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Examiners' Report
June 2010

GCSE Chemistry 6CH02

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June 2010

Publications Code US023630

Introduction

Section A of the paper contained questions that were found to be straightforward by the majority of candidates. The average mark for the multiple-choice component of the paper was just over 12/20. This mark was very similar to the average mark for the paper as a whole. The structured questions in Sections B and C also offered opportunities for candidates of all abilities to show their skills.

Question 19(b)

The majority of candidates answered this question well. A number of candidates, however, thought that an initial burette reading of 0.00 cm^3 meant that the burette was empty. It was also incorrect to state that titres 2, 3 and 4 were all within 0.05 cm^3 of each other.

(b) Explain why the mean titre should be based only on titrations 2, 3 and 4.

(1)

Because they all dyper from no more then 0.1 unlike titration 1 making them more reliable results.

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Examiner Comments

This candidate realised that titres 2, 3 and 4 were concordant, since they were within 0.1 cm^3 of each other.

(b) Explain why the mean titre should be based only on titrations 2, 3 and 4.

(1)

Titration 1 is usually a rough titre so is less accurate.

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Examiner Comments

Titre 1 is normally the "rangefinder", so answers such as this were, of course, acceptable.

Question 19(c)-(d)

Q19(c) proved straightforward for those who averaged the values of titres 2, 3 and 4. Some candidates averaged all four titres, despite having realised that titration 1 was a rangefinder. Other candidates averaged just two titre values. The five available marks for part (d) were accessed by many. However, some candidates found it challenging when "scaling up" was required in part (d)(iii). Consequential marking allowed many candidates to earn credit so long as their answers followed on logically from a previously incorrect response.

(c) Calculate the mean titre in cm^3.

(1)

$$\frac{27.95 + 28.05 + 28.00}{3} = 28.00\ cm^3$$

(d) (i) Using your answer to (c), calculate the number of moles of sodium hydroxide in the mean titre.

(1)

$$\text{No of moles} = \frac{\text{vol} \times \text{conc}}{1000} = \frac{28.00 \times 0.1}{1000}$$

$$= 0.0028 \text{ moles}$$

(ii) Hence state the number of moles of ethanoic acid, CH_3COOH, in 25.0 cm^3 of the **diluted** solution used in the titration.

(1)

1 mole of NaOH reacts with 1 mole of the acid

∴ there are 0.0028 moles in the diluted solution.

(iii) Calculate the concentration of the **diluted** acid solution in mol dm^{-3}.

(1)

N° of moles = $\frac{\text{vol} \times \text{conc}}{1000}$

conc = $\frac{\text{N° of moles} \times 1000}{\text{vol}}$

conc = 0·112 mol dm^{-3} (in the diluted acid soln)

(iv) Hence calculate the concentration of the ethanoic acid in the **original** vinegar solution in mol dm^{-3}.

(1)

The diluted soln is 10 times a dilute, ∴ the concentration in the original solution is: 0·112 × 10

concentration = 1·12 mol dm^{-3}

(v) Use your answer from (d)(iv) to state the concentration of the ethanoic acid in the **original** vinegar solution in units of g dm^{-3}.

[The molar mass of the ethanoic acid is 60 g mol^{-1}.]

(1)

1·12 moles weighs 60 × 1·12 = 67·2g

∴ there are 67·2g in 1 dm^3

∴ concentration = 67·2g dm^{-3}

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Examiner Comments

This is an excellent answer, with all parts correct.

Question 19(e)

The mark scheme allowed different ways of accessing the marks to (e). The majority of correct answers focused on the need to use a pipette or burette in order to measure out the volume of vinegar solution more accurately. A sizeable minority, however, confused the titration stage of the procedure with the step which was required by the question.

(e) Suggest, with a reason, how the student's method of preparing the diluted solution could be improved.

(2)

Improvement

A pipette could be used to measure the vinegar instead of a measuring cylinder.

Reason

A measuring cylinder is not accurate enough and a pipette is ~~most~~ more precise.

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Examiner Comments

This candidate is aware that a pipette is more accurate than a measuring cylinder to measure out the volume of solution required.

(e) Suggest, with a reason, how the student's method of preparing the diluted solution could be improved.

(2)

Improvement

Use a larger volume of vinegar.

Reason

This would reduce the amount of ~~reaction~~ uncertainty in the final result.

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Examiner Comments

This candidate did not appreciate that the question was focusing on how the volume of vinegar solution could be measured more accurately.

Question 19(f) (i)

The majority of candidates opted for X as the range for the true value of the titre of 27.95 cm^3. Candidates often did not appreciate that the titre was a difference between two burette readings and that, therefore, the error for each titre value was +/- 0.10 cm^3 overall. This made Z the correct range.

Question 19(f) (ii)

Although there were some vague responses to this question, many excellent answers were seen which described specific reasons such as “the jet of the burette not being filled” or “not reading the meniscus at eye-level”.

(ii) Suggest ONE reason why a student may obtain volumes outside the uncertainty of the burette when performing a titration.

(1)

The student may not read from the bottom of the meniscus, resulting in a random error.

(Total for Question 19 = 13 marks)

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Examiner Comments

This candidate realises that the volume of solution in the burette should be read from the bottom of the meniscus.

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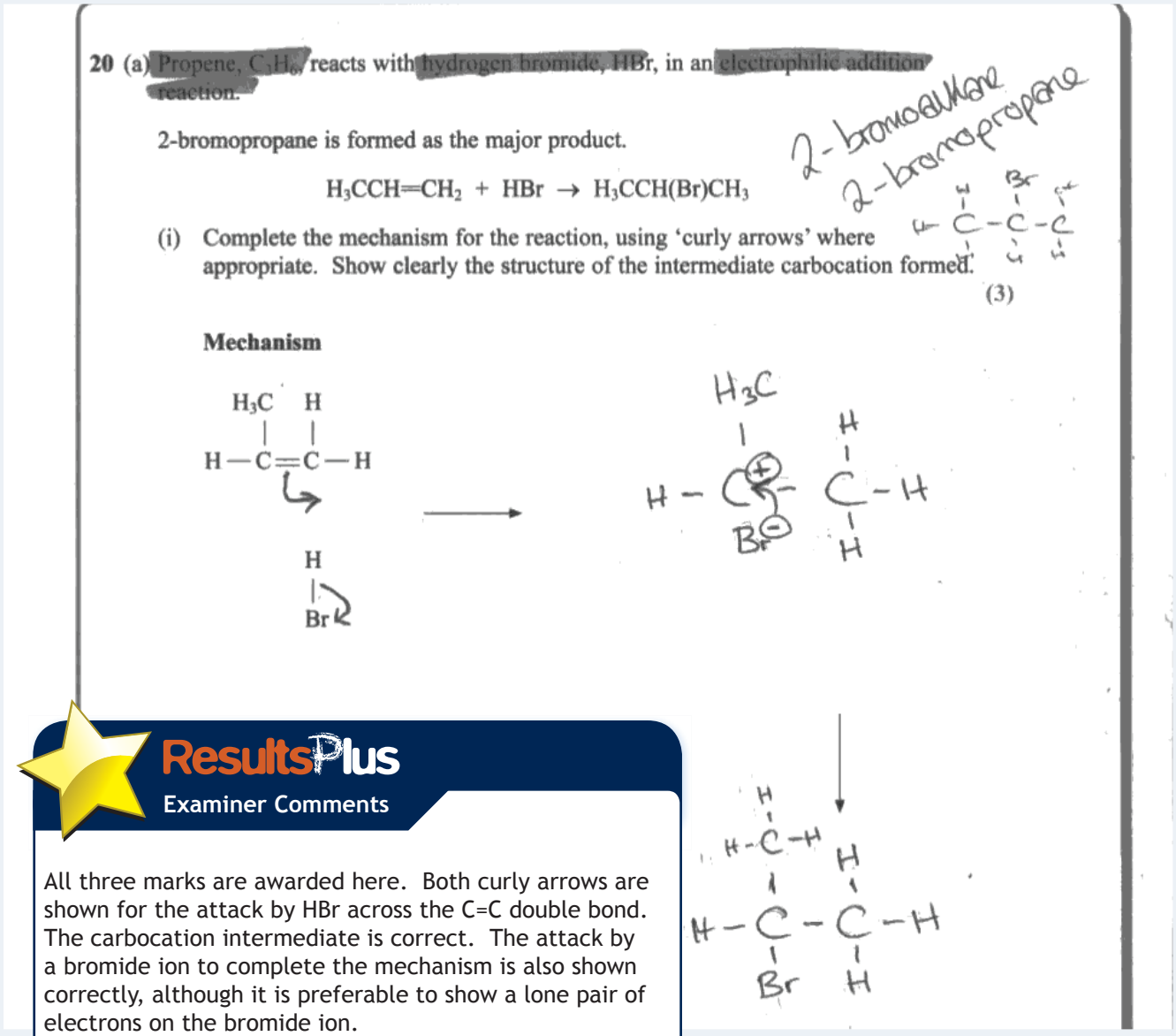
Examiner Tip

When doing practical work, be aware of what constitutes good technique and why.

Question 20(a) (i)

The majority of candidates earned some credit for their mechanisms in Q20(a)(i). Scoring the first mark proved to be the most difficult, possibly as it required two "curly arrows" to be shown correctly. Many candidates remain under the impression that a curly arrow represents the movement of an atom, or group of atoms, to form a new linkage rather than the movement of an electron pair. The second mark was more frequently awarded, but many drew the wrong carbocation. A partial, instead of a full, positive charge often appeared on an otherwise correct carbocation. Pleasingly, the bromide ion was invariably shown with both a negative charge and a lone pair of electrons.



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Examiner Comments

All three marks are awarded here. Both curly arrows are shown for the attack by HBr across the C=C double bond. The carbocation intermediate is correct. The attack by a bromide ion to complete the mechanism is also shown correctly, although it is preferable to show a lone pair of electrons on the bromide ion.

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Examiner Tip

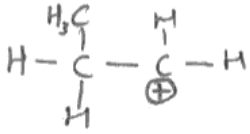
Show lone pairs on attacking species, where relevant.

Question 20(a) (ii)

The requirement to draw the structure of the alternative carbocation was misread by a sizeable number of candidates who, instead, drew the alternative product, 1-bromopropane.

(ii) Draw the structure of the alternative carbocation that can be formed in the reaction between propene and hydrogen bromide.

(1)



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Examiner Comments

The carbocation has been shown very clearly in this response.

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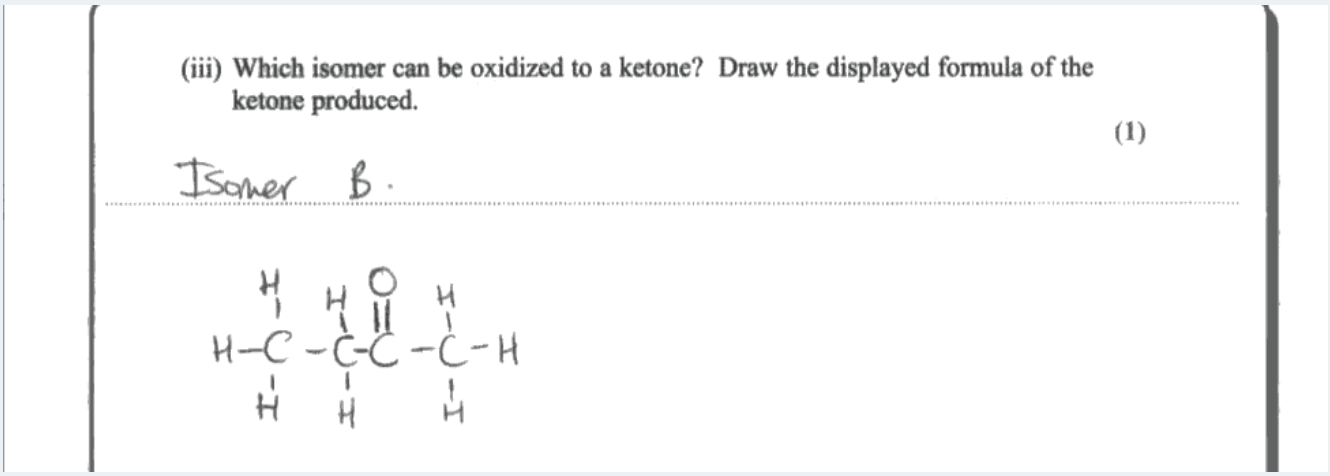
Examiner Tip

Be aware that Unit 2 requires knowledge of Organic Chemistry covered in Unit 1. Always read your specification very thoroughly!

Question 20(b) (iii)

Despite being asked to draw the displayed formula of the ketone produced, a number of candidates gave the structural formula of butanone instead. A minority of candidates correctly identified isomer B, but then drew butan-2-ol instead of butanone.


(iii) Which isomer can be oxidized to a ketone? Draw the displayed formula of the ketone produced.

(1)

Isomer B.

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Examiner Comments

Both points required by the question have been addressed. The candidate has drawn the displayed formula of the oxidation product correctly.

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Examiner Tip

Don't give a structural or molecular formula when a displayed formula is asked for!

Question 20(b) (i)-(ii)

These items were, in general, very well answered. Candidates were able to identify the secondary alcohol in (b)(ii) and were aware that tertiary alcohols are resistant to oxidation under the conditions stated in (b)(ii). In (b)(i), however, there were occasionally problems in communicating the structural features inherent in a secondary alcohol. Some candidates thought it was sufficient to write that the "-OH is on the second carbon atom in the chain" for their justification.

(b) Four isomers, each with the molecular formula $C_4H_{10}O$, are shown below.

Isomer **A**: $CH_3CH_2CH_2CH_2OH$

Isomer **B**: $CH_3CH_2CH(OH)CH_3$

Isomer **C**: $(CH_3)_3COH$

Isomer **D**: $CH_3CH(CH_3)CH_2OH$

(i) Which isomer is a secondary alcohol? Justify your answer.

(2)

Isomer D because it has 2 carbon atoms joined to 1 C bond and a OH group.

(ii) Which isomer is resistant to oxidation when heated with acidified potassium dichromate(VI)? Justify your answer in terms of the structure of the isomer.

(2)

Isomer C because it has a branched structure and requires a lot of energy to break the bonds.

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Examiner Comments

In (b)(i), an incorrect isomer has been selected and the structure of a secondary alcohol has not been correctly described. In (b)(ii), isomer C is identified correctly but the fact that C is a tertiary alcohol has been overlooked.

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Examiner Tip

Be able to explain the difference in structure between primary, secondary and tertiary alcohols.

Question 20(b) (iv)

Fortunately, the majority of candidates spotted the plural in this question and identified isomers A and D correctly.

Question 20(b) (v)

It is pleasing to report that the majority of candidates were aware of the fact that "steamy fumes" would be seen, with many fewer stating that "white solid" or "white smoke" would be observed.

Question 20(b) (vi)

Many candidates were able to identify hydrogen chloride, HCl, as one of the products and scored a mark for this. A significant number of candidates were able to complete the equation correctly, but others did not do so. Phosphorus trichloride, PCl_3, was frequently suggested as a product instead of phosphorus oxytrichloride, $POCl_3$.

(vi) Complete the equation for the reaction shown below. State symbols are **not** required.

(2)

$C_4H_9OH + PCl_5 \rightarrow$ PCl_4 + C_4H_9O + HCl

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Examiner Comments

This candidate has scored one out of the two available marks as the formation of hydrogen chloride, HCl, has been acknowledged. The rest of the equation is incorrect.

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Examiner Tip

Make sure you learn the equations for Organic reactions thoroughly!

Question 21(a)

Parts (a)(i) and (a)(iii) were answered very well in general. Candidates' answers revealed a sound understanding of Le Chatelier's principle. Part (a)(ii) proved to be very challenging and elicited a wide variety of responses. Incorrect answers tended to focus on the gases being liquefied if they were cooled or that more carbon dioxide would be released into the atmosphere. Nonetheless, credit was earned by candidates who realised that (a)(ii) required a consideration of the kinetics of the process rather than the position of equilibrium.

21 (a) In the catalytic converter of a car engine's exhaust system, the following reaction occurs.

$2NO(g) + 2CO(g) \rightleftharpoons N_2(g) + 2CO_2(g)$ $\Delta H = -745 \text{ kJ mol}^{-1}$

The temperature in a catalytic converter is high.

(i) State the effect, if any, on the position of equilibrium if the temperature is lowered. Give a reason for your answer.

(2)

Effect The yield of the forward reaction will increase

Reason The reaction moves to oppose the change applied to it and so it will favour the exothermic reaction since this will raise the temperature

(ii) The gases from the engine are **not** cooled before entering the converter. Explain why this is so.

(2)

Cooling requires a lot of energy in itself which is expensive. Also, by cooling the gases, although the yield will increase, the rate of reaction will DECREASE significantly, so the effect of the decrease in rate of reaction and expensive cooling makes it more viable to raise the temperature and so compromise yield to favour a higher rate of reaction and no energy wasted on cooling!

(iii) State the effect, if any, on the position of equilibrium if the pressure on the reacting gases is increased. Give a reason for your answer.

(2)

Effect It will favour the forward reaction

Reason There are fewer gas molecules on the product side (fewer moles) and so they will occupy a smaller volume. The reaction moves to oppose the change applied to it and so it will favour the forward reaction which will decrease the pressure!

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Examiner Comments

All the required points in the Mark Scheme have been addressed in parts (a)(i), (ii) and (iii).

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Examiner Tip

Make sure you can apply Le Chatelier's principle to an equilibrium reaction!

Question 21(b) (i)

Many candidates were able to calculate both oxidation numbers of nitrogen correctly and included the "+" sign in each case.

Question 21(b) (ii)-(iv)

In (b)(ii), relatively few candidates could balance the half-equation correctly which was surprising given that the reacting and product species were given. In (b)(iii), a large number were unable to write down correctly the half equation for the oxidation of silver atoms to silver ions and it was difficult to understand why some candidates gave the silver ion a multiple charge given that the formula for the silver ion had been given in the question. As a result of the above, only a minority scored both marks for (b)(iv). Consequential marking, however, allowed credit to be earned in (b)(iv) where attempts had been made to cancel out the electrons on the basis of answers given to (b)(ii) and (b)(iii).

(ii) Balance the half-equation for the reduction of nitrate ions, NO_3^-, in acidic solution.

(1)

$NO_3^- + \underline{4}\ H^+ + \underline{3}\ e^- \rightarrow NO + \underline{2}\ H_2O$

(iii) Write the half-equation for the oxidation of silver metal, Ag, to silver ions, Ag^+.

(1)

$Ag \longrightarrow Ag^+ + e^-$

(iv) Hence deduce the full ionic equation for the reaction between silver metal and nitrate ions in acidic solution. State symbols are **not** required.

(2)

$NO_3^- + 4H^+ + 2e^- + Ag \rightarrow NO + 2H_2O + Ag^+$

$NO_3^- + 4H^+ + 2e^- + Ag \rightarrow NO + 2H_2O + Ag^+$

~~$NO_3^- + 4H^+ + 3e^- \rightarrow NO + 2H_2O + Ag^+ + e^-$~~

$NO_3^- + 4H^+ \quad 2e^- \longrightarrow NO + 2H_2O + Ag^+$

(Total for Question 21 = 12 marks)

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Examiner Comments

The half-equations in (b)(ii) and (b)(iii) are both correct. However, this candidate has not combined the two half-equations correctly in (b)(iv).

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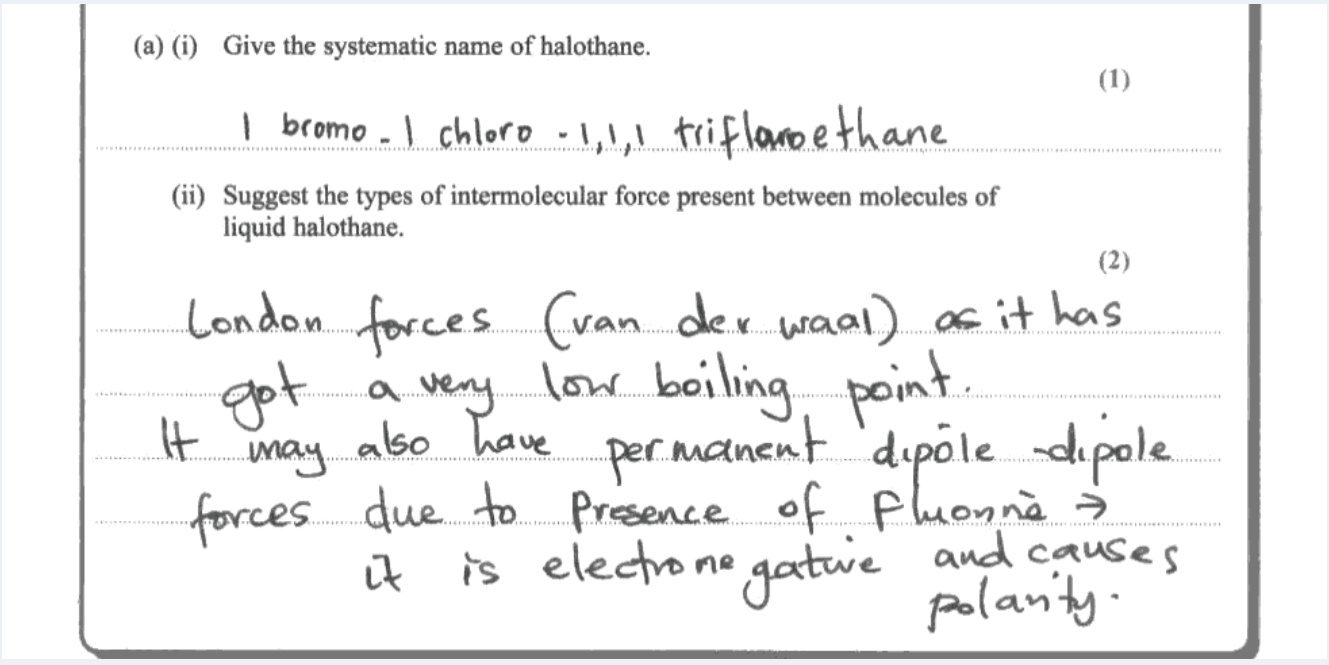
Examiner Tip

Practise combining half-equations to get the overall ionic equation for several simple redox processes.

Question 22(a) (i)-(ii)

Q22(a)(i) was found to be particularly demanding. This was in contrast to part (a)(ii) which showed that many candidates had a good understanding of the intermolecular forces that exist between polar molecules.



(a) (i) Give the systematic name of halothane.

(1)

1 bromo - 1 chloro - 1,1,1 triflaroethane

(ii) Suggest the types of intermolecular force present between molecules of liquid halothane.

(2)

London forces (van der waal) as it has got a very low boiling point. It may also have permanent dipole-dipole forces due to presence of fluorine → it is electronegative and causes polarity.

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Examiner Comments

This candidate has had a go at naming halothane systematically in (a)(i). The name given unfortunately does not take into account the fact that the fluorine atoms are not on the same carbon atom as the bromine and chlorine atoms. (a)(ii) is correctly answered.

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Examiner Tip

Practise naming organic compounds met during the AS course.

Question 22(a) (iii)-(v)

In Q22(a)(iii), many candidates were able to score a mark. The most common error was to suggest that halothane was flammable, despite stating that CFCs are used as fire retardants in answers to part (c)(ii) later on. In (a)(iv), the majority of candidates were aware that ethanol acted as a solvent in this experiment. A sizeable number of candidates, however, were under the impression that ethanol was a reactant and was responsible for the introduction of an -OH group into the organic compound, in place of the -Br atom. Part (a)(v) required that both the colour and state of the silver bromide were given and, pleasingly, "cream precipitate" was often seen. Quite a few candidates, however, thought that the formation of aqueous bromine would be observed. Therefore, answers such as "brown solution" were seen from time to time.

(iii) In the above experiment, suggest ONE reason why a water bath was used rather than heating the test tube containing the reaction mixture directly over a Bunsen flame.

(1)

highly flammable reaction mixture, so to lower risks involved.

(iv) Suggest why ethanol was used in this experiment.

(1)

:OH⁻ is a Primary alcohol, reacts easily. ^ nucleophile and will react quickly and attack molecule.

(v) What would be seen in the test tube as the reaction progressed?

(1)

Cream precipitate in tube

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Examiner Comments

In (a)(iii), this candidate is aware of the flammability of the reaction mixture (due to the presence of the ethanol as a solvent). The role of the ethanol is not described correctly in (a)(iv).

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Examiner Tip

When doing practical work, make sure you understand the reasons for the steps involved.

Question 22(a) (vi)

Although a number of candidates scored the mark for this part, a large number of answers were given showing the state of the silver bromide formed as an aqueous solution, rather than as a solid.

(vi) Write an ionic equation to show the reaction between aqueous silver ions and aqueous bromide ions. Include state symbols in your equation.

(1)

$Ag^+_{(aq)} + Br^-_{(aq)} \rightarrow AgBr_{(aq)}$

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Examiner Comments

This candidate did not give the correct state symbol, (s), for the precipitate of silver bromide.

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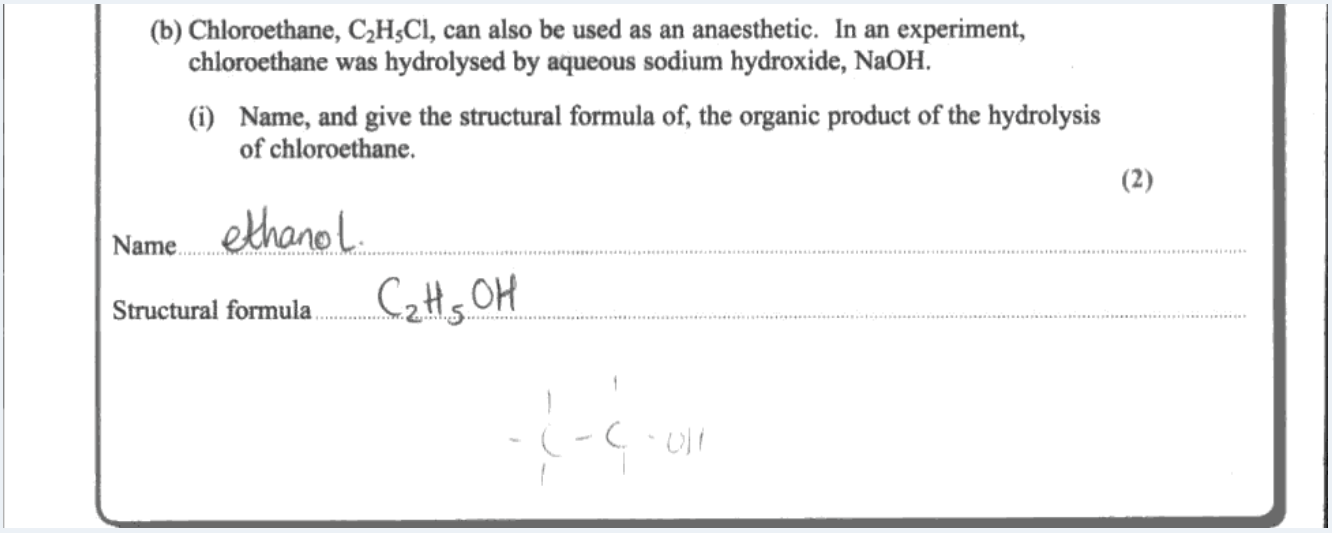
Examiner Tip

Check your state symbols carefully!

Question 22(b) (i)

This was, in general, well answered. A number of candidates, however, were under the impression that an elimination reaction had occurred and that ethene, rather than ethanol, was the hydrolysis product.



(b) Chloroethane, C_2H_5Cl, can also be used as an anaesthetic. In an experiment, chloroethane was hydrolysed by aqueous sodium hydroxide, NaOH.

(i) Name, and give the structural formula of, the organic product of the hydrolysis of chloroethane.

(2)

Name ethanol.

Structural formula C_2H_5OH

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Examiner Comments

This is correctly answered.

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Examiner Tip

Learn your Organic reactions thoroughly!

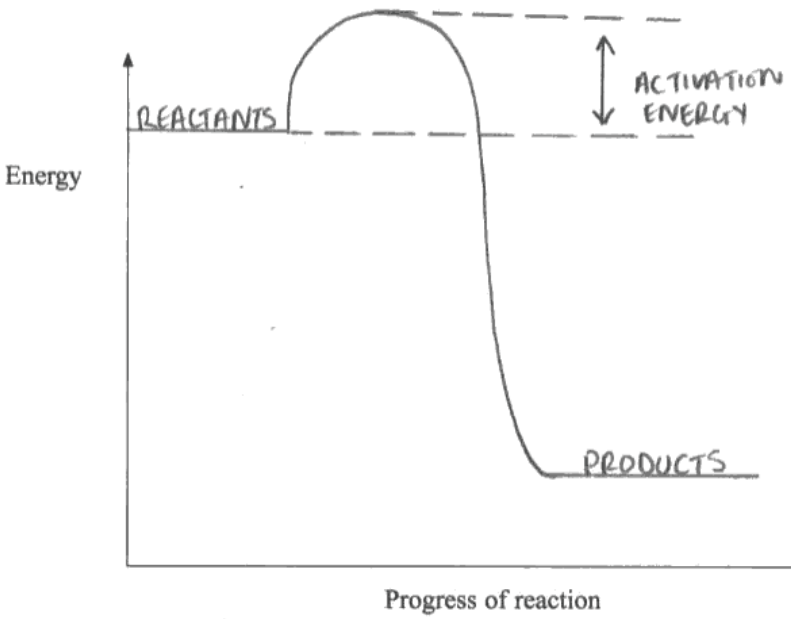
Question 22(b) (ii)

Most candidates scored two or three out of the three available marks. The most common errors were not labelling the reactants and products (for the first mark) or for annotating the energy profile incorrectly with a double-headed arrow to show the activation energy (for the third mark). Since activation energy is an endothermic quantity, the arrow to show this energy change had to be pointing upwards.

(ii) The hydrolysis of chloroethane is an exothermic reaction which takes place in a single step.

On the diagram below, draw the energy profile for the reaction. Label clearly the activation energy for the reaction.

(3)



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Examiner Comments

The arrow for the activation energy annotation should point upwards (endothermic direction), rather than be double-headed!

Question 22(c) (i)

The vast majority of candidates were aware of the meaning of the term “CFC”.

Question 22(c) (ii)

This part was very well-answered, with the correct response being given most frequently as either “a fire retardant” or “in aerosols”.

(ii) Suggest ONE use for CFCs other than as a refrigerant.

(1)

They are used as propellants in aerosols

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Examiner Comments

This is a very good answer.

Question 22ciii

A good proportion managed to score the last three available marks, but many wrote the equation incorrectly or did not attempt to combine the equations given. Only a minority of candidates mentioned the role of the chlorine free radical as that of a catalyst. The harmful effect of depletion of the ozone layer was often not known, with frequent references instead being made to global warming and/or the greenhouse effect. The best responses seen to this question gave the overall equation, showing reasoning, to access the first mark, followed by four succint responses to earn the four remaining marks.

*(iii) In the stratosphere, CFCs are broken down by absorption of UV radiation to form chlorine free radicals.

The following two reactions occur.

$Cl\bullet + O_3 \rightarrow ClO\bullet + O_2$

$ClO\bullet + O \rightarrow Cl\bullet + O_2$

Combine these two equations to give the overall equation for the reaction of ozone in the stratosphere. State the role played by the chlorine free radical in the overall reaction. Hence explain why many scientists consider the effect of CFCs on ozone to be harmful.

(5)

$O_3 + O \rightarrow 2O_2$.

Scientists consider CFC's as dangerous because they deplete Ozone (O_3) in the upper atmosphere, through free radical reactions. In these chain reactions one radical such as $Cl^{\bullet}$ can destroy 10,000 Ozone molecules. This is a problem because it absorbs harmful UV radiation. Depletion can lead to increased risk of cancers, and global warming.

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Examiner Comments

This candidate has not mentioned the role of the chlorine free radical as a catalyst. Otherwise, all other points required by the Mark Scheme have been addressed, including the combination of the two equations to give a single overall equation.

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Examiner Tip

Always read the question very carefully!

Question 22(d)

Many good answers were seen to (d)(i) and (d)(ii). In (d)(i), the most common errors were mentioning the electronegativity of fluorine as a reason for the strength of the C-F bond or references to intermolecular forces. In (d)(ii), if errors did occur they were for stating that UV radiation was absorbed or that the molecule vibrates instead of bonds vibrating.

(d) The compound of formula CH_2F_2 has replaced several CFCs for commercial use. If molecules of CH_2F_2 reach the stratosphere, they do not break down to produce fluorine free radicals.

(i) Suggest why C–F bonds are **not** broken in the stratosphere.

(1)

the bonds are to strong to be overcome to produce fluorine free radicals

*(ii) The compound CH_2F_2 acts as a greenhouse gas when it absorbs a particular type of radiation.

Name the type of radiation and explain why a molecule of CH_2F_2 is able to absorb this radiation.

(2)

It can absorb infrared (IR) radiation as it is a polar molecule.

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Examiner Comments

Both (d)(i) and (ii) are correctly answered. In (d)(i), the word "to" in "to strong" is read as "too".

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Examiner Tip

Always be clear in your own mind about the different types of radiation.

(d) The compound of formula CH_2F_2 has replaced several CFCs for commercial use. If molecules of CH_2F_2 reach the stratosphere, they do not break down to produce fluorine free radicals.

(i) Suggest why C–F bonds are **not** broken in the stratosphere.

(1)

This is because the energy needed to overcome this bond cannot be obtained from UV radiation the more energy is needed

*(ii) The compound CH_2F_2 acts as a greenhouse gas when it absorbs a particular type of radiation.

Name the type of radiation and explain why a molecule of CH_2F_2 is able to absorb this radiation.

(2)

Infared radiation is absorbed by the C-H bonds and the re milled. The C-H bond vibrates and the polarity changes. The radiation never escapes the earth therefore returns to earth

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Examiner Comments

A good clear answer.

Grade Boundaries

Grade	Max. Mark	A	B	C	D	E	N	U
Raw boundary mark	80	60	54	48	42	36	30	0
Uniform boundary mark	120	96	84	72	60	48	36	0

This paper seemed to be accessible to the full range of candidates. There was no evidence of any time pressure, with the vast majority of candidates attempting every question.

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