2014 Chemistry

Advanced Higher (Revised)

Finalised Marking Instructions

Part One: General Marking Principles for Chemistry Advanced Higher Revised

This information is provided to help you understand the general principles you must apply when marking candidate responses to questions in this Paper. These principles must be read in conjunction with the specific Marking Instructions for each question.

(a) Marks for each candidate response must always be assigned in line with these general marking principles and the specific Marking Instructions for the relevant question. If a specific candidate response does not seem to be covered by either the principles or detailed Marking Instructions, and you are uncertain how to assess it, you must seek guidance from your Team Leader/Principal Assessor.

(b) Marking should always be positive ie, marks should be awarded for what is correct and not deducted for errors or omissions.

GENERAL MARKING ADVICE: Chemistry Advanced Higher Revised

The marking schemes are written to assist in determining the "minimal acceptable answer" rather than listing every possible correct and incorrect answer. The following notes are offered to support Markers in making judgements on candidates' evidence, and apply to marking both end of unit assessments and course assessments.

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

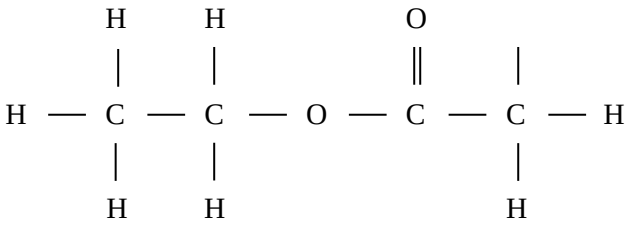
Using $\Delta S^o = S^o_{\text{reactants}} - S^o_{\text{products}}$ would gain zero marks.

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.

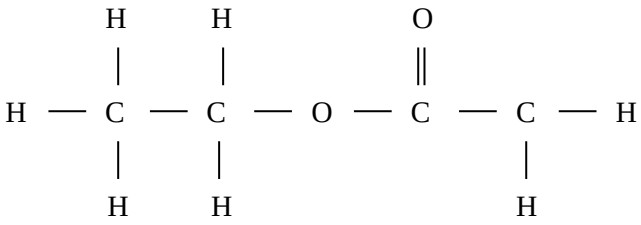
Examples:



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

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

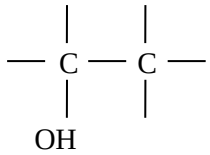
Example:



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.

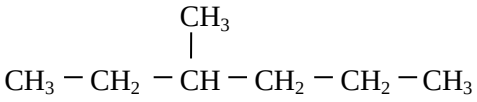
$$C_3H_8(g) + 5O_2(g) \longrightarrow 3CO_2(g) + 4H_2O(\ell)$$

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.

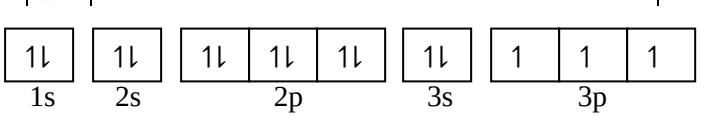
Part Two: Marking Instructions for each Question

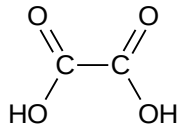
Section A

Question	Acceptable Answer(s)
1	B
2	C
3	C
4	D
5	D
6	B
7	C
8	A
9	A
10	C
11	D
12	B
13	A
14	B
15	B

Question	Acceptable Answer(s)
16	D
17	A
18	B
19	C
20	B
21	C
22	D
23	B
24	A
25	A
26	D
27	C
28	D
29	A
30	A

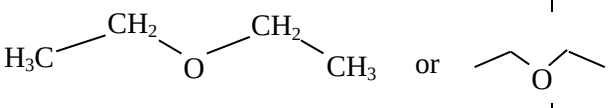
Section B

Question			Acceptable answer	Mark	Unacceptable answer
1	(a)	(i)	An electron is excited/promoted to a higher energy level. When it falls back to a lower/ground state, energy (corresponding to red light) is emitted.	1 1	Mention of absorption of light or complementary colours or transmitted light or d-d transition = cancelling error (= −1)
1	(a)	(ii)	E = Lhc/ λ or E = Lhc/1000 λ or similar correct relationship = 170 (169·6/169·60) (kJ (mol^{-1})) $2{\cdot}82 \times 10^{-22}$ (kJ) = 1 (no L)	1 1	Wrong units = −1
1	(b)		1, 0, 0, −½	1	Wrong order
1	(c)	(i)	 (box labels not needed) Need arrows (full or half headed)	1	Vertical lines
1	(c)	(ii)	The (three degenerate) **3p orbitals** are filled singly **or 3p orbitals** are filled in such a way as to maximise the number of parallel spins.	1	
1	(c)	(iii)	4, 0, 0, +½ or 4, 0, 0, -½ or 4, 0, 0, ½	1	0.5
1	(d)		Many **different** electron transitions (in the visible region) **or** many **different** energy levels. (ignore absorption if penalised already)	1	
1	(e)		73 mg per kg = $7{\cdot}3 \times 10^{-2}$ g per 10^3 g = **$7{\cdot}3 \times 10^{-11}$ g** of Hg in 10^{-6} g of hair Number of mol = $7{\cdot}3 \times 10^{-11}/200{\cdot}6$ = $3{\cdot}64 \times 10^{-13}$ (mol) Allow follow through from incorrect number of grams.	1 1	
				(11)	

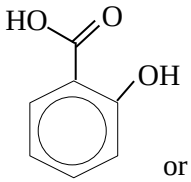
Question			Acceptable answer	Mark	Unacceptable answer
2	(a)		 HOOCCOOH/ ignore bond angles	1	HO_2CCO_2H Bond from C−H(O) $(COOH)_2$
2	(b)		Number of moles of $CaSO_4$ = 3·89/136·1 = 0·0286 Number of moles of H_2O = 1·05/18 = 0·0583 Value of x = 2 Must be a whole number. Ignore sig figs in working.	1 1	Moles of $CaSO_4$ without H_2O Moles of H_2O without $CaSO_4$
2	(c)		n for oxalic acid = $16·55 \times 10^{-3} \times 0·0563$ = $9·32 \times 10^{-4}$ c for NaOH = $(9·32 \times 10^{-4} \times 2)/0·020$ = 0·0932 mol l^{-1} 0·093/0·09318/0·093177 If use non concordant (16·77 cm^3) = 0·0944 mol l^{-1} =1 mark	1 1	Wrong or missing units = −1 −1 for each error
2	(d)		Not available in high purity/not stable in solid or solution/solid is deliquescent/hygroscopic/ low gfm/absorbs water/absorbs CO_2	1	
				(6)	

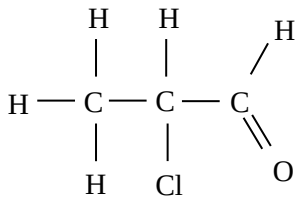
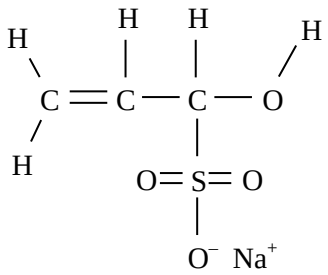
Question			Acceptable answer	Mark	Unacceptable answer
3	**(a)**	**(i)**	−16 kJ mol^{-1}/kJ or answer in joules	**1**	Capital K = wrong units Lower case j.
3	**(a)**	**(ii)**	−162·5 J K^{-1} (mol^{-1})	**1**	−265
3	**(b)**		$\Delta G° = \Delta H° - T\Delta S° = 0$ or $T = \Delta H°/\Delta S°$ or $T = \frac{-164\,000}{-162 \cdot 5}$ = 1009 K/1009·2 K/736·2 °C Standard state signs not required. 619 K (Follow on from wrong answer in (a)(ii)) 1·009 or 1.01 or 1 K = 1 mark **Must have correct units.**	**1** **1**	Negative value for temperature. Lose one mark. $\Delta G° = \Delta H° - T\Delta S°$ without 0 °K (Deduct 1 mark) < 1009·23
				(4)	

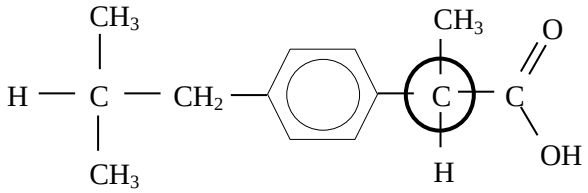
Question			Acceptable answer	Mark	Unacceptable answer
4			This is an open ended question. 1 mark: The student has demonstrated a limited understanding of the chemistry involved. The student has made some statement(s) which is/are relevant, showing that at least a little of the relevant chemistry is understood. 2 marks: The student has demonstrated a reasonable understanding of the chemistry involved. The student makes some statements which are relevant showing understanding of the problem. 3 marks: The maximum available mark would be awarded to a student who has demonstrated a good understanding of the chemistry involved. The student has shown a good understanding of the chemistry involved and has provided a logically correct answer to the question asked. This type of response might include a statement of the principles involved, a relationship or an equation and an application of these to answer the question. This does not mean that the answer has to be what might be termed an 'excellent' or 'complete' answer.	**3**	The student has demonstrated no understanding of the chemistry involved. There is no evidence that the student has recognised the area of chemistry involved or has given any statement of a relevant chemistry principle. This mark would also be given when the student merely restates the chemistry given in the question.
				(3)	

Question			Acceptable answer	Mark	Unacceptable answer
5	(a)		 or (bond angles not important) $CH_3CH_2OCH_2CH_3$ / $C_2H_5OC_2H_5$	**1**	
5	(b)		A separating funnel/separatory funnel/ recognisable diagram.	**1**	Flask (but not cancelling if recognisable diagram)
5	(c)		n for organic acid (ethoxyethane) in 25 cm^3 = 0·0227 × 1·10 = **2·497 × 10^{-2} mol/ 0·999 mol l^{-1}** n for organic acid (aqueous) in 25 cm^3 = 0·00825 × 0·10 = **8·25 × 10^{-4} mol/ 0·033 mol l^{-1}** $K = \frac{[\text{organic acid}](\text{ethoxyethane})}{[\text{organicacid}](\text{aqueous})} = 30 \cdot 3$ 30·27 / 30 / 30·267 0·033 = 2 marks (Inverted K) Ignore lower case K	**1** **1** **1**	Units = −1 mark
				(5)	

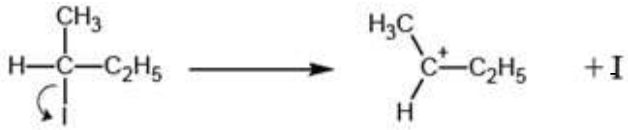
Question			Acceptable answer	Mark	Unacceptable answer
6	**(a)**		Any correct answer such as chloromethane or correct formula. Bromomethane Iodomethane Methyl chloride etc. Ignore wrong formula.	**1**	Fluoromethane CH_3^+ Wrong name with correct formula.
6	**(b)**		Accept aluminium chloride or iron(III) chloride or aluminium bromide or iron(III) bromide or **correct** formula. Wrong formula is not a cancelling error. Correct formula but wrong name is not a cancelling error.	**1**	Wrong formula Aluminium oxide
6	**(c)**		Electrophilic substitution	**1**	Substitution Nucleophilic
				(3)	

Question			Acceptable answer	Mark	Unacceptable answer
7	(a)		Antagonist	1	ante
7	(b)	(i)	 or full structural formula/ Kekule	1	
7	(b)	(ii)	$C_7O_3H_6$ $C_9H_8O_4$ 138 180 $5 \times \frac{100}{67} = 7 \cdot 463\,\text{g}$ 138 $\rightarrow$ 180 $X \rightarrow 7 \cdot 463$ $X = \frac{138 \times 7 \cdot 463}{180} = 5 \cdot 72$ g 5·71 g/5·73 g/5·7 g 3·83 g/3·8 g= 2 marks (missing 67%) FT from incorrect formula mass.	1 1 1	Deduct mark for missing units.
				(5)	

Question			Acceptable answer	Mark	Unacceptable answer
8	**(a)**	**(i)**	Addition ignore nucleophilic/electrophilic	**1**	Sulfonation
8	**(a)**	**(ii)**	Melting point/mixed melting point thin layer chromatography infra-red spectra nmr spectra make a derivative and measure melting point.	**1**	Brady's reagent (any mention of). Mass spectroscopy Spectroscopy Flame tests X-ray crystallography Boiling point
8	**(b)**	**(i)**	 $CH_3CHClCHO$ Or the 3-chloro product / CH_2ClCH_2CHO	**1**	$CH_3CHClCOH$ CH_2ClCH_2COH
8	**(b)**	**(ii)**	 $CH_2CHCH(OH)SO_3^-Na^+$ Or $SO_3^-Na^+$ in bracket	**1**	NA
8	**(b)**	**(iii)**	Lithium aluminium hydride/$LiAlH_4$ Sodium borohydride/sodium tetrahydroborate/$NaBH_4$ correct name or correct formula = 1 no cancelling if one correct and one wrong Lithium/Sodium/Potassium aluminium tetrahydride etc. Lithal	**1**	Wrong formula Lithium aluminium anhydride (but ignore if the correct formula is given)
				(5)	

Question			Acceptable answer	Mark	Unacceptable answer
9	(a)		 **Must show as minimum acceptable the carbon plus the 4 different groups attached to it.**	**1**	
9	(b)	(i)	**A** due to the presence of the peak at 1690 cm^{-1} **or** **A** since IR spectrum shows that a ketone is present **or** **A** due to −C=O stretch at 1690	**1**	**A** since IR spectrum shows that an aldehyde is present **A** since IR spectrum shows that a C=O is present 1720 (unless specifying due to ibuprofen) = cancelling
9	(b)	(ii)	Equilibrium/reversible reaction/side reactions/ losses during purification/crystallisation/ mass transfer losses/mechanical losses/ incomplete/impure reactants.	**1**	
9	(b)	(iii)	**Some idea of**: React with (H, K) CN^- (to increase chain length and replace Br) **or** make a nitrile (Acid) hydrolysis of the nitrile (to form a carboxylic acid) **or** react with (dilute) acid. Make a nitrile followed by hydrolysis = 2	**1** **1**	
				(5)	

Question			Acceptable answer	Mark	Unacceptable answer
10			This is an open ended question 1 mark: The student has demonstrated a limited understanding of the chemistry involved. The student has made some statement(s) which is/are relevant, showing that at least a little of the relevant chemistry is understood. 2 marks: The student has demonstrated a reasonable understanding of the chemistry involved. The student makes some statements which are relevant showing understanding of the problem. 3 marks: The maximum available mark would be awarded to a student who has demonstrated a good understanding of the chemistry involved. The student has shown a good understanding of the chemistry involved and has provided a logically correct answer to the question asked. This type of response might include a statement of the principles involved, a relationship or an equation and an application of these to answer the question. This does not mean that the answer has to be what might be termed an 'excellent' or 'complete' answer.		The student has demonstrated no understanding of the chemistry involved. There is no evidence that the student has recognised the area of chemistry involved or has given any statement of a relevant chemistry principle. This mark would also be given when the student merely restates the chemistry given in the question.
				(3)	

Question			Acceptable answer	Mark	Unacceptable answer
11	**(a)**	**(i)**	1 or first	**1**	
11	**(a)**	**(ii)**	0 or zero	**1**	No order
11	**(b)**	**(i)**	Rate = $k[CH_3CHIC_2H_5]$ **Must** follow from answer to (a).	 **1**	 Do not accept capital K
11	**(b)**	**(ii)**	Accept $(1{\cdot}37 - 1{\cdot}45) \times 10^{-3}$ Units = s^{-1} $1{\cdot}4 \times 10^{-3}$ using first line of the table. Follow through from (a) and/or (b) (i)	 **1** **1**	
11	**(c)**			**1**	
				**1**	
			1 for correct use of curly arrows. Follow through from (a) – 2nd order – S_N2 mechanism. Carbocation on its own = 1 Second line with both reactants and product = 1 Ignore bonds to wrong atoms in carbocation only. Shape of carbocation is not important For S_N2, 1 mark for correct 5-membered transition state with bracket and –ve charge. Dotted bonds not needed. 1 mark = correct reactants and products	**1**	If mechanism does not follow from rate equation = 0 Intermediate in a bracket with overall charge of +
11	**(d)**		The OH^- ion can attack either side of the carbocation (forming equal quantities of both optical isomers and so a racemic mixture is formed)	**1**	Racemic mixture or similar on its own. It is flat.
				(9)	

Question			Acceptable answer	Mark	Unacceptable answer
12	**(a)**	**(i)**	AgCl 1 mole = 143·4g Mass of Ag in 100 cm^3 = (107·9/143·4) × 0·620 **= 0·467g** % Ag in coin = (4·67/10·04) × 100 = **46·5** % 47/46·514/46·51 (0·467/10·04) × 100 = 4·65 % = 1	**1** **1**	
12	**(a)**	**(ii)**	Add more HCl, (no more precipitate should form)/add more Cl^- ions/add Br^- ions/add I^- ions. Any other reasonable suggestion plus result eg add aldehyde → silver mirror	**1**	Add more chlorine Testing conductivity
12	**(b)**		CuCNS, 1 mol = 121·6 g Mass of Cu in 100 cm^3 = (63·5/121·6) × 0·320 **= 0·167** g % Cu in coin = (1·67/10·04) × 100 = **16·6** % 17/16·64/16·644 1·66 % = 1	**1** **1**	
				(5)	

Question			Acceptable answer	Mark	Unacceptable answer
13	**(a)**	**(i)**	$0{\cdot}333 \text{ mol } 1^{-1}$ $0{\cdot}33 \text{ mol } 1^{-1}$ /$0{\cdot}3333 \text{ mol } 1^{-1}$ /$0{\cdot}33333 \text{ mol } 1^{-1}$ $1/3 \text{ mol } l^{-1}$	**1**	Deduct 1 mark for missing/ wrong units. Recurring 'dot'. $0{\cdot}3 \text{ mol } l^{-1}$
13	**(a)**	**(ii)**	$pH = pKa - \log\frac{[acid]}{[salt]}$ $= 4{\cdot}76 - \log (0{\cdot}666/0{\cdot}333) = 4{\cdot}46$ $[H^+] = 10^{-4{\cdot}46} = 3{\cdot}47 - 3{\cdot}55 \times 10^{-5} \text{ mol } l^{-1}$ $3{\cdot}5 \times 10^{-5} \text{ mol } l^{-1}$ Follow through from incorrect second line. So correct relationship, wrong numbers, correct arithmetic = 2 marks. [base] in place of [salt]. Acceptable to take a ratio of volumes for second mark. If acid/salt wrong way round (pH 5·06, $[H^+] = 8{\cdot}69 - 8{\cdot}71 \times 10^{-6} \text{ mol } l^{-1}$) OR have +, lose first mark but can follow through. **3 marks for correct answer regardless of method used.**	**1** **1** **1**	Wrong relationship = wrong principle = 0 ½ appearing = 0
13	**(b)**		The OH^- ions would remove $H^+(aq)$ from the solution OR appropriate equation The OH^- ions would react/neutralise the H^+. These $H^+(aq)$ ions would be replaced by the dissociation of ethanoic acid molecules into ethanoate and $H^+(aq)$ ions OR appropriate equation with reversible arrow. State symbols not required.	**1** **1**	Potassium hydroxide neutralising H^+.
				(6)	

[END OF MARKING INSTRUCTIONS]