# 2013 Chemistry Revised

# Advanced Higher

# Finalised Marking Instructions

## Part One: General Marking Principles for Chemistry Revised 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 Revised 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 |

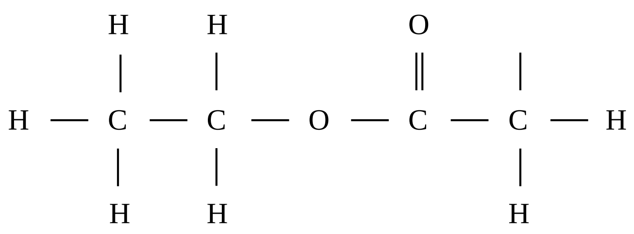
Using $\Delta S^{o} = S^{o}_{\text{reactants}} - S^{o}_{\text{products}}$ would gain zero marks.

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.

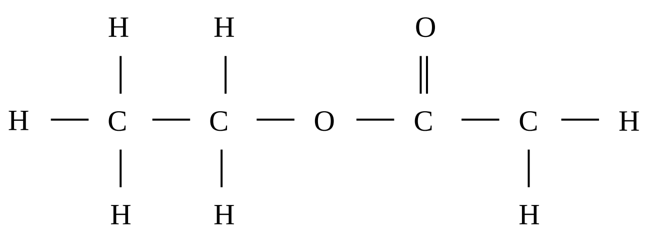
**Examples**:



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

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

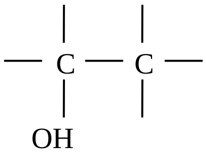
**Example**:



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.

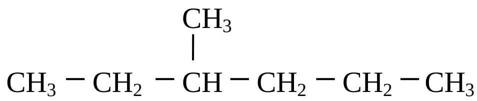
$$C_3H_8(g) + 5O_2(g) \longrightarrow 3CO_2(g) + 4H_2O(\ell)$$

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.

**Part Two: Marking Instructions for each Question**

**Section A**

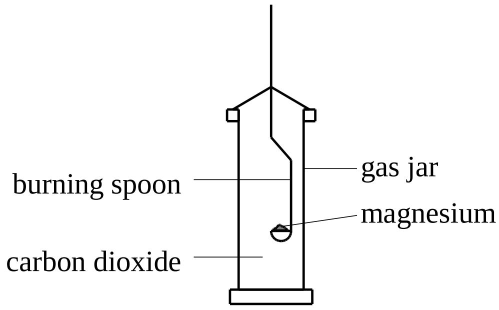
| Question | | | Acceptable Answer |
|---|---|---|---|
| **1** | | | **C** |
| **2** | | | **B** |
| **3** | | | **A** |
| **4** | | | **D** |
| **5** | | | **A** |
| **6** | | | **A** |
| **7** | | | **C** |
| **8** | | | **B** |
| **9** | | | **C** |
| **10** | | | **B** |
| **11** | | | **A** |
| **12** | | | **B** |
| **13** | | | **C** |
| **14** | | | **A** |
| **15** | | | **D** |

| Question | | | Acceptable Answer |
|---|---|---|---|
| **16** | | | **C** |
| **17** | | | **D** |
| **18** | | | **A** |
| **19** | | | **B** |
| **20** | | | **D** |
| **21** | | | **C** |
| **22** | | | **D** |
| **23** | | | **A** |
| **24** | | | **D** |
| **25** | | | **B** |
| **26** | | | **D** |
| **27** | | | **C** |
| **28** | | | **A** |
| **29** | | | **D** |
| **30** | | | **D** |

**Section B**

| Question | | | Acceptable Answer | Mark | Unacceptable answer |
|---|---|---|---|---|---|
| **1** | **a** | | The electronic configuration of a carbon atom is $1s^2 2s^2 2p^2$.<br><br>The electrons in the 2p orbitals are said to be “degenerate”.<br><br>What is meant by the term “degenerate”?<br><br>Equal energy/same energy | **1** | |
| **1** | **b** | | Draw the electronic configuration of a carbon atom in orbital box notation.<br><br><br>1s 2s 2p<br><br>Double headed arrows<br>Both 2p arrows facing down<br>No need to put in 1s etc | **1** | Lines not arrows<br>2p arrows facing in opposite directions |
| **1** | **c** | | Explain what is thought to take place when carbon atoms form four equivalent single bonds in methane.<br><br>A mixing/merging/combining of one s orbital and three p orbitals/$sp^3$ hybridisation **1**<br><br>To form **four degenerate** (hybrid) orbitals/or acceptable diagram showing this<br><br>**Or**<br><br>An electron promoted from 2s to 2p orbital **1** | **2**<br><br>**(4)** | |

| Question | | | Acceptable Answer | Mark | Unacceptable answer |
|---|---|---|---|---|---|
| **2** | | | Burning magnesium continues to burn when placed in a gas jar of carbon dioxide according to the equation.<br><br>$2Mg(s) + CO_2(g) \rightarrow 2MgO(s) + C(s)$ | | |

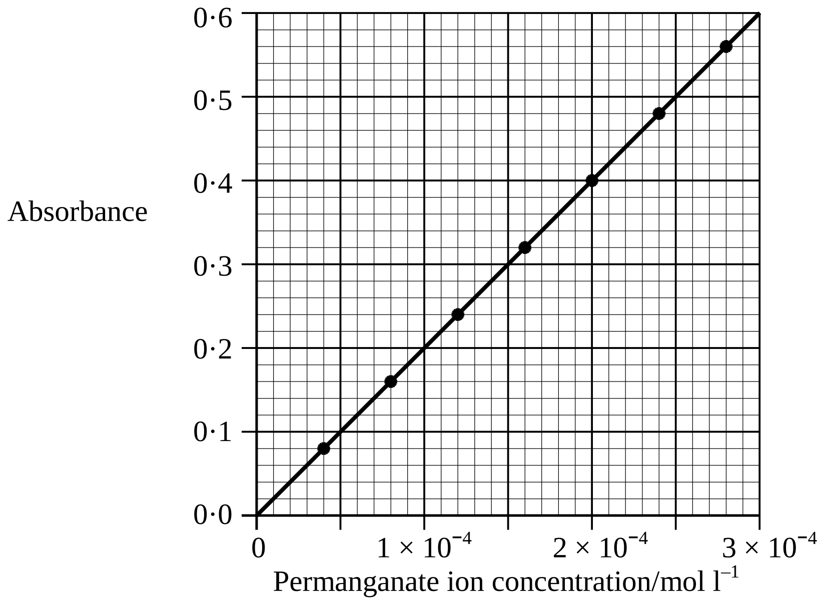



| substance | $S^o$/JK$^{-1}$ mol$^{-1}$ |
|---|---|
| Mg(s) | 33·0 |
| $CO_2(g)$ | 214 |
| MgO(s) | 27·0 |
| C(s) | 5·70 |

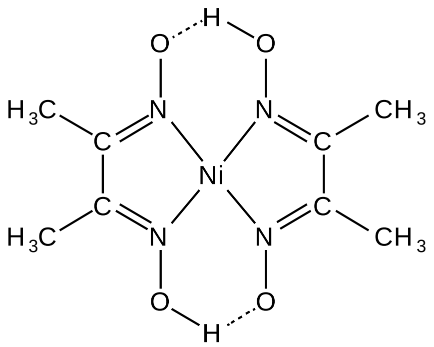
| Question | | | Acceptable Answer | Mark | Unacceptable answer |
|---|---|---|---|---|---|
| **2** | **a** | | Using the values from the table above, calculate $\Delta S^o$ for the reaction.<br><br>$-220{\cdot}3$ J K$^{-1}$ (mol$^{-1}$) or $-0{\cdot}2203$ kJ K$^{-1}$ (mol$^{-1}$)<br><br>$-220$ J K$^{-1}$ (mol$^{-1}$) or $-0{\cdot}220$ kJ K$^{-1}$ (mol$^{-1}$)<br><br>Max of 5 sig figs | **1** | No units or wrong units such as J k$^{-1}$ mol$^{-1}$ or j K$^{-1}$ mol$^{-1}$<br><br>negative sign missing |
| **2** | **b** | | Using the information below and your answer to (a), calculate $\Delta G^o$ for the burning of magnesium in carbon dioxide.<br><br>$Mg(s) + \frac{1}{2}O_2(g) \rightarrow MgO(s)$ $\Delta H^o = -493$ kJ mol$^{-1}$<br><br>$C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H^o = -394$ kJ mol$^{-1}$<br><br>**Correct follow through from wrong answer in (a) can get 3 marks in (b)**<br><br>$\Delta H^o = -592$ kJ mol$^{-1}$ or 296 (kJ mol$^{-1}$) **1**<br><br>$\Delta G^o = \Delta H^o - T\Delta S^o$ (or without standard signs) **1**<br><br>= **$-526{\cdot}35$** kJ (mol$^{-1}$) or kJ)<br>(Accept $-526$ (kJ mol$^{-1}$), $-526{\cdot}4$ kJ mol$^{-1}$) **1** | **3**<br><br>**(4)** | |

<table>
<tr><th colspan="3">Question</th><th>Acceptable Answer</th><th>Mark</th><th>Unacceptable answer</th></tr>
<tr><td>3</td><td></td><td></td><td>
A student measured the pH of water at various temperatures using a pH meter and obtained the following results.<br><br>
<table>
<tr><th>Temperature/ °C</th><th>pH</th></tr>
<tr><td>20</td><td>7·08</td></tr>
<tr><td>30</td><td>6·92</td></tr>
<tr><td>50</td><td>6·63</td></tr>
</table><br>
The student was unsure whether the results were accurate or if the pH meter was faulty.<br><br>
Using your knowledge of chemistry, discuss possible reasons for the results obtained.<br><br>
This is an open ended question<br><br>
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.<br><br>
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.<br><br>
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.
</td><td>3<br><br>(3)</td><td>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.</td></tr>
</table>

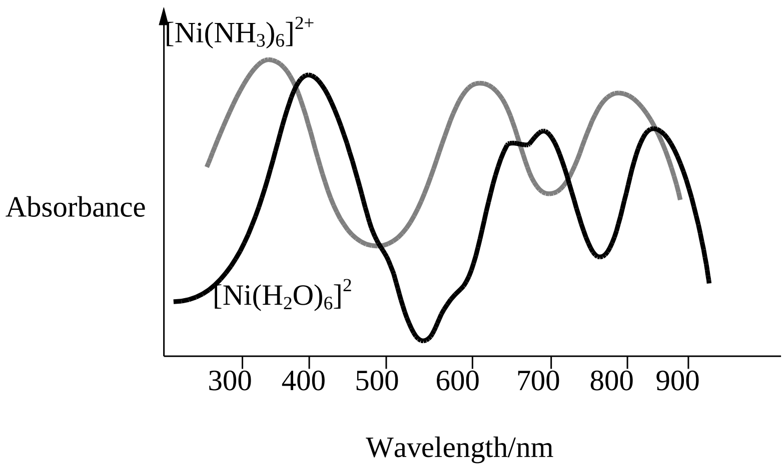
| Question | | | Acceptable Answer | Mark | Unacceptable answer |
|---|---|---|---|---|---|
| **4** | | | The manganese content of a steel paperclip can be determined by oxidising the manganese firstly into manganese(II) ions and then to the purple permanganate ion. Colorimetry is then used to find the concentration of the permanganate ion, from which the percentage manganese in the steel paperclip can be determined. | | |
| **4** | **a** | | What data must be collected to allow the calibration graph to be drawn?<br><br>A series of standard solutions of different concentrations of $KMnO_4$ is made up and their absorbances measured.<br>Absorbances of permanganate solution**s** of known concentration**s**/variety of concentration**s**<br>(must mention permanganate or manganate or purple solutions)<br>Accept absorbancy/absorption/transmittance/transmission | **1** | Intensity of radiation/adsorption |
| **4** | **b** | | Which colour of filter or wavelength of light should be used in this procedure?<br><br>Green or 500 to 560 nm<br>(Accept blue-green or green-yellow) | **1** | Complementary colour |

| Question | | | Acceptable Answer | Mark | Unacceptable answer |
|---|---|---|---|---|---|
| **4** | **c** | | In a determination, the manganese in 0·245 g of steel was oxidised to permanganate ions and the solution made up to 100 $cm^3$ in a standard flask. The absorbance of the solution was measured as 0·26.<br><br>Use this information and the following calibration graph to calculate the percentage of manganese in this sample of steel.<br><br><br><br>(Absorbance = 0·26) so $[MnO_4^-]$ = 13 × $10^{-5}$ (mol $l^{-1}$) **1**<br><br>In 100 $cm^3$, n = 1·3 × $10^{-5}$ mol<br>mass of Mn = 1·3 × $10^{-5}$ × 54·9 = 0·0007137 **1**<br><br>% Mn = (0·0007137/0·245) × 100 = 0·29 % **1** | **3** | |

| Question | | | Acceptable Answer | Mark | Unacceptable answer |
|---|---|---|---|---|---|
| **4** | **d** | | Colorimetry is not used to determine potassium content because potassium ions are not coloured. The concentration of potassium ions in a compound can be determined using atomic absorption spectroscopy at a wavelength of 405 nm.<br><br>Calculate the energy, in kJ $mol^{-1}$, of this radiation.<br><br>$E = \frac{Lhc}{\lambda}$ or $E = \frac{Lhc}{1000\lambda}$ **1**<br><br>= 296 or 295·6 or 295·64 or 295·65 (kJ $mol^{-1}$) **1** | **2**<br><br>**(7)** | |

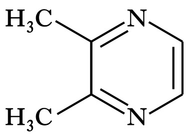
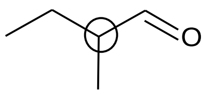
| Question | | | Acceptable Answer | Mark | Unacceptable answer |
|---|---|---|---|---|---|
| **5** | | | Nickel(II) ions react quantitatively with dimethylglyoxime ($C_4H_8O_2N_2$) forming a complex which precipitates out as a red solid. The equation for the reaction and the structure of the complex are shown below.<br><br>$Ni^{2+} + 2C_4H_8O_2N_2 \rightarrow Ni(C_4H_7O_2N_2)_2 + 2H^+$<br><br><br><br>Relative formula mass = 288·7 | | |
| **5** | **a** | | What is the coordination number of nickel in the complex?<br><br>4 or four | **1** | |
| **5** | **b** | | When 0·968 g of an impure sample of nickel(II) sulfate, $NiSO_4.7H_2O$, was dissolved in water and reacted with dimethylglyoxime, 0·942 g of the red precipitate was formed.<br><br>Calculate the percentage, by mass, of nickel in the impulse sample of nickel(II) sulfate.<br><br>Mass of nickel in DMG complex<br>= 0·942 × (58·7/288·7) = 0·1915 g or 0·192 g **1**<br><br>% Ni in impure salt = (0·1915/0·968) × 100 = 19·8 % **1**<br>(Accept 19·79 % and 19·786 % and 19·835 % or 19·83 %)<br><br>(Deduct 1 mark per error up to a maximum of 2 marks) | **2** | 20·9 % (%Ni in pure salt)<br>20·3 % use of 0·968 instead of 0·942 in first line<br><br>Use of AN in place of RAM (0) |

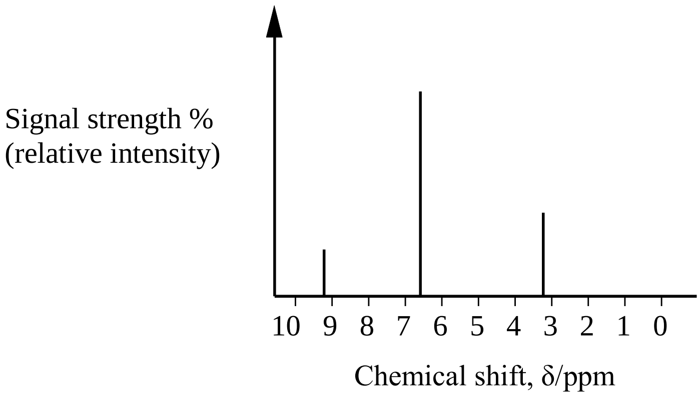
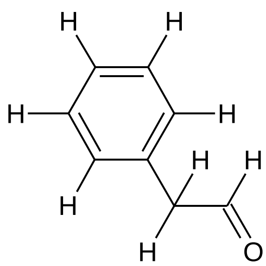
| Question | | | Acceptable Answer | Mark | Unacceptable answer |
|---|---|---|---|---|---|
| 5 | c | | The formulae of two very common ions of nickel are $[Ni(H_2O)_6]^{2+}$ and $[Ni(NH_3)_6]^{2+}$. | | |
| 5 | c | i | Name the complex ion $[Ni(H_2O)_6]^{2+}$.<br><br>Hexaaquanickel(II) | 1 | Hexaquanickel(II)<br>Hexaaquonickel(II)<br>Hexaaquanickel(2) |
| 5 | c | ii | In terms of s, p and d orbitals, write down the electronic configuration of the nickel ion in $[Ni(H_2O)_6]^{2+}$.<br><br>$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^8$<br><br>$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^8 4s^0$ | 1 | $[Ar]\ 3d^8$ |
| 5 | d | | The relative ability of a ligand to split the d-orbitals when forming a complex ion is given in the spectrochemical series. Three ligands from this series and their relative ability to split the d-orbitals are shown below.<br><br>$NH_3 > N_2O > Cl^-$<br><br>The absorption spectra for $[Ni(H_2O)_6]^{2+}$ and $[Ni(NH_3)_6]^{2+}$ are shown on the following page. | | |



| Question | | | Acceptable Answer | Mark | Unacceptable answer |
|---|---|---|---|---|---|
| **5** | **d** | **i** | Why is $[Ni(H_2O)_6]^{2+}(Cl^-)_2(aq)$ likely to be green?<br><br>Red and blue are absorbed/green light transmitted or not absorbed<br><br>Light of approx. 500 – 600 nm transmitted/not absorbed | **1** | Absorbs wavelength complementary to the wavelength of green |
| **5** | **d** | **ii** | Explain why the peaks in the absorption spectrum of $[Ni(NH_3)_6]^{2+}$ are at shorter wavelengths.<br><br>$NH_3$ results in greater ligand field splitting which means that more energy is needed to promote electron. Since $E \propto \frac{1}{\lambda}$ **1**<br>the wavelength of light absorbed will be less **1**<br><br>d-orbitals split more or similar statement for 1st mark<br><br>Correct tie in with energy and wavelength for 2nd mark | **2** | |
| **5** | **d** | **iii** | Predict the colour of $[Ni(NH_3)_6]^{2+}(Cl^-)_2(aq)$.<br><br>Purple/blue-green/blue/blue-violet | **1**<br><br>**(9)** | |

| Question | | | Acceptable Answer | Mark | Unacceptable answer |
|---|---|---|---|---|---|
| **6** | | | Propanoic acid is a weak acid. Sodium propanoate is a salt which can be formed from it. Both propanoic acid and sodium propanoate can be used as mould inhibitors. | | |
| **6** | **a** | | Calculate the pH of 0·10 mol $l^{-1}$ propanoic acid solution.<br><br>pH = ½ $pK_a$ − ½ log c **1**<br><br>= 2·935 or 2·94 or 2·9 **1**<br><br>Max of 4 sig figs | **2** | Wrong relationship = 0 marks |
| **6** | **b** | | 0·20 moles of sodium propanoate are added to 100 $cm^3$ of the 0·10 mol $l^{-1}$ solution of propanoic acid.<br><br>Calculate the pH of the buffer solution formed.<br><br>$pH = pK_a - \log\frac{\text{acid}}{\text{salt}}$ **1**<br><br>= 6·171 or 6·17 or 6·2 **1** | **2**<br><br>**(4)** | Wrong relationship = 0 marks |

| Question | | | Acceptable Answer | Mark | Unacceptable answer |
|---|---|---|---|---|---|
| **7** | | | The dominant flavours of chocolate are due to molecules called substituted pyrazines. These are produced when sugars and amino acids react during the roasting of cocoa beans.<br><br>An example is 2,3-dimethylpyrazine<br><br><br><br>This compound is responsible for the nutty flavour of chocolate. Other substances responsible for the distinctive smell of chocolate are aldehydes including phenylethanal, 2-methylbutanal and 3-methylbutanal. | | |
| **7** | **a** | | Write the molecular formula for 2,3-dimethylpyrazine.<br><br>$C_6H_8N_2$ | **1** | |
| **7** | **b** | | Draw a skeletal formula for 2-methylbutanal and circle the asymmetric carbon present.<br><br><br><br>1 mark for drawing the formula correctly<br>1 mark for circling the correct carbon | **2** | Structural formula showing all the carbons unacceptable for 1$^{st}$ mark but can still get 2$^{nd}$ mark |

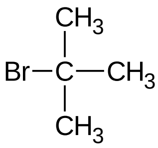
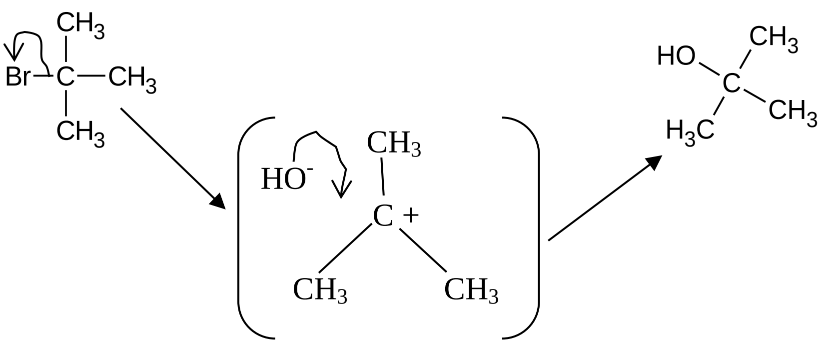
| Question | | | Acceptable Answer | Mark | Unacceptable answer |
|---|---|---|---|---|---|
| **7** | **c** | | The low resolution proton NMR spectrum shown is that of one of the aldehydes in chocolate.<br><br><br>Explain which of the three aldehydes above would give this proton NMR spectrum.<br><br>Phenylethanal **1**<br><br>$2^{nd}$ mark for correct explanation such as:<br><br>3 peaks since there are 3 different proton environments.<br>3·2 ppm protons adjacent to carbonyl carbon<br>6·7 ppm aromatic protons<br>It has the correct ratio for hydrogens **1**<br>5:1 ratio of the largest to smallest | **2** | |

| Question | | | Acceptable Answer | Mark | Unacceptable answer |
|---|---|---|---|---|---|
| **7** | **d** | | Anandamide is another substance also found in small quantities in chocolate, that plays a role in appetite, memory, fertility and pain depression. It binds to the same receptors as the cannabinoid drugs and enhances some of the body's natural responses.<br><br>What general term is used for substance that behaves in this way?<br><br>Agonist | **1**<br><br>**(6)** | |

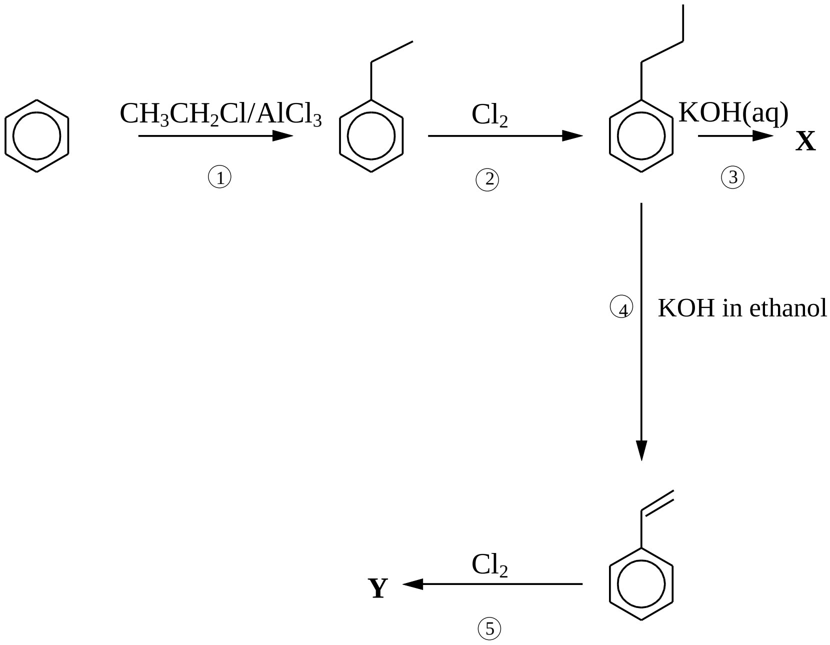
| Question | | | Acceptable Answer | Mark | Unacceptable answer |
|---|---|---|---|---|---|
| **8** | | | A kinetics study was carried out on the reaction between a haloalkane, $C_4H_9Br$, and aqueous sodium hydroxide.<br><br>$C_4H_9Br + NaOH \rightarrow C_4H_9OH + NaBr$<br><br>The following results were obtained. | | |

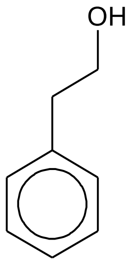
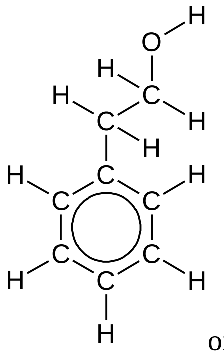
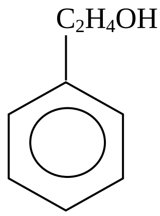
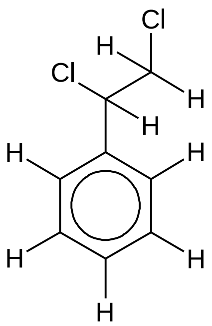
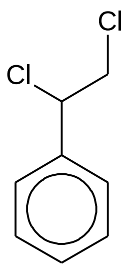
| $[C_4H_9Br]$/mol $l^{-1}$ | [NaOH]/mol $l^{-1}$ | Initial Rate/mol $l^{-1}s^{-1}$ |
|---|---|---|
| $8{\cdot}0 \times 10^{-4}$ | 0·10 | 0·15 |
| $1{\cdot}6 \times 10^{-3}$ | 0·10 | 0·30 |
| $1{\cdot}6 \times 10^{-3}$ | 0·20 | 0·30 |
| $3{\cdot}2 \times 10^{-3}$ | 0·40 | 0·60 |

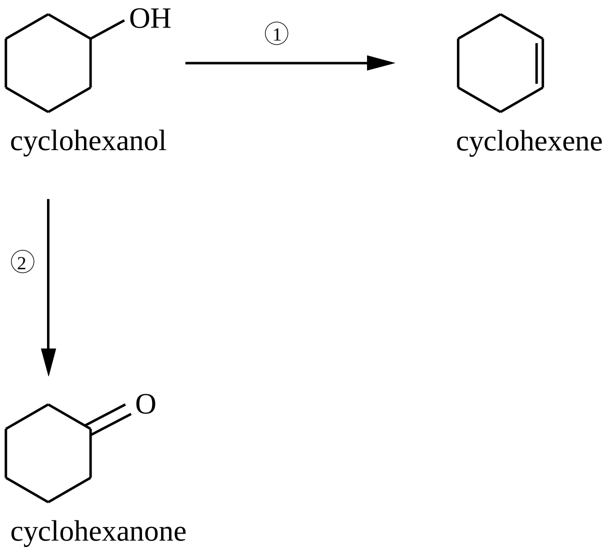
| Question | | | Acceptable Answer | Mark | Unacceptable answer |
|---|---|---|---|---|---|
| **8** | **a** | | What is the order of reaction with respect to | | |
| **8** | **a** | **i** | the haloalkane<br><br>First order | | |
| | **a** | **ii** | the sodium hydroxide?<br><br>Zero order | **1** | |
| **8** | **b** | | Write the rate equation for the reaction.<br><br>Rate = $k[C_4H_9Br]$ or Rate = $k[C_4H_9Br]^1\ [NaOH]^o$<br><br>(accept correct follow on from wrong answers in (a) | **1** | Round brackets (0)<br><br>No marks if K used in place of k |
| **8** | **c** | | Calculate a value for the rate constant, k, including the appropriate units.<br><br>k =Rate/$[C_4H_9Br]$ = $0{\cdot}15/8{\cdot}0 \times 10^{-4} = 187{\cdot}5\ s^{-1}$ **1**<br><br>1 mark for correct units. Accept 188 and 190 $s^{-1}$ **1**<br><br>(Don't penalise for K in place of k)<br><br>Correct follow through from (a) or (b) | **2** | Any wrong units, deduct 1 mark even if already lost 2 marks for units previously – except if correct due to follow through. |

| Question | | | Acceptable Answer | Mark | Unacceptable answer |
|---|---|---|---|---|---|
| **8** | **d** | | There are four structural isomers of $C_4H_9Br$.<br><br>Explain which isomer is likely to have been used.<br><br>The tertiary haloalkane or 2-bromomethylpropane or 2-bromo-2-methylpropane<br>Accept 2-methyl-2-bromopropane **1**<br><br><br>or any other correct structural formula<br><br>And<br><br>Correct explanation in terms of<br>Stability of carbocation or Steric hindrance **1** | **2** | Cancelling errors apply if correct structure and wrong name or vice-versa but accept "methy" as a slip if the structure is correct<br>But if only the name is given then do not accept errors such as "brom" or "methy"<br>2-methylbromopropane |
| **8** | **e** | | Outline the mechanism for this reaction using curly arrow notation.<br><br><br><br>carbocation intermediate<br><br>1 mark for reactant and for curly arrow showing heterolytic fission of C – Br bond **1**<br>1 mark for correct carbocation intermediate **1**<br>1 mark for 2nd curly arrow and final product **1** | **3**<br><br>**(9)** | |

| Question | | | Acceptable Answer | Mark | Unacceptable answer |
| --- | --- | --- | --- | --- | --- |
| **9** | **a** | | State one of the characteristics of a primary standard.<br><br>Fairly high molecular mass/available in high purity/ (thermodynamically) stable/soluble in water or named solvent/soluble | **1** | |
| **9** | **b** | | As a part of an AH Chemistry investigation, a student had to prepare a standard solution of sodium carbonate.<br><br>Outline how the student prepare this standard solution from pure sodium carbonate.<br><br>1. Accurately weigh required/correct mass of $Na_2CO_3$ and dissolve completely in small volume of water.<br>2. Transfer the solution to a standard flask, rinsing the beaker with deionised water and transferring the rinsing's to the flask.<br>3. Add deionised water up to the mark adding the last few drops with a dropper.<br>4. Invert to mix.<br><br>(Deduct 1 mark for each error/omission up to maximum of 2 marks) | **2** | |
| **9** | **c** | | Outline how 250 $cm^3$ of 0·20 mol $l^{-1}$ sodium carbonate solution would be prepared from a standard 1·00 mol $l^{-1}$ sodium carbonate solution.<br><br>$(M_1V_1 = M_2V_2)\ V = \frac{0{\cdot}2 \times 250}{1} = 50cm^3$<br><br>Measure $50cm^3$ of stock solution using a pipette and transfer to a $250cm^3$ standard flask. Add deionised water up to the mark, stopper and invert.<br>(1 for correct volume, 1 for correct procedure) | **2**<br><br>**(5)** | |

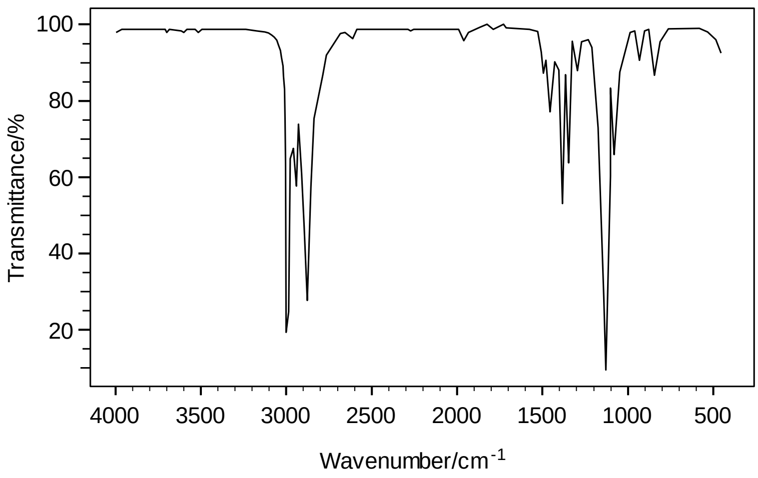
| Question | | | Acceptable Answer | Mark | Unacceptable answer |
|---|---|---|---|---|---|
| **10** | | | A student devised the following reaction sequence.<br><br> | | |
| **10** | **a** | | What type of reaction is taking place in step 1 ?<br><br>Electrophilic substitution/alkylation | **1** | Nucleophilic substitution<br>substitution<br>Electrophilic |
| **10** | **b** | | During step 2, chlorine firstly undergoes homolytic fission. Explain what this means.<br><br>Chlorine molecules have changed into chlorine radicals or chlorine atoms<br>or Chlorine has changed into chlorine radicals or chlorine atoms<br>or both atoms retain one electron from the covalent bond<br>or correct equation | **1** | |

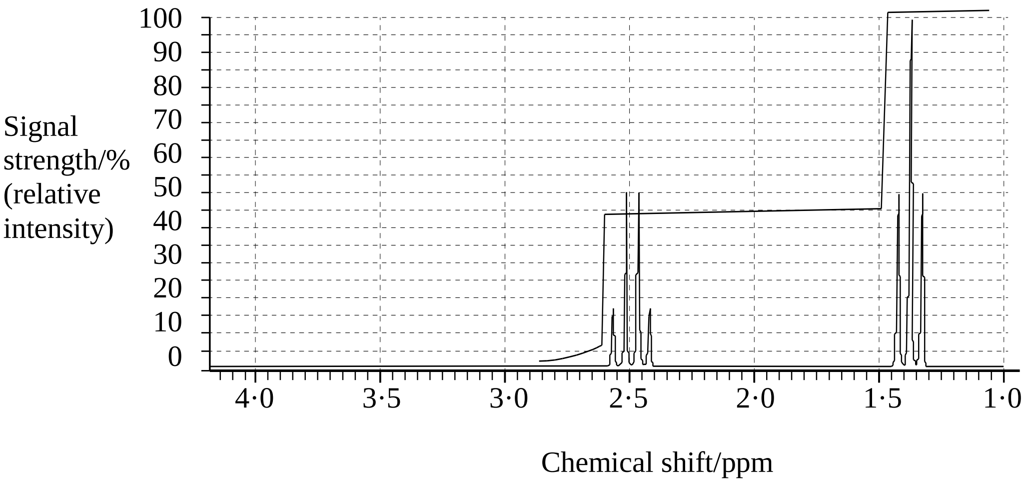
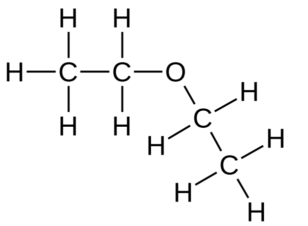
| Question | | | Acceptable Answer | Mark | Unacceptable answer |
|---|---|---|---|---|---|
| **10** | **c** | | Draw a structural formula for product **X**.<br> or  or any other correct SF. | **1** | <br>Ring missing or no alternate double/single bonds |
| **10** | **d** | | What type of reaction is taking place in step ④ ?<br><br>(base induced) Elimination | **1** | Acid induced elimination |
| **10** | **e** | | Draw a structural formula for product **Y**.<br> or <br>or $C_6H_5CHClCH_2Cl$<br>or any other correct structural formula | **1**<br><br>**(5)** | Ring missing or no alternate double/single bonds (0) marks unless already penalised in (c)<br><br>$C_6H_5CCl_2CH_3$ |

| Question | | | Acceptable Answer | Mark | Unacceptable answer |
|---|---|---|---|---|---|
| **11** | | | Cyclohexanol can be converted into cyclohexene or cyclohexanone using different reagents as outlined below.<br><br> | | |
| **11** | **a** | | Suggest a dehydrating agent that could be used to convert cyclohexanol into cyclohexene in reaction ①<br><br>Phosphoric acid<br>or/aluminium oxide<br>or (concentrated) sulphuric acid | **1** | Silica/anhydrous calcium chloride |

| Question | | | Acceptable Answer | Mark | Unacceptable answer |
|---|---|---|---|---|---|
| **11** | **b** | | In an experiment, a student obtained 3·14 g of cyclohexene from 4·36 g of cyclohexanol. | | |
| **11** | **b** | **i** | Calculate the percentage yield.<br><br>One mole cyclohexanol gives one mole cyclohexene<br>moles cyclohexanol = 4·36/100 = **0·0436** moles **1**<br>theoretical yield of cyclohexene = 0·0436 × 82<br>= **3·575 (g)** **1**<br>% yield = 3·14 × 100/3·575 = **87·8** (%) **1**<br><br>Using 0·44 mol, gives 3·608 g giving 87·029 or 87·03 (%) for 3 marks<br><br>Deduct 1 mark per error<br><br>Accept any answer between 87 and 88 (%) for 3 marks<br><br>Award 1 mark for both formula masses correct | **3** | Wrong FM, deduct 1 mark |
| **11** | **b** | **ii** | Give a reason why the yield is not 100%.<br><br>Impure starting materials/mechanical losses/mass transfer losses/reaction may not go to completion/side reactions/equilibrium reaction | **1** | |

| Question | | | Acceptable Answer | Mark | Unacceptable answer |
|---|---|---|---|---|---|
| 11 | c | | **Using your knowledge of chemistry**, comment on how it could be established that the product of reaction ②, is cyclohexanone.<br><br>This is an open ended question<br><br>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.<br><br>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.<br><br>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**<br><br>**(8)** | 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. |

| Question | | | Acceptable Answer | Mark | Unacceptable answer |
|---|---|---|---|---|---|
| 12 | | | 5·00 g of an organic compound **A** was burned completely producing 11·89 g of $CO_2$ and 6·08 g of $H_2O$ as the only products. | | |
| 12 | a | | **Using the information above**, calculate the empirical formula for compound **A**.<br><br>Mass of C = (12/44 × 11·9) = 3·243 g<br>Mass of H = (2/18 × 6·08) = 0·676 g<br>So mass of O = 5·00 − 3·243 − 0·676 = 1·081 g **1**<br>C : H : O<br>3·243 : 0·676 : 1·081<br><br>Ratio of moles 0·270 : 0·676 : 0·0676<br><br>4 : 10 : 1 **1**<br><br>Empirical formula $C_4H_{10}O$ **1** | 3 | Correct answer, no working = 1 mark |
| 12 | b | | The infra-red spectrum of compound **A** is shown below.<br><br><br><br><br>Which bond is responsible for the peak at 1140 $cm^{-1}$?<br><br>C-O (stretch) | 1 | |

| Question | | | Acceptable Answer | Mark | Unacceptable answer |
|---|---|---|---|---|---|
| **12** | **c** | | The mass spectrum of compound **A** shows the molecular ion to have a mass/charge ratio of 74. Deduce the molecular formula of compound **A**.<br><br>$C_4H_{10}O$ | **1** | |
| **12** | **d** | | The high resolution proton NMR spectrum of compound **A** is shown below.<br><br><br><br><br>Using all the above information, deduce the structural formula for compound **A**.<br><br><br><br>(accept skeletal or shortened structural formula of ethoxyethane) | **1**<br><br>**(6)** | |

[END OF MARKING INSTRUCTIONS]