2015 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

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

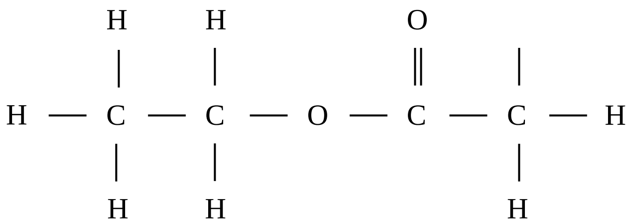
Using $\Delta S^o = S^o_{\text{reactants}} - S^o_{\text{products}}$ would gain zero marks.

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.

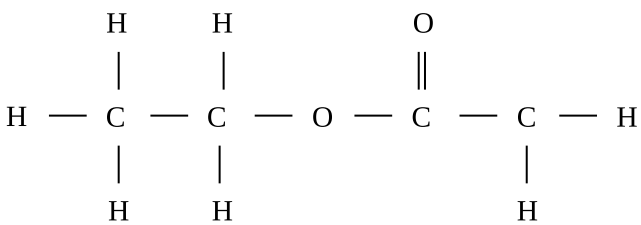
Examples:



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

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

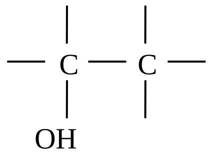
Example:



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.

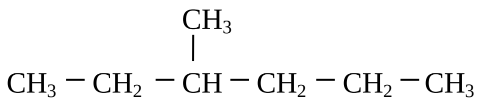
$$C_3H_8(g) + 5O_2(g) \longrightarrow 3CO_2(g) + 4H_2O(\ell)$$

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.

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Part Two: Marking Instructions for each Question

Section A

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

Question	Expected Answer(s)	Max Mark
21.	D	**1**
22.	A	**1**
23.	B	**1**
24.	A	**1**
25.	B	**1**
26.	D	**1**
27.	B	**1**
28.	C	**1**
29.	A	**1**
30.	A	**1**
31.	A	**1**
32.	D	**1**
33.	B	**1**
34.	A	**1**
35.	B	**1**
36.	D	**1**
37.	B	**1**
38.	C	**1**
39.	C	**1**
40.	C	**1**

Section B

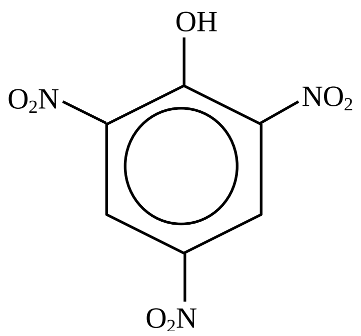
Question			Acceptable Answer	Max Mark	Unacceptable
1	**a**	**i**	Equal energy/same energy/contains the same energy	**1**	Same energy level/same energy subshell/
1	**a**	**ii**	Correct statement of Hund's Rule. Each orbital should be filled singly before spin pairing takes place The 2p should be filled singly (before spin pairing takes place) The 2p should be filled singly (before they double up) Orbital box diagram showing **correct** representation	**1**	"**They**" should be filled singly ….. Each orbital should be filled singly Breaks Hund's rule
1	**b**	**i**	$E = Lhc/\lambda$ **(1)** $\lambda = 6 \cdot 02 \times 10^{23} \times 6 \cdot 63 \times 10^{-34} \times 3 \times 10^{8} / 502000$ **(1)** $\lambda = 238 \cdot 5\text{nm} = 239\text{nm}$ or $2 \cdot 39 \times 10^{-7}$m or $2 \cdot 385 \times 10^{-7}$m **(1)** Correct = 3 sig figs – accept 2 sig figs to 5 sig figs (240nm and 238·52nm are also acceptable) 238nm = (2) Not using L = (2) if units correct So $3 \cdot 96 \times 10^{-31}$ m or 3.9622×10^{-31} m or $3 \cdot 962 \times 10^{-31}$ m or $3 \cdot 96 \times 10^{-22}$ nm or $4 \cdot 0 \times 10^{-31}$ m would all get (2) marks If don't convert J to kJ and get $2 \cdot 39 \times 10^{-4}$m / $2 \cdot 385 \times 10^{-4}$ m / 23852 nm / 24000 nm then **(2)** Correct answer with no working = **(3)**	**3**	E = Lhf (and nothing else) **(0)** **or** f = c/λ (and nothing else) **(0)** Correct figures but in wrong place and no equation given = **(0)** No units = −1 Mistake in a number = −1 Two errors in one line = −1 Wrong answer with no working = 0 (unless the answers are one of those mentioned here)
1	**b**	**i**	No – wavelength required is too short. Wavelength required is outside visible range. UV light required / visible light too long wavelength / frequency of visible light too low / visible light is between 400-700nm / 239nm is not in the visible region If calculated waveength in part (i) is in the range 400-700nm then follow through answer " yes" with correct explanation = **(1)**	**1**	No with no explanation. Visible light (energy) not enough No with wrong range of visible light = **(0)** No because visible light is not correct wavelength / energy. Any mention of energy with no explanation = **(0)**
				(6)	

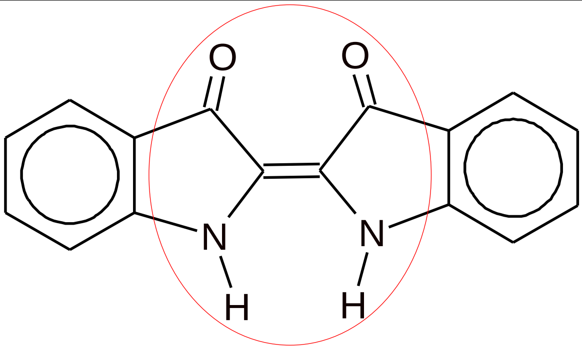
Question			Acceptable Answer	Max Mark	Unacceptable
2	**a**		$\Delta H° = (-394 + 130) - (-110 - 348)$ $= 194$	**1**	-194
2	**b**		$\Delta S° = (214 + 161) - (44 + 198)$ $= 133$		-133 / $0{\cdot}133$
2	**c**		$\Delta G^o = \Delta H^o - T\Delta S^o = 0$ **or** $T = \dfrac{\Delta H^o}{\Delta S^o}$ **(1)** $= \dfrac{194000}{133} = 1458 \cdot 6\,\mathrm{K}$ **or** $1459\,\mathrm{K}$ or 1460 K Allow 3 to 5 sig figs Follow through from incorrect (a) and (b) 194/133 = **(1)** Standard symbols not needed for first mark	**2**	Deduct 1 mark for ^{o}K or for −ve value for temp 1458 K, 1458, 1500 K, 1458.65 K are only worth 1 mark if correct relationship given
				(4)	

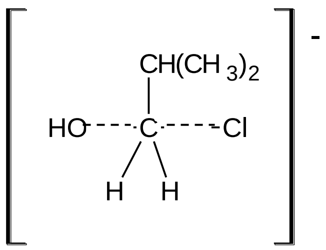
Question			Acceptable Answer	Max Mark	Unacceptable
3	**a**	**i**	1·26 V	**1**	No units (0)
3	**a**	**ii**	$\Delta G^{o} = -\,n\,F\,E^{o}$ / $\Delta G = -nFE$ **(1)** − 121·59 (kJ mol^{-1})/ − 121·6 (kJ/mol^{-1}) **or** −122 would get (2) marks 121·59 gets (1) only unless correct follow through from (i) −71·41 follow through from 0·74 in (i) = **(2)**	**2**	Incorrect follow through = **(1)** If use +nFE = maximum of **(1)**
3	**b**	**i**	(IV), 4, +4, IV, 4+, four	**1**	−4 / 4−
3	**b**	**ii**	Both the blue / VO^{2+} and yellow / VO_2^{+} coloured (ions) are present (and will produce the green colour) / yellow and blue gives green	**1**	Green is an intermediate colour between blue and yellow
3	**b**	**iii**	3 / three	**1**	
3	**b**	**iv**	(Oxygen) oxidises the vanadium ions / reacts with oxygen / oxygen turns it back / oxygen effects the mixture / oxidation of V^{2+} ion / reacts with air to oxidised form/it has been oxidised	**1**	Reacts with the air / oxygen reduces the vanadium ions / oxide ions / oxygen reacts with zinc / due to something escaping
				(7)	
4	**a**		Green / lime green / light green	**1**	Green − blue or blue – green, cyan, turquoise, aqua marine
4	**b**		Hydrogen peroxide / H_2O_2 / O_2H_2	**1**	
4	**c**		Octahedral (incorrect spelling is OK)	**1**	Octagonal / octahedron / octagon
				(3)	

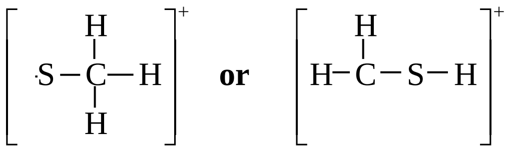
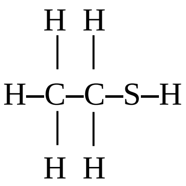
Question			Acceptable Answer	Max Mark	Unacceptable
5	a	i	At equilibrium $[NO_2] = 0{\cdot}24$ mol l^{-1} N_2O_4 reacted → $0{\cdot}24/2 = 0{\cdot}12$ $[N_2O_4]$ at equilibrium → $0{\cdot}28 - 0{\cdot}12 = 0{\cdot}16$ **(1)** $K = [NO_2]^2/[N_2O_4]$ **or** $= (0{\cdot}24)^2/(0{\cdot}16)$ **(1)** $= 0{\cdot}36$ **(1)** Correct FT from incorrect (or missing 0·16) For example $0{\cdot}24^2 / 0{\cdot}28 = 0{\cdot}206 / 0{\cdot}21 / 0{\cdot}2$ **(2)** $0{\cdot}24^2 / 0{\cdot}12 = 0{\cdot}48$ **(2)**	3	$0{\cdot}24^2/0{\cdot}28 \times 127 = 0$ marks 1 mark deducted if units given
5	a	ii	The forward reaction is endothermic since decreasing the temp has favoured the reverse reaction. The forward reaction is endothermic with an acceptable reason that shows an understanding of degree of dissociation (eg more product forms at higher temperatures / as temp decreases the yield decreases). **Or** There is bond breaking taking place therefore the reaction is endothermic. Correct FT from (i)	1	Reaction is endothermic because as temperature decreases K decreases
5	b	i	$x = 7{\cdot}40 \times 10^{-4} / 7{\cdot}4 \times 10^{-4}$ **(1)** $y = 2{\cdot}96 \times 10^{-3} / 3{\cdot}0 \times 10^{-3}$ **(1)**	2	3×10^{-3}
5	b	ii	Rate = k $[NO]^2$ $k = \dfrac{7 \cdot 40 \times 10^{-4}}{\left(2 \cdot 00 \times 10^{-3}\right)^2} = 185$ **(1)** $l\ mol^{-1}s^{-1}$ **(1)** (units in any order eg $mol^{-1}ls^{-1}$) − if unit is incorrect lose one mark	2	
				(8)	

Question			Acceptable Answer	Max Mark	Unacceptable
6	**a**		$\Delta H_5 = -698$ **(1)** 337 + 243 + 751 + 1970 + (−698) + (−2774) = −171 allow follow through from incorrect ΔH_5	**2**	
6	**b**		337 + 121·5 + 751 + (−349) + (−921) = −60·5 −1 for each incorrect number 2nd mark for correct calculation with follow through from wrong numbers	**2**	If only use 3 numbers for example – wrong principle
6	**c**		$CuCl_2$ – more negative ΔH_f value FT from a) and b) so whichever is more negative Negative formation energy means reverse reaction is less likely than CuCl	**1**	More energy to break Greater / smaller (but not cancelling) Negative formation energy means reverse reaction is less likely
				(5)	
7	**a**		Phenolphthalein (including incorrect spellings – provided it sounds correct when spoken) / phenylphthalein	**1**	phenylalanine
7	**b**	**i**	mol H_2SO_4 = 8·65/1000 × 0·050 = $4{\cdot}325 \times 10^{-4}$ (mol) $4{\cdot}3 \times 10^{-4}$ or $4{\cdot}33 \times 10^{-4}$ (8·6 /1000 × 0·050 = **(1)**)	**1**	$4{\cdot}0 \times 10^{-4}$
7	**b**	**ii**	Mol NaOH in 25 cm^3 sample = $4{\cdot}325 \times 10^{-4} \times 2 = 8{\cdot}65 \times 10^{-4}$ mol mol NaOH in 250 cm^3 standard flask = $8{\cdot}65 \times 10^{-3}$ (0·00865 mol) / $8{\cdot}7 \times 10^{-3}$ Follow on = 20 × answer to part (i)	**1**	
7	**b**	**iii**	Initial moles of NaOH = 25/1000 × 1 = 0·025 mol Moles of NaOH reacting with ASA = 0·025 – 0·00865 = 0·01635 / 0·016 / 0·0164 Accept 0·0163 as follow on from 8·7	**1**	

Question			Acceptable Answer	Max Mark	Unacceptable
7	**b**	**iv**	Moles of ASA = 0·01635/2 = 0·008175 Mass of ASA 0·008175 × 180 = 1·4715 g **(1)** Mass of ASA in one tablet = 0·2943 g **(1)** **0·29 / 0·294 / 0·2952 / 0·295 / 0·3 or converted to mg** Allow follow through from any answer in (iii) 1 mark for 90 × answer to part (iii) 2 marks for 18 x answer to part (iii)	**2**	
				(6)	
8	**a**		sp^2	**1**	
8	**b**	**i**	Chloromethane / bromomethane and $FeCl_3$ / $FeBr_3$ / $AlCl_3$ / $AlBr_3$ Reagent and catalyst needed for mark	**1**	
8	**b**	**ii**	Electrophilic substitution / alkylation / Friedel Crafts	**1**	Nucleophilic is cancelling substitution
8	**c**	**i**	 Kekule structure is fine Must have correct placing of bonds to nitro groups	**1**	Bonds from benzene ring going to O of the nitro group
8	**c**	**ii**	NO_2^+	**1**	NO^{2+} H_2SO_4 / HNO_3
				(5)	

Question			Acceptable Answer	Max Mark	Unacceptable
9	a		An answer such as red and green being absorbed (and blue being transmitted) / absorbs all colours except blue / orange absorbed/red and yellow absorbed	1	Reflects – cancelling Blue light emitted - cancelling General answer in terms of absorption and transmittance
9	b		 Non – skeletal Circled part most important – NH on same side with C=O on opposite.	1	
9	c		Addition Ignore electrophilic and nucleophilic	1	
				(3)	

Question			Acceptable Answer	Max Mark	Unacceptable
10	**a**		2-chloro-2-methylpropane 2-chloromethylpropane	**1**	2,2-chloromethylpropane methyl-2-chloropropane 2-methylchloropropane
10	**b**		$CH_3CH = CHCH_3$ **(1)** and $CH_2 = CHCH_2CH_3$ **(1)** Or full structural formulae Ignore incorrect names	**2**	Names only
10	**c**	**i**	2-methylpropan-1-ol Methylpropan-1-ol 1-hydroxy-2-methylpropane Methyl-1-propanol	**1**	
10	**c**	**ii**	Five membered transition state with negative charge  Needs dotted bonds as above Wedges and dotted 3D bonds are OK.	**1**	OH---- (dotted bond going – to H of OH)
10	**d**		$CH_3CH_2CH_2CH_2Cl$ Or full structural / skeletal	**1**	
10	**e**		3 / three	**1**	
10	**f**		A= (has an asymmetric carbon and so) must be a racemic mix **(1)** B = no chiral carbon / no carbon with four different groups around it **(1)**	**2**	Carbon does not have four molecules around it Carbon does not have four atoms around it B does not have an optical isomer
				(9)	

Question			Acceptable Answer	Max Mark	Unacceptable
11	a		C = 0·96g H = 0·24g S = 1·28g **(1)** C 0·96g/12 = 0·08 H 0·24g/ 1 = 0·24 S 1·28g/32·1 = 0·04 2 6 1 **(1)** (Empirical formula C_2H_6S) Alternative methods acceptable: C = 3·52/44 = 0·08; H = 2·16 /18 = 0·12; S = 2·56/64 = 0·04 **(1)** Mole ratio CO_2 : H_2O : SO_2 = 2: 3: 1 So 2 × C : 6 × H : 1 × S **(1)** Must use values given in question.	2	
11	b		 **SCH_3^+ or CH_2SH^+** any order of atoms with a positive charge is acceptable Round brackets OK If no brackets for full structural then charge must be on S (LHS fragment) or C (RHS fragment)	1	No charge / negative charge
11	c		 **or** CH_3CH_2SH	1	Alkene structure = 0 S with two methyl groups is not acceptable C_2H_5SH
				(4)	

[END OF MARKING INSTRUCTIONS]