$C_6H_6SO_3$ Any order	**1**	$C_6H_5SO_3H$
(e)	 CH_2Br or – $CHBr_2$ or – CBr_3	**1**	

[END OF MARKING INSTRUCTIONS]