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2012 Chemistry

Advanced Higher

Finalised Marking Instructions

Chemistry Advanced Higher

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^0/J K^{-1} mol^{-1}
C_2H_2	201
HCl	187
CH_2ClCH_2Cl	208

   Using $\Delta S^0 = S^0{}_{reactants} - S^0{}_{products}$ 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:

$$
\begin{array}{c}
\quad\;\; H \quad\;\;\; H \qquad\quad O \\
\quad\;\; | \quad\;\;\; | \qquad\quad \| \quad\; | \\
H - C - C - O - C - C - H \\
\quad\;\; | \quad\;\;\; | \qquad\qquad\; | \\
\quad\;\; H \quad\;\;\; H \qquad\qquad H
\end{array}
$$
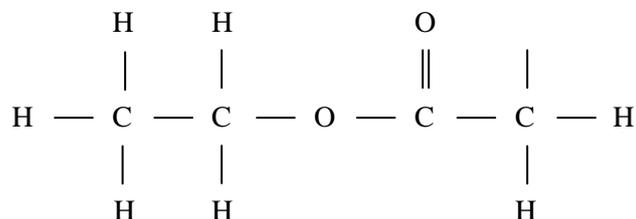
Would not be penalised as the structural formula for ethyl ethanoate.

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

Example:

$$
\begin{array}{c}
\quad\;\; H \quad\;\;\; H \qquad\quad O \\
\quad\;\; | \quad\;\;\; | \qquad\quad \| \\
H - C - C - O - C - C - H \\
\quad\;\; | \quad\;\;\; | \qquad\qquad\; | \\
\quad\;\; H \quad\;\;\; H \qquad\qquad H
\end{array}
$$
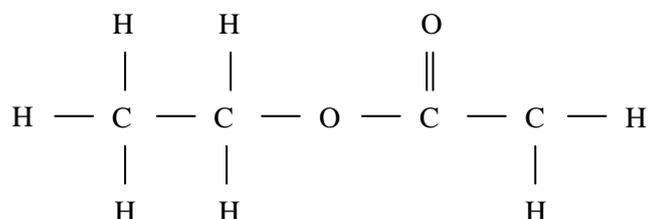
12 If a structural formula is asked for, CH_3- and CH_3CH_2- are acceptable as methyl and ethyl groups respectively.

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

$$
\begin{array}{c}
\;\; | \quad\;\; | \\
- C - C - \\
\;\; | \quad\;\; | \\
OH
\end{array}
$$
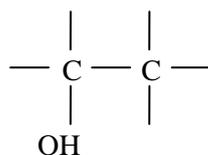
15 A symbol or correct formula should be accepted in place of a name **unless stated otherwise in the marking scheme**.

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.

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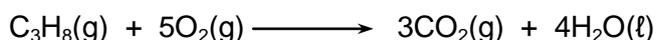
Name the kind of enthalpy change which the student measured.

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.

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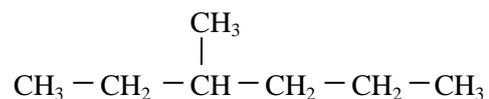
Name the hydrocarbon.

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.

2012 Chemistry Advanced Higher

Marking scheme

Section A

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

Section B   (Penalise only up to a maximum of 2 marks for wrong/missing units and penalise up to a maximum of 2 marks for sig figs but only penalise once per question)

Question	Acceptable Answer	Mark	Unacceptable Answer
1 (a) (i)	$E = \dfrac{Lhc}{\lambda}$ $= \dfrac{(6 \cdot 02 \times 10^{23}) \times (6 \cdot 63 \times 10^{-34}) \times (3 \cdot 00 \times 10^{8})}{1000 \quad \times \quad 405 \times 10^{-9}}$ $= 296$ (kJ mol^{-1}) Accept 295·6 to 296 (max 5 sig figs) Correct answer only gets 2 marks, but if outwith above range then 0 marks If L omitted, $E = 4 \cdot 91 \times 10^{-22}$ (1 mark only) Units not required but if wrong units given, then deduct 1 mark	**1** **1**	If use $L = 6 \times 10^{23}$ then get $E = 294 \cdot 67$ (deduct this mark so get 1 mark out of 2) $4 \cdot 91 \times 10^{-19}$ (missing out L and 1000) 0 marks out of 2
(ii)	$1s^2\ 2s^2 2p^6\ 3s^2 3p^6 3d^{10} 4s^0$ Accept numbers on line or subscripts but must read correctly Accept capitals [Ne] $3s^2\ 3p^6\ 3d^{10}$ with or without any brackets Correct orbital box notation	**1**	[Ar]$3d^{10}$
(b)	Photovoltaic effect / photoconductive Incorrect spelling – markers discretion but must be almost right (photo and volt minimum)	**1**	Photoelectric, PV
(c)	Positive holes, +ve hole(s)	**1**	Electrons / Holes
		(5)	

Question			Acceptable Answer	Mark	Unacceptable Answer
2	**(a)**	**(i)**	5 or V or (V) , +5, 5+		Minus values
		(ii)	3 or III or (III), +3, 3+ If (i) and (ii) not given, answers must be in correct order	**1**	
	(b)		$2HNO_2$ + $4H^+$ + $4e^-$ → $H_2N_2O_2$ + $2H_2O$ (Accept multiples and submultiples) State symbols not required and ignore wrong state symbols Negative sign on e can be omitted	**1**	
	(c)		Dicyanocuprate(I) / (i) / (1) brackets not needed Dicyanocupprate(I) Ignore spaces, dashes, commas and capitals	**1**	Dicyanocuprate Bicyanocuprate(I) Dicyanocopperate(I) Dicyanocupparate(I)
				(3)	

	Question	Acceptable Answer	Mark	Unacceptable Answer
3	**(a)**	The relative radii of the ions. The relative size of the ions. The radius ratio of the ions. Relative ionic radii of the elements Size of ionic radii in relation to each other Upside down ratio acceptable (r+ve/r-ve or r–ve/r+ve)	1	The radius of the ions Relative ionic radii of the **atoms** Mention of covalent radii Size **difference** Size **comparison** Closeness of packing
	(b)	Each sodium ion has six chloride ions surrounding it and each chloride ion has six sodium ions surrounding it. Each sodium ion / +ve ion has six chloride ions / -ve ions surrounding it and vice-versa Symbols instead of names would be fine, eg, Na ion	1	Each sodium ion has six chloride ions surrounding it Mention of atoms instead of ions (unless already penalised in part (a) Answers such as one sodium **bonded** to 6 chlorides or **attached** or **bound or similar.** However **attracted** to would be acceptable Na^- and Cl^+ Chlor**ine** ion unless chlor**ide** also stated somewhere in the answer.
	(c)	Potassium fluoride, accept fluoride on its own, KF, K^+F^-, F^-	1	Wrong formula, flouride, fluride, wrong charges, fluor**ine**, F_2, F, KF_2
	(d) **(i)**	Lattice enthalpy and hydration / solvation enthalpies/enthalpy / energies (of the ions). Ignore 'making' or 'formation'	1	
	(ii)	The entropy change is positive/positive entropy/increase in entropy/increase in disorder / ΔS positive	1	Entropy/entropy change/high entropy ΔG^o negative on its own but not a cancelling error, but if $\Delta G^o = 0$ then it will be a cancelling error.
			(5)	

Question		Acceptable Answer	Mark	Unacceptable Answer
4	**(a)**	Trigonal (planar) / correctly drawn structure	**1**	Triangular
	(b)	Oxygen donates/provides a (free/lone) pair of electrons (to boron) or correct idea that both electrons have come from the oxygen – must state that electrons come from the oxygen	**1**	Oxygen donates electrons to boron Boron donates the electrons Oxygen acts as a ligand General statement about dative covalent bond formation Positive boron – can be a cancelling error
	(c)	Cyclic ethers or ether(s) or furans or cycloethers, hydrofuran Ignore spaces, dashes, commas	**1**	Aromatic ether
			(3)	

Question	Acceptable Answer	Mark	Unacceptable Answer
5 **(a)**	No of moles thiosulphate 15·25 x 0·102/1000 = 1·56 x 10^{-3} so moles Cu^{2+} = 1·56 x 10^{-3} Mass Cu per sample = 63·5 x1·56 x 10^{-3} = 9·88 x 10^{-2} Mass of Cu in key = 9·88 x 10^{-2} x 1000/25 = 3·95g (Accept 3·96 g) Deduct 1 mark per error (multiply first answer by 2540 for FT for 2 marks)	1 1 1	4 g (2 out of 3 marks) 3·87 g or 3·88 g (2 out of 3 marks – used 0.1 instead of 0.102) 4.015 g (2 out of 3 marks – averaging all three titres) 7·88 g or 7·9 g worth 2 out of 3 (wrong ratio) <u>Deduct 1 mark if wrong or missing units</u>
(b)	Use distilled/ deionised water. Rinsings. (Start with different samples from the key and) carry out replicates / duplicates. Cover beaker with watch glass when key is being dissolved Increase sample size for titration	1	More titrations / More samples Measure the 10 g of KI accurately Use a more accurate balance
(c)	EDTA complexes with Cu (and Ni) Other interfering metal ions EDTA complexing with something else/impurities Error in EDTA concentration	1	Impurities on its own Mechanical losses/mass transfer losses EDTA solution too concentrated Any answer relating to poor experimental technique
		(5)	

Question		Acceptable Answer	Mark	Unacceptable Answer
6	**(a)**	Separating funnel/separation funnel/separatory funnel	**1**	Unlabelled diagram Hirsch or Buchner or dropping funnel Separating flask/tube
	(b)	Accept 0·127 − 0·130/0·13	**1**	Reciprocal of correct answer gives 7·7
	(c)	Different temperature List of possible answers including different temperature One of the solutions may be saturated System hadn't reached equilibrium (before separation)	**1**	Chemicals have "gone off" Solvent evaporated - on its own
	(d)	Ethanol and water are miscible Ethanol soluble in water Two layers won't be formed	**1**	Ester formation Ethanol reacts with water on its own is not acceptable but not a cancelling error
			(4)	

Question	Acceptable Answer	Mark	Unacceptable Answer
7 **(a)**	$pH = \frac{1}{2}pK_a - \frac{1}{2}\log c$ *or* $c = \dfrac{\sqrt{[H^+]^2}}{K_a}$ or $2.5 = \frac{1}{2} \times 4.76 - \frac{1}{2} \log c$ $= \dfrac{\sqrt{(10^{-2.5})^2}}{1.7 \times 10^{-5}}$ $c = 5.75 \times 10^{-1}$ mol l^{-1} / M(0.575) $= 0.575$ mol l^{-1} $(0.588$ mol $l^{-1})$ Accept 0.58 or 0.59 mol l^{-1}	1 1	Wrong relationship = wrong principle = 0 marks Deduct 1 mark for missing units in final answer (or wrong units – look out for mol^{-1}, deduct 1 mark)
(b)	Because of the (dark) colour of vinegar or words to that effect, eg the colour change would be hard to see	1	
(c)	CH_3COO^- or correct structural formula or $C_2H_3O_2^-$ Superscripted numbers – accept as slip, except if before the charge states (aq) acceptable	1	
		(4)	

Question	Acceptable Answer	Mark	Unacceptable Answer
8 **(a)**	"Temperatures **below** 2000 K" or 0 - 2000 K 500-2000 K no other range other than 0 or 500 – 2000 K	1	2000 K or temperatures above 2000 K Temps below 2000 °K Any single temperature
(b)	Slope of line is- ΔS or $2C + O_2 \rightarrow 2CO$ has increase in entropy or or 1 mole gas makes two moles gas or increase in disorder or ΔS is positive	1	Decrease in entropy As temperature increases, feasibility increases Answer in terms of feasibility **only** but acceptable to have a correct answer followed by mention of feasibility Exothermic reaction so favoured by lower temperature
(c)	Boiling point of Mg/Change of state/magnesium becomes a gas	1	Melting point of Mg
		(3)	

Question	Acceptable Answer	Mark	Unacceptable Answer
9	$\Delta G = -nFE^{o}$ or $E^{o} = \dfrac{-\Delta G}{nF}$ (ignore standard state sign) Formula without negative sign, giving final answer as a negative value, then maximum = 2/3. (Ignore wrong lower case/upper case letters if values substituted correctly. However if this is all that is written, then 0 marks) $\dfrac{279 \cdot 8 \times 10^{3}}{2 \times 96,500}$ = 1·45 V(olts) Units must be given.	1 1 1	Using n = 1, get 2·89 V or 2·9 V (so 2 out of 3) 2·89 V or 2·9 V on its own (2) 2·89 or 2·9 (on its own) (1) (Deduct 1 mark per error) No relationship given, final answer = 1·56 V or 0·04 V (0) (E^{o} values used wrongly) If n = 4, get final answer of 0·7 V (2 out of 3) **but** may have got this by using the inverse of correct relationship – still 2 out of 3)
		(3)	

Question	Acceptable Answer	Mark	Unacceptable Answer
10 **(a)**	Zero or 0	**1**	'No' order
(b)	First or 1	**1**	
(c)	s^{-1} allow for follow through from wrong answer to (a) and (b) Adding (a) and (b) to get 2nd order gives $l\ mol^{-1}\ s^{-1}$ Adding (a) and (b) to get 3rd order gives $l^2\ mol^{-2}\ s^{-1}$ Adding (a) and (b) to get 4th order gives $l^3\ mol^{-3}\ s^{-1}$ In any order	**1**	
		(3)	

	Question		Acceptable Answer	Mark	Unacceptable Answer
11	**(a)**	**(i)**	Hydrogen or H_2	**1**	H on its own
		(ii)	Hydrogen chloride or HCl or hydrochloric acid	**1**	Chlorine/name of any other gas
	(b)	**(i)**	acid chloride, carboxylic acid chloride / acyl chloride	**1**	Chloride Aryl chloride / alkanoic acid chloride / unsaturated acid chloride
		(ii)	 $C_6H_5COOCH(CH_3)_2$ (C_6H_5 must be aromatic)	**1**	"Benzene ring" without delocalised electrons or alternate double/single bonds
		(iii)	Faster reaction/ More vigorous reaction/ greater yield/needs no catalyst/HCl produced instead of H_2O then no H_2O to hydrolyse the ester back into reactants/no equilibrium reached (in an open system)/produces HCl which can be sold as a by-product/lower temperature/reacts more readily	**1**	'Water not produced' / 'HCl is produced' on its own
				(5)	
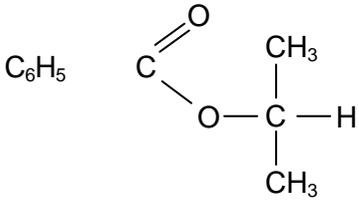
Question			Acceptable Answer	Mark	Unacceptable Answer
12	**(a)**		$C_8H_{14}S_2O_2$ (acceptable in any order).	**1**	
	(b)	**(i)**	The carbon atom where the tail joins the ring. Structure may be slightly wrong or only part-drawn but correct carbon must be circled	**1**	
		(ii)	It has four different atoms or groups (things/substituents) attached to it. It is a chiral centre/it is asymmetric The "tail" and hydrogen atom attached to that carbon atom can each be in front of or behind the plane of the ring. Chiral (carbon)	**1**	4 different molecules...... 4 different functional groups
				(3)	

	Question	Acceptable Answer	Mark	Unacceptable Answer
13	**(a)**	To prevent evaporation or idea of products or reactant or gases or chemicals escaping To reduce smell. Ethyl benzoate/ethanol / it is flammable/combustible/inflammable	1	To get a higher % yield (not cancelling)
	(b)	(Alkaline) hydrolysis/hydrolysing	1	Acid hydrolysis.
	(c)	A few glass beads or anti-bumping granules.	1	
	(d)	The oily layer disappears/no longer two layers/goes clear/lack of film/no more oily droplets/cloudy to colourless	1	Colour change
	(e)	$C_6H_5COOC_2H_5$ (150 g) $\rightarrow$ C_6H_5COOH (122 g) 5·64 g $\rightarrow$ **4·59** g 73·2 % of 4·59 g = **3·36 g** Or Using mol calculation, then get 0·0275 mol (1) Final answer = 3·36 g (as before) Units required	1 1	Final answer = 4·13 g (0) – have taken 73·2 % of 5·64
			(6)	

Question			Acceptable Answer	Mark	Unacceptable Answer
14	**(a)**	**(i)**	Electrophilic substitution.	**1**	Nucleophilic substitution/substitution
		(ii)	Aminobenzene/Phenylamine/Aniline or correct (structural) formula / $C_6H_5NH_2$	**1**	Molecular formula
	(b)	**(i)**		**1**	SO_3H attached to benzene ring C_6H_5 in place of benzene ring
		(ii)	 Accept all open or filled circles or x for electrons. Ignore partial charges. 24 electrons, 8 per atom	**1**	Lone pair on sulphur
				(4)	
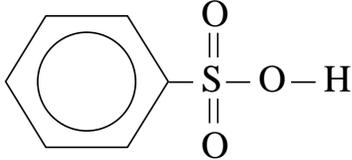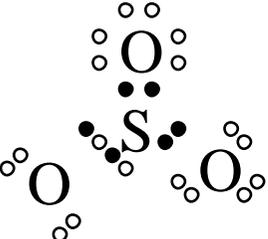
Question	Acceptable Answer	Mark	Unacceptable Answer
15 (a)	$CH_3CH_2CHClCH_3$ or	1	1-chlorobutane or any other isomer
(b)	Allow correct follow through from 1-chlorobutane in (a) Charge not required but negative charge acceptable in correct position Two dotted lines required in correct position Wedge not required	1	OH - - - Positive charge Negative charge on wrong position
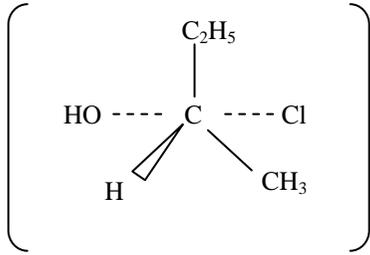
Question	Acceptable Answer	Mark	Unacceptable Answer
(c)	 Accept positions of 4·5 – 6·0 and 1·6 – 2·6 Height 3:1 TMS line optional Labels not required but scale needed on x-axis (1 mark for 2 lines only any position, any relative heights) Backwards scale No FT from (a)	**1** for positions **1** for heights	Wrong number of lines = 0
		(4)	

[END OF MARKING INSTRUCTIONS]