2014 Chemistry

Advanced Higher

Finalised Marking Instructions

Part One: General Marking Principles for: Chemistry Advanced Higher

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

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.

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

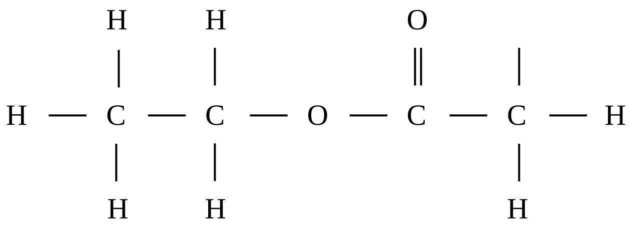
Using $\Delta S^o = S^o_{\text{reactants}} - S^o_{\text{products}}$ would gain zero marks.

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.

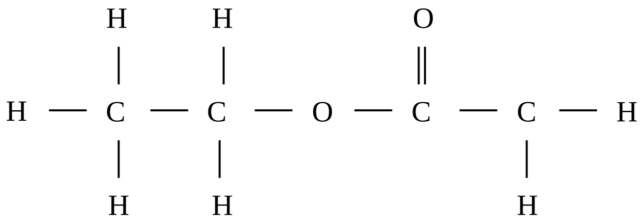
Examples:



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

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

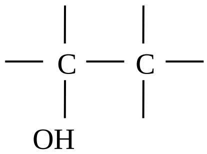
Example:



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.

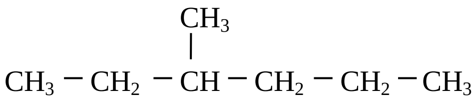
$$C_3H_8(g) + 5O_2(g) \longrightarrow 3CO_2(g) + 4H_2O(\ell)$$

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.

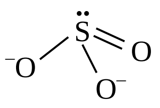
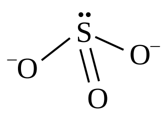
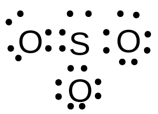
Part Two: Marking Instructions for each Question

Section A

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

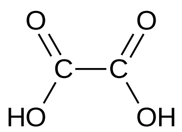
Question	Acceptable Answer(s)
21	D
22	C
23	B
24	A
25	C
26	B
27	B
28	C
29	C
30	A
31	D
32	A
33	A
34	B
35	D
36	A
37	D
38	D
39	C
40	A

Section B

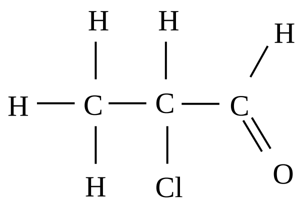
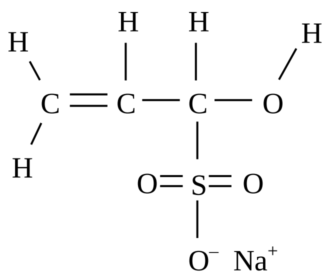
Question			Acceptable Answer(s)	Mark	Unacceptable Answer
1	**(a)**		Al_2O_3 and NaCl (allow minor slips)	**1**	
1	**(b)**		$SiCl_4$ and PCl_3 (allow minor slips)	**1**	
1	**(c)**		Amphoteric oxides exhibit both basic and acidic properties. React **with** both acids and bases (alkalis). Behaves as an acid and a base. Acidic and basic.	**1**	Reacts **as an** acid and an alkali. Proton donor/acceptor = cancelling error.
1	**(d)**		Trigonal pyramid/pyramidal trigonal Or correct structure (showing it is not flat). Wrong name – correct structure.	**1**	Pyramidal Tripod Trigonal Triagonal
				(4)	
2	**(a)**		 or  (acceptable to be drawn as a T shape/ignore bond angles) Must have lone pair.	**1**	Missing lone pair. Two single electrons.
2	**(b)**		 (needs lone pair on S) Ignore correct charges. Ignore crosses altogether.	**1**	Incorrect charges – too many, too few, wrong position.
	(c)		+4, 4, 4+, IV, four	**1**	−4, 4−
				(3)	

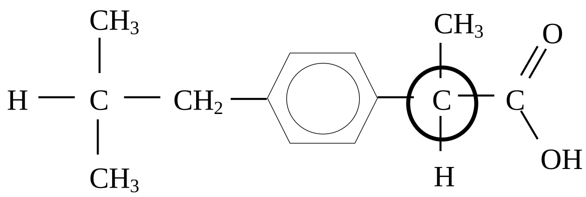
Question			Acceptable Answer(s)	Mark	Unacceptable Answer
3	**(a)**	**(i)**	-164 kJ mol^{-1}/kJ or answer in joules **Must have correct units**	**1**	Capital K = wrong units Lower case j.
3	**(a)**	**(ii)**	$-162{\cdot}5$ J K^{-1} (mol^{-1})/-163 J K^{-1} **Must have correct units**	**1**	-265
3	**(b)**		$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ = 0$ or $T = \Delta H^\circ/\Delta S^\circ$ or $T = \dfrac{-164\,000}{-162\cdot 5}$ = 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. $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$ without 0 °K (Deduct 1 mark) <
				(4)	

Question			Acceptable Answer(s)	Mark	Unacceptable Answer
4	**(a)**		6, six, VI	**1**	+6, 6+, −6, 6−
4	**(b)**		Hexaaquachromium(III) Ignore spaces Ignore chloride/trichloride/3	**1**	Hexaquachromium(III) Hexaaquochromium(III) Hexaaquacromium(III)
4	**(c)**	**(i)**	(Ligands) split the degenerate d orbitals (sub shell) into **orbitals of different energies**. splitting of d orbitals **or** no longer degenerate The difference in energy corresponds to light in the visible region (white light) of the spectrum **or** absorption of visible energy (white light) resulting in complementary colour observed. d-d transitions = 1 mark d orbitals split and d-d transitions = 1 mark	**1** **1**	Change of energy of d orbitals Mention of electrons falling back or emission loses this second mark (cancelling error for second mark).
4	**(c)**	**(ii)**	(Different ligands cause) different **degree of splitting** Absorb energy of different wavelengths. Δ different/energy different. Different frequencies absorbed/transmitted. Different ligand field strengths. Ligands are in a different position of spectrochemical series. Correct diagram showing all 5 orbitals (electrons not needed).	**1**	Different ligands/mixtures of ligands on its own. Different ligand fields on its own. Different wavelengths/~ frequency on its own. Different d-d split. Different colours absorbed.
4	**(d)**		Octahedral/octahedron/correct diagram/ square bipyramid.	**1**	8 sided Diamond
4	**(e)**		$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ (4s^0)$ Correct orbital box notation with labelled boxes. Subscript numbers. $[Ne]\ 3s^2\ 3p^6\ 3d^5$	**1**	$[Ar]\ 3d^5$

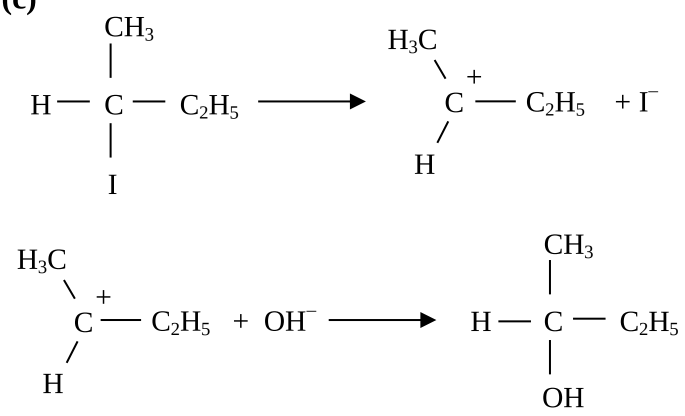
Question			Acceptable Answer(s)	Mark	Unacceptable Answer
4.	**(f)**	**(i)**	One mole = 266·5 g so 2·565 g = $\mathbf{9{\cdot}625 \times 10^{-3}}$ (mol) $\mathbf{9{\cdot}62 \times 10^{-3}}$/$\mathbf{9{\cdot}6247 \times 10^{-3}}$/ $\mathbf{9{\cdot}62477 \times 10^{-3}}$/$\mathbf{9{\cdot}6248 \times 10^{-3}}$	**1**	$\mathbf{9{\cdot}63 \times 10^{-3}}$ **0·01**
4	**(f)**	**(ii)**	One mole = 143·4 g, so 2·748 g = $\mathbf{1{\cdot}916 \times 10^{-2}}$ (moles) $\mathbf{1{\cdot}92 \times 10^{-2}}$/$\mathbf{1{\cdot}9163 \times 10^{-2}}$/ $\mathbf{1{\cdot}91631 \times 10^{-2}}$	**1**	0·02 $\mathbf{1{\cdot}9 \times 10^{-2}}$
4	**(f)**	**(iii)**	B Ratio of 1:3 in i) and ii) = A, 1:1 = C	**1**	
				(10)	
5	**(a)**		 HOOCCOOH/ignore bond angles	**1**	HO_2CCO_2H Bond from C−H(O) $(COOH)_2$
5	**(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 $CaSO_4$.
				(3)	

Question			Acceptable Answer(s)	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(s)	Mark	Unacceptable Answer
7	**(a)**	**(i)**	Addition ignore nucleophilic/electrophilic	**1**	Sulphonation
7	**(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. Mass spectroscopy Spectroscopy Flame tests X-ray crystallography
7	**(b)**	**(i)**	 $CH_3CHClCHO$ Or the 3-chloro product/CH_2ClCH_2CHO	**1**	$CH_3CHClCOH$ CH_2ClCH_2COH
7	**(b)**	**(ii)**	 $CH_2CHCH(OH)SO_3^-Na^+$ Or $SO_3^-Na^+$ in bracket	**1**	NA
7	**(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 aluminium tetrahydride etc. Sodium/Potassium	**1**	Wrong formula Lithium aluminium anhydride (but ignore if the correct formula is given)
				(5)	

Question			Acceptable Answer(s)	Mark	Unacceptable Answer
8	**(a)**		 **Must show as minimum acceptable the carbon plus the 4 different groups attached to it. Enough for markers to be able to recognise it as the correct carbon**	**1**	
8	**(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 a aldehyde is present **A** since IR spectrum shows that a C=O is present 1720 (unless specifying due to ibuprofen)
8	**(b)**	**(ii)**	Any test that would work such as Brady's (2, 4-DNP) reagent reacting with A to form a precipitate or derivative. Lithium aluminium hydride with A to give the alcohol. Silver nitrate/Tollen's with B to give a precipitate. NaOH will react with B to give the alcohol. Looking for a reagent and a result (on the correct compound).	**1**	Brady's reagent Reagent plus wrong observation. Tollen's with B to give silver mirror.
8	**(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(s)	Mark	Unacceptable Answer
9	**(a)**		Phosphoric acid or correct formula or orthophosphoric acid.	**1**	Sulphuric acid Dilute phosphoric acid
9	**(b)**		Ethanol	**1**	
9	**(c)**		$C_7O_3H_6$ $C_9H_8O_4$ 138 180 $5\times\frac{100}{67}=7\cdot463\text{g}$ 138 $\rightarrow$ 180 X $\rightarrow$ 7·463 $X=\frac{138\times7\cdot463}{180}=5\cdot72$ 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(s)	Mark	Unacceptable Answer
10	**(a)**	**(i)**	1 or first	**1**	
10	**(a)**	**(ii)**	0 or zero	**1**	‘No order’
10	**(b)**	**(i)**	Rate = k[$CH_3CHIC_2H_5$] **Must** follow from answer to (a).	**1**	Do not accept capital K
10	**(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**	
10	**(c)**		 Ignore (incorrect) curly arrows. Follow through from (a) – 2nd order – SN_2 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 SN_2 1 mark = correct 5 membered transition state with bracket and –ve charge. Dotted bonds not needed. 1 mark = correct reactants and products	**1** **1**	If mechanism does not follow from rate equation = 0 Intermediate in a bracket with overall charge of +
10	**(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.
				(8)	

Question			Acceptable Answer(s)	Mark	Unacceptable Answer
11	**(a)**		So that only the $[I_2]$ varies (significantly). So that the concentrations of hydrogen ions and propanone remain (almost) constant or stay the same. So that any changes must be due to $[I_2]$	**1**	So that propanone and hydrogen ions are in excess. So that I_2 is the limiting reagent.
11	**(b)**		Sodium hydrogencarbonate (solution) Sodium bicarbonate/bicarbonate of soda $NaHCO_3$ (correct name and wrong formula = 1)	**1**	Correct formula and wrong name. Dicarbonate of soda
11	**(c)**		Sodium thiosulphate/sodium thiosulfate/ $Na_2S_2O_3$ (correct name and wrong formula = 1)	**1**	Wrong name and correct formula
11	**(d)**		0 or zero order	**1**	'No order' – but do not penalise for this twice (10 (a)(ii)).
				(4)	

Question			Acceptable Answer(s)	Mark	Unacceptable Answer
12	**(a)**	**(i)**	0·333 mol l^{-1} 0·33 mol l^{-1}/0·3333 mol l^{-1}/ 0·33333 mol l^{-1} 1/3 mol l^{-1}	**1**	Deduct 1 mark for missing/ wrong units. Recurring 'dot'. 0·3 mol l^{-1}
12	**(a)**	**(ii)**	pH $= \text{pKa} - \log\dfrac{[\text{acid}]}{[\text{salt}]}$ = 4·76 – log (0·666/0·333) = 4·46 $[H^+] = 10^{-4{\cdot}46} = 3{\cdot}47 - 3{\cdot}55 \times 10^{-5}$ mol l^{-1} $3{\cdot}5 \times 10^{-5}$ 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, $[H^+] = 8{\cdot}69 - 8{\cdot}71 \times 10^{-6}$ 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
12	**(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**	
				(6)	

[END OF MARKING INSTRUCTIONS]