2007 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:

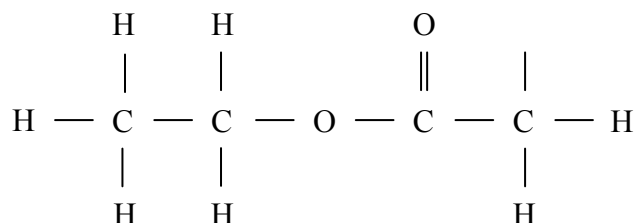$$C_2H_2 + 2HCl \longrightarrow CH_2ClCH_2Cl$$
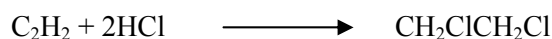
Compound	S^o/J K^{-1} mol^{-1}
C$_2$H$_2$	201
HCl	187
CH$_2$ClCH$_2$Cl	208

Using $\Delta S^o = S^o_{\text{reactions}} - S^o_{\text{products}}$ 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.

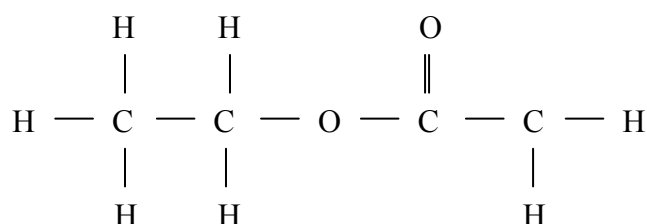11 In a structural formula, if one hydrogen atom is missing but the bond is shown, no marks are deducted.

Examples:

$$H - \overset{\displaystyle H}{\underset{\displaystyle H}{\overset{|}{\underset{|}{C}}}} - \overset{\displaystyle H}{\underset{\displaystyle H}{\overset{|}{\underset{|}{C}}}} - O - \overset{\displaystyle O}{\overset{\|}{C}} - \overset{\underset{\displaystyle H}{|}}{C} - H$$

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

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

Example:

$$H - \overset{\displaystyle H}{\underset{\displaystyle H}{\overset{|}{\underset{|}{C}}}} - \overset{\displaystyle H}{\underset{\displaystyle H}{\overset{|}{\underset{|}{C}}}} - O - \overset{\displaystyle O}{\overset{\|}{C}} - \overset{\underset{\displaystyle H}{|}}{C} - H$$

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

$$- \overset{|}{\underset{\displaystyle OH}{\overset{|}{C}}} - \overset{|}{\underset{|}{C}} -$$
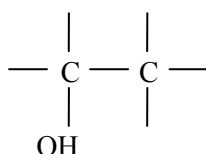
15 A symbol or correct formula should be accepted in place of a name **unless stated otherwise in the marking scheme**.

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.

$$C_3H_8(g) + 5O_2(g) \longrightarrow 3CO_2(g) + 4H_2O(l)$$
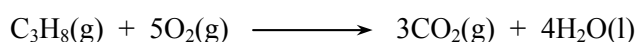
   Name the kind of enthalpy change which the student measured.

        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.

$$CH_3 - CH_2 - \overset{\overset{\textstyle CH_3}{|}}{CH} - CH_2 - CH_2 - CH_3$$
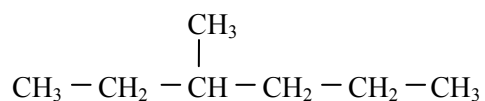
Name the hydrocarbon.

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.

Marking scheme

Section A

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

Section B

Question	Acceptable Answer	Mark	Unacceptable Answer
1 (a)	+173.9/+174	1	173.8/-ve sign/wrong units
(b)	$\Delta G^o = \Delta H^o - T \Delta S^o$	1	$\Delta G^o = \Delta H^o + T \Delta S^o = 0$ marks
	Just feasible when $\Delta G^o = 0$ $\Delta H^o - T \Delta S^o = 0$ $T \Delta S^o = \Delta H^o$ $T = \dfrac{\Delta H^o}{\Delta S^o}$	1	
	$= \dfrac{266\,000}{173.9}$ $= 1529.6$ K/1530 K/1528.7 K (follow through from 174 in (a)) Accept correct follow through from incorrect answer to (a) Ignore conversion to ^{o}C	1	^{o}K Deduct 1 mark or no units – deduct 1 mark 1529 K – deduct 1 mark

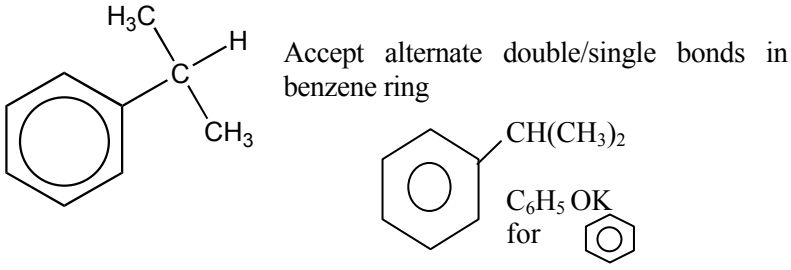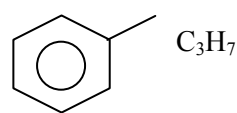| Question		Acceptable Answer	Mark	Unacceptable Answer
2	**(a)**	$\dfrac{[CH_4(g)][H_2S(g)]^2}{[CS_2(g)][H_2(g)]^4}$ **K** State symbols not required	**1**	
	(b)	$\dfrac{0.0054 \times 0.00010^2}{0.012 \times 0.0020^4}$ **K** $\dfrac{5.4 \times 10^{-11}}{1.92 \times 10^{-13}}$ = 281/281.25/281.3	**1**	Units given, then 0 marks 282

Question	Acceptable Answer	Mark	Unacceptable Answer
3 (a)	Proton Donor/donates H^+ ions/ H_3O^+ ions/donates hydrogen ions	**1**	Donates hydrogen
(b)	$HCO_3^-(aq)$/HCO_3^-	**1**	HCO_3 (no charge given)
(c)	$pH = \frac{1}{2} pKa - \frac{1}{2} \log c$ May use Data booklet value for pKa which is 6.35 giving a final answer of 3.675 or 3.68 $= \frac{1}{2} 6.4 - \frac{1}{2} \log 0.1$ $= 3.2 + 0.5$ $= 3.7/3.67$ $H^+ = \sqrt{Ka \times c} = 1$ mark $pH = -\log [H^+] = 3.67$ 2 marks	**1** **1**	Wrong formula given = Or Wrong equation = 0 marks

Question			Acceptable Answer	Mark	Unacceptable Answer
4	**(a)**	**(i)**	$1/1^{st}$ order		
		(ii)	$1/1^{st}$ order (both correct answers required for 1 mark)	**1**	
	(b)		Rate = $k[H_2O_2][HI]$ Accept follow through from (a)	**1**	If capital K given then 0 marks
	(c)		$$k = \frac{Rate}{[H_2O_2][HI]}$$ $$= \frac{4.3 \times 10^{-9}}{3.2 \times 10^{-4} \times 4.1 \times 10^{-4}}$$ = 0.0328/0.033 $mol^{-1}\, l\, s^{-1}/l\, mol^{-1}s^{-1}$ (accept follow through if rate equation answer is wrong)	**1** **1**	0.03/0.032

Question	Acceptable Answer	Mark	Unacceptable Answer
5 **(a)**	$\Delta G = -nFE/-nFE°/-nFemf$	**1**	$\Delta G = nFE$
	$= -2 \times 96\ 500 \times 0.94$	**1**	If candidate gives n=1 then answer of -90.71 gets 2 marks out of 3
	$= -181.42$ (units not required/ignore kJ) $= -181.4/-181$	**1**	If candidate gives n=0.1 or 0.2 then 0 marks
(b)	The concentration of both solutions should be 1 moll^{-1} /1M/1 molar	**1**	
(c)	1.10 V	**1**	

Question	Acceptable Answer	Mark	Unacceptable Answer
6 (a)	Binds less strongly with metal ions than EDTA/changes colour when it binds with metal ions One colour when bound to metal ions, another colour when free	1	Self indicating Changes colour at the end point
(b)	n = V x c = 24.25/1000 x 0.101 = 2.45 x 10^{-3} or 2.449 x 10^{-3} moles EDTA = 2.45 x 10^{-3} moles Ni^{2+} in 20 cm^3 = 0.0122 moles Ni^{2+} in 100 cm^3 0.0122 x 58.7 g = 0.719 g Ni^{2+} in salt % Ni = 0.719 / 3.43 x 100 = 20.96 % (21%)	1 1 1	Average titre = 24.36 or 24.37 lose 1 mark Average titre = 24.475 or 24.48 lose 1 mark
(c)	Impurities/sample might be damp/not correct number of moles of water of crystallisation	1	Didn't dissolve completely/difficulty determining end point/side reactions/errors in burette readings

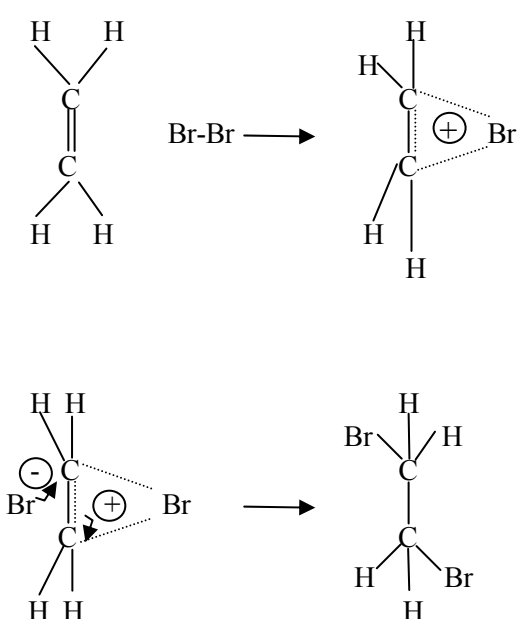| Question			Acceptable Answer	Mark	Unacceptable Answer
7	**(a)**	**(i)**	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^1/1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^{10}$	**1**	$[Ar]\ 3d^{10}\ 4s^1$
		(ii)	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^7/1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^7\ 4s^0$	**1**	$[Ar]\ 3d^7$
	(b)	**(i)**	$Cu^+\ (g) \longrightarrow Cu^{2+}\ (g)\ +\ e$	**1**	Omitting state symbols = 0 marks
		(ii)	The electron in copper is being removed from a <u>full d subshell</u>/ special stability associated with d^{10}. 3d orbital<u>s</u> are full. Full 3d energy level/full 3rd shell/ full d energy level/full set of d-orbital<u>s</u>	**1**	Full 3d level/full 3d shell/3d orbital is full Use of "shell" instead of "subshell"

Question			Acceptable Answer	Mark	Unacceptable Answer
8	**(a)**	**(i)**	Covalent (or polar covalent) in aluminium chloride /covalent molecular Ionic in magnesium chloride	**1**	Non-polar covalent/covalent network/covalent lattice
		(ii)	Al_2Cl_6 $(AlCl_3)_2$	**1**	$2AlCl_3$/dimer
	(b)		HCl/HCl(g)/hydrogen chloride/hydrochloric acid (gas)	**1**	H^+Cl^- (g)/ H^+Cl^-(aq)
	(c)		 Accept alternate double/single bonds in benzene ring C_6H_5 OK for (benzene ring) Also di- and poly-substituted	**1**	C_3H_7
	(d)	**(i)**	Different ionic radii of positive ions/Ratios of ionic radii are different/ Cs^+ ion bigger than Na^+	**1**	Na^+ bigger than Cs^+
		(ii)	NaCl as the ionic radius ratio of Fe:O is similar to that of Na:Cl. 6:6 as the ionic radius ratio of Fe:O is similar to that of Na:Cl. Explanation must mention ions or show changes.	**1**	Covalent radii Cs bigger than Na Difference instead of ratio

Question	Acceptable Answer	Mark	Unacceptable Answer
9 **(a)**	Lone pairs/electrons available to form dative covalent bonds	**1**	Unpaired electrons/negative charges
(b) **(i)**	III or 3 or 3+ or +3	**1**	-3
(ii)	Oxidising agent/to oxidise Cr(III)/electron acceptor	**1**	To provide oxygen
(c)	Hexacyanochromate(II)	**1**	Dashes/commas in middle of name

Question			Acceptable Answer	Mark	Unacceptable Answer
10	**(a)**	**(i)**	Esters	**1**	
		(ii)	Solvents, perfumes etc	**1**	To make things smell good
	(b)	**(i)**	3-methylbutan-1-ol	**1**	3-methylbut-1-ol
		(ii)	Condensation/esterification	**1**	

Question		Acceptable Answer	Mark	Unacceptable Answer
11	**(a)**	4 and 5	**1**	
	(b)	Structural fragment/section of a molecule which gives it pharmacological/biological activity/causes biological reaction or structural fragment/section of a molecule that binds to receptor/triggers response	**1**	Group of atoms/active part of drug functional group
	(c)	Agonist	**1**	

Question	Acceptable Answer	Mark	Unacceptable Answer
12 **(a)** **(i)**	Hydrolysis/Alkaline hydrolysis	**1**	Acid hydrolysis/substitution
(ii)	Hydrochloric acid/HCl/Conc HCl	**1**	Weak acid/acids
(iii)	Recrystallisation	**1**	
(iv)	7.02 g/7.03 g/7.0g	**1**	

Method 1

theoretical mass of benzoic acid $= \dfrac{4.0 \times 100}{70}$

$= 5.71$ g   **(1)**

$122 \longleftrightarrow 150$

$5.71 \longleftrightarrow \dfrac{150 \times 5.71}{122}$

$= 7.02$ g   (- 1 mark if no units)   **(1)**

Method 2

150 g $\longleftrightarrow 122$ g

$\dfrac{150 \times 4.0}{122} \longleftrightarrow 4.0$ **(1)**

$= 4.92$

mass required $= \dfrac{4.92 \times 100}{70}$

$= 7.03$ g   (- 1 mark if no units)   **(1)**

Other methods acceptable but deduct 1 mark if wrong GFM which may give correct final answer

Question		Acceptable Answer	Mark	Unacceptable Answer
(b)	**(i)**	Dehydration/elimination/cracking	**1**	
	(ii)	Need all 3 dotted lines $\oplus$ charge must be inside the triangle	**1**	
		Curly arrows not required.	**1**	Br^+ attacking the intermediate $Br°$ attacking the intermediate Br attacking the intermediate

Question			Acceptable Answer	Mark	Unacceptable Answer
13	(a)	(i)	3.52 g CO_2 contains 0.96 g C		
			1.44 g H_2O contains 0.16 g H	1	Deduct maximum of 1 if correct but no units given
			(both required for 1 mark)	1	
			therefore 0.64 g O		
		(ii)	C H O		
			$\dfrac{0.96}{12}$ $\dfrac{0.16}{1}$ $\dfrac{0.64}{16}$		
			$\dfrac{0.08}{0.04}$ $\dfrac{0.16}{0.04}$ $\dfrac{0.04}{0.04}$	1	
			2 4 1		
			C_2H_4O		
	(b)		$C_4H_8O_2$ $(C_2H_4O)_2$	1	$2C_2H_4O$
	(c)	(i)	$$CH_3 - CH_2 - CH_2 - \overset{\displaystyle O}{\overset{\|}{C}} - O - H$$ Butanoic acid	1	Methyl propanoate + correct structure = 0 Propyl methanoate + correct structure = 1
		(ii)	Standard <u>reference</u> substance/for comparison purposes	1	To be a standard/to ensure that the equipment is working properly

[END OF MARKING INSTRUCTIONS]