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Examiners' Report
June 2011

GCE Chemistry 6CH08 01

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Introduction

This was an accessible paper for many candidates who were able to show their understanding of the practical aspects of chemistry. An important feature of answering these questions is for candidates to try to visualise what is happening in the reaction vessel, exactly as though they were in the laboratory. They should also understand the reasons for what they are doing rather than simply regarding them as processes performed merely because they are told to do them. Every step has a reason which needs to be understood and explained.

Question 1 (a)

Many candidates were able to give two ions which form blue complexes. The most common incorrect answers were Fe^{2+} and Cr^{3+}.

(a) Give the formulae of **two** different transition metal ions which can form blue complex cations.

(2)

Cu^{2+}, Co^{2+}

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Examiner Comments

This answer is unambiguous and correct.

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Examiner Tip

Candidates must be careful to write Co^{2+} and not CO^{2+}, a completely different (and fictional) species.

(a) Give the formulae of **two** different transition metal ions which can form blue complex cations.

(2)

Copper (II), ~~[illegible]~~ Cobalt (II) - $[Cu(H_2O)_6]^{2+}$, $[Co(H_2O)_6]^{2+}$

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Examiner Comments

The question asks for formulae, not names. Here the names appear first, but because they are correct they were ignored. Had they been wrong the candidate would have lost credit.

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Examiner Tip

Candidates must answer the question asked.

Question 1 (b)

The answer to part (i) is steam - candidates are being asked what their observations are, i.e. what they **see**. They are not being asked to test for water, by far the most common erroneous answer. In (ii) the inference 'alkaline' is a low-level response and doesn't tell us much about the substance. 'Ammonia' is the appropriate answer. In (iii) it was not always clear where the water came from, particularly if hydrates were considered. Sometimes it was hard to tell whether the candidate meant 'water of crystallisation' or simply thought that the crystals were damp.

This answer scored full marks.

(b) Complete the following table.

	Test	Observation	Inference(s)	
(i)	Heat compound **W**.	fumes of steam at 100°C.	Water	(1)
(ii)	Test any gas evolved with moist red litmus paper.	Red litmus paper turns blue	Ammonia (NH_3)	(1)

(iii) Suggest **two** sources of the water which was given off when a pure dry sample of **W** was heated.

(2)

Some of water was ~~left during crystallization method~~ present during crystallization.

The ions used were hydrated complex ions.

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Examiner Comments

In (iii) the candidate was given the benefit of doubt with 'water present **during** crystallisation'. It isn't completely unambigous and phrases such as this, cause examiners to pause for thought.

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Examiner Tip

Make the meaning of an answer clear enough so that examiners don't have to ponder the truth or falsity of what is written.

(b) Complete the following table.

	Test	Observation	Inference(s)	
(i)	Heat compound **W**.	Steam given off.	Water	(1)
(ii)	Test any gas evolved with moist red litmus paper.	Red litmus paper turns blue	alkaline gas given off	(1)

(iii) Suggest **two** sources of the water which was given off when a pure dry sample of **W** was heated.

(2)

- the water of crystallisation from the salt
- the water in the complex ion of the transition metal.

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Examiner Comments

Although incorrect in (ii), the answer to (iii) is clearer than in the previous example.

Question 1 (c) (i)

Most candidates gave a correct answer for the colour of the precipitate. The correct formulas for the green-yellow ion was much rarer, either owing to small errors as in the second example below or to completely wrong ideas.

	Test	Observation	Formula	
(i)	Add concentrated hydrochloric acid slowly,	blue -coloured precipitate	$Cu(OH)_2$	(1)
	until in excess.	green-yellow solution	$[CuCl_4]^{2-}$	(1)

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Examiner Comments

This is a perfect, clear answer.

The precipitate is correctly described, but the charge has been missed off the copper(I) complex.

	Test	Observation	Formula	
(i)	Add concentrated hydrochloric acid slowly,	Blue -coloured precipitate	$Cu(OH)_2$	(1)
	until in excess.	green-yellow solution	$CuCl_3$	(1)

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Examiner Comments

Candidates need to take great care with charges.

Question 1 (c) (ii)

The vast majority of candidates knew that $BaSO_4$ is the precipitate.

Question 1 (c) (iii)

Most of the errors in the question concerned that first precipitate, as stated in the comment to the second example.

(iii)	Add dilute sulfuric acid until the solution is pale blue; then add potassium iodide solution. KI reducing agent	white precipitate	CuI	(1)
		in a brown solution	I_2	(1)

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Examiner Comments

This is a correct and clear answer.

(iii)	Add dilute sulfuric acid until the solution is pale blue; then add potassium iodide solution.	white precipitate	CuI_2	(1)
		in a brown solution	$I_{2(aq)}$	(1)

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Examiner Comments

The erroneous identification of CuI_2 as the precipitate was not uncommon, although many candidates produced much wilder suggestions. The correct identification of I_2 was common. Hardly any candidates gave names.

Question 1 (d)

There were very few correct answers to this question. Even candidates who had answered previous parts correctly and had identified copper(II) ions, water and ammonia, failed to put them together into a complex cation. Many answers simply ignored the earlier evidence. Candidates need to appreciate that the tests they have described lead somewhere at the conclusion of the question.

(d) Suggest the **formula** of the complex cation in an aqueous solution of compound **W**.

(1)

~~$[Cu(H_2O)_6]^{2+}$~~ $[Cu(H_2O)_2(NH_3)_4]^{2+}$

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Examiner Comments
This is an uncommon example of a correct answer.

(d) Suggest the **formula** of the complex cation in an aqueous solution of compound **W**.

(1)

$[Cu(NH_3)_4]^{2+}$

(Total for Question 1 = 12 marks)

Cu SO4

Cu NH_3 SO4

$[Cu(NH_3)_4]^{2+}$ SO_4^{2-}

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Examiner Comments
Although this ion probably should have some water ligands as well (opinion is divided about the coordination of copper(II) ions, but six is more likely) it is good enough for credit.

Question 2 (a) (i)

Methyl orange, when going from alkaline to neutral solution, changes from yellow to orange. If it is to red the titration has overshot.

This answer clearly shows the colour change.

(a) (i) What colour change would you see at the end point of the titration?

(1)

Yellow ~~Red~~ to orange

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Examiner Comments

Whenever colours change in a reaction, no matter what the context, it is always the **change** that candidates are expected to give.

Question 2 (a) (ii)

Many candidates did not appreciate that propanone merely slows the reaction rather than stopping it completely. The second mark was awarded as a stand-alone mark so the majority of candidates who scored one out of two did so here.

(ii) Explain why it is necessary to titrate the samples **immediately** after they have been withdrawn from the reaction mixture. State the effect, if any, on the titre if this were not done.

(2)

Because ~~propor~~ propanone does not completely stop reaction, reaction continues. The titre would be less than the actual titre. ~~at that~~

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Examiner Comments

This answer shows complete understanding, clearly expressed.

Although this candidate understands the **slowing** of the reaction, the purpose of the titration has not been understood.

(ii) Explain why it is necessary to titrate the samples **immediately** after they have been withdrawn from the reaction mixture. State the effect, if any, on the titre if this were not done.

(2)

It is necessary the titrate the samples immediately ~~so the~~ because the reaction has been slowed down by the propanone so ~~if the sample is left longer~~, the titre would increase because ~~more~~ a greater volume of hydrochloric acid would be needed.

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Examiner Comments

Here is a good example of the candidate needing to visualise doing the experiment to get a feel for what is happening in the reaction flask.

(ii) Explain why it is necessary to titrate the samples **immediately** after they have been withdrawn from the reaction mixture. State the effect, if any, on the titre if this were not done.

(2)

The are titrated immediately, because they are volatile liquids, and they will evaporate hence giving a low titre value.

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Examiner Comments

The candidate has little understanding of what is happening in the flask when propanone is added, but gets the second mark as a stand-alone credit.

Question 2 (b)

If candidates lost marks here it was because they did not make it clear that halogenoalkanes are insoluble in water. This point is elaborated further below.

This answer shows that the solubility of the halogenoalkane in ethanol and in water has been considered. The candidate truly understands the system.

(b) Suggest why it is necessary to use a solvent of aqueous ethanol rather than water alone for this reaction.

(1)

Because 2-chloro-2-methyl propane is insoluble in water and soluble in ethanol. ~~As ethanol is soluble~~ This is done to bring reactant molecules close to each other

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Examiner Comments

Phrases such as 'ethanol rather than water' should give the candidate the idea that the effect of both substances needs to be addressed in their answer.

(b) Suggest why it is necessary to use a solvent of aqueous ethanol rather than water alone for this reaction.

(1)

Aqueous ethanol is required so that halogeno alkane can be dissolved.

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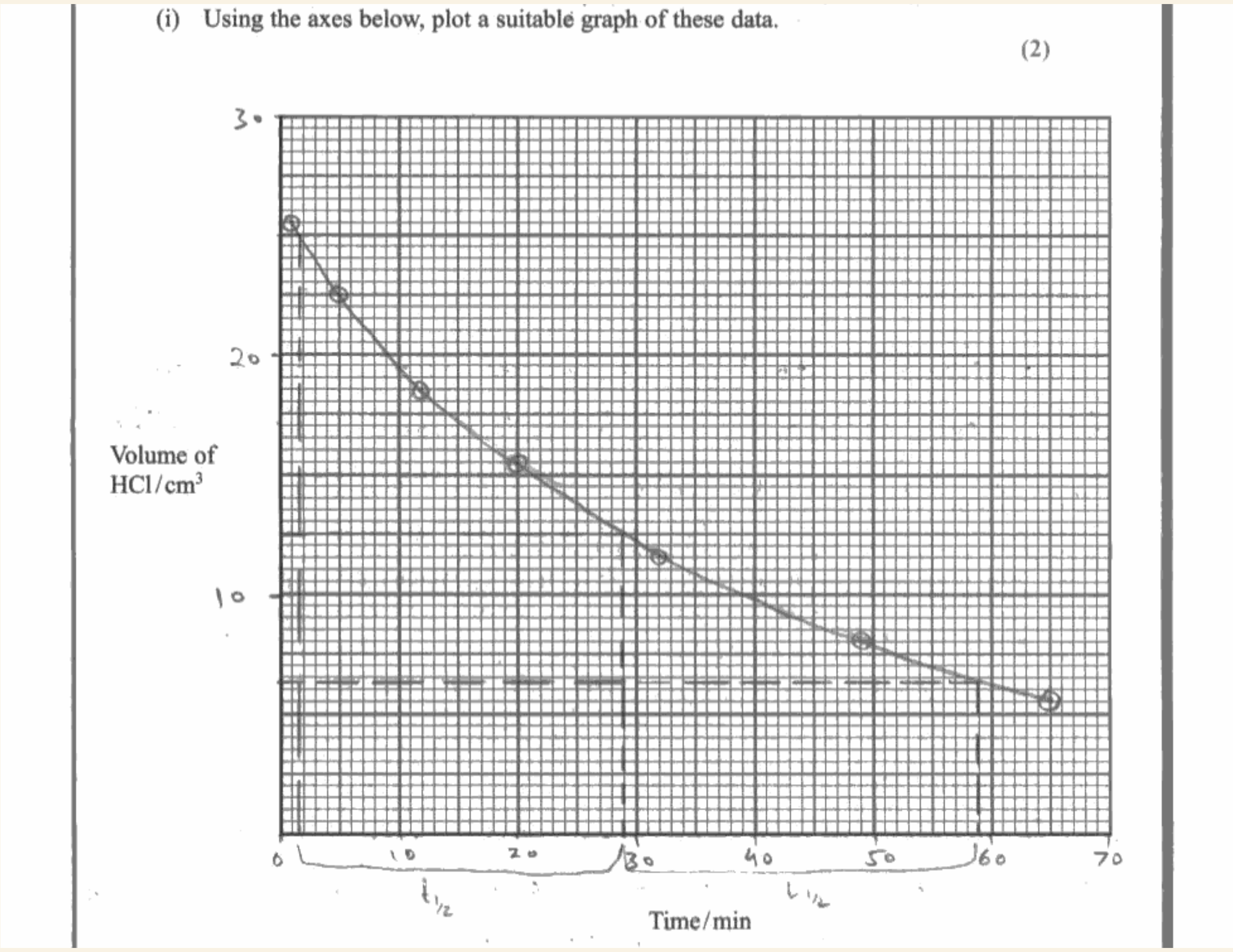
Examiner Comments

This answer refers only to aqueous ethanol. The examiner cannot be certain that the candidate knows why water alone will not suffice. To suggest merely that it works is not enough.

Question 2 (c)

The vast majority of candidates drew good graphs; sadly for the weaker answers this produced the only credit for the answer. Candidates should be aware that the use of fine pencil for drawing graphs is likely to make them difficult to see on the screen. The misunderstanding of **successive** half-lives was common with candidates giving the sum of the two half-lives for the second answer. Part (iii) was marked independently of this error. Several candidates gave analytical tests for halogenoalkanes in part v; however they had not been asked to show that a halogenoalkane is present. Others knew that the concentration of the halogenoalkane could be changed but then said that the 'effect on the rate should be observed'. To show first-order kinetics it is essential to state that the rate is proportional to the concentration for full credit.



(ii) Show **two** successive half-life measurements on your graph and write their values below.

(2)

First half-life ....29 − 1.5 = 27.5 s....

Second half-life ....59 − 29 = 30 s....

(iii) Explain how your answers to (ii) show that this reaction is first order.

(1)

The graph has an approximately constant halflife as seen on graphs of 1st order reactions

(iv) Give the units of the rate constant for this reaction.

(1)

~~mol dm⁻³ s⁻¹ / mol dm⁻³~~ ~~units~~ units of k = s^{-1}

(v) Because the initial concentrations of the reactants are the same, it is not possible to tell whether the rate equation is of the form

rate = $k[(CH_3)_3CCl]$

or of the form rate = $k[OH^-]$

Suggest a further experiment which could be carried out to show that it is in fact first order with respect to the halogenoalkane.

(2)

The reaction could be repeated using double the concentration of halogenoalkane. The rate would double.

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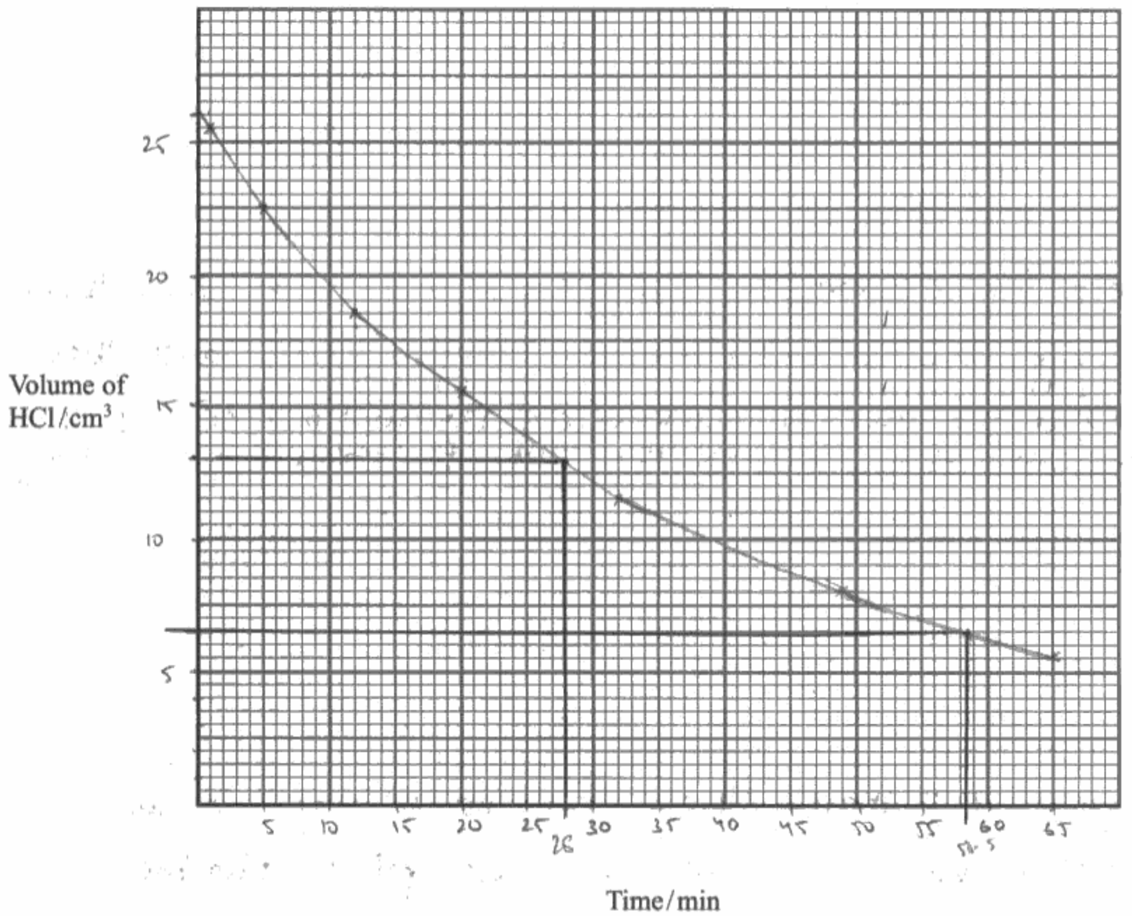
Examiner Comments

This is a good answer which shows the successive half-lives very clearly on the graph and which makes the examiner's job very easy. The answer is crisp and unambiguous throughout.

(i) Using the axes below, plot a suitable graph of these data.

(2)



(ii) Show **two** successive half-life measurements on your graph and write their values below.

(2)

First half-life .... 28 min

Second half-life .... 58.5 min

(iii) Explain how your answers to (ii) show that this reaction is first order.

(1)

The half life remains the same. Volume has no effect on half-life. i.e it took 28 min for the sample to fall to half its value & then again it took 20min to fall another half.

(iv) Give the units of the rate constant for this reaction.

(1)

mol s^{-1}

(v) Because the initial concentrations of the reactants are the same, it is not possible to tell whether the rate equation is of the form

$$\text{rate} = k[(CH_3)_3CCl]$$

or of the form

$$\text{rate} = k[OH^-]$$

Suggest a further experiment which could be carried out to show that it is in fact first order with respect to the halogenoalkane.

(2)

Keep the concentration of $[OH^-]$ very large and ~~then~~ change the concentration of halogenoalkane and then ~~det~~ find the rate of reaction. e.g Doubling the conc. of the halogenoalkane doubles the rate of reaction shows that it is first order.

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Examiner Comments

This is an example of a candidate who has interpreted the **successive** half-lives as being the sum of the two rather than the individual values for one followed by the other. Apart from the incorrect units for the rate constant the remainder of the answer is good.

Question 2 (d) (i)

This question was answered poorly by the majority of candidates. They did not appreciate that the initial reaction mixture has a pH of 7 because it is water and halogenoalkane only so that no extra hydrogen ions have yet been produced. The numerical value of the pH was required,

The answer 'neutral' is not a **value** for the pH, although it was a common answer. This candidate says that there is a lack of hydrogen ions and hydroxide ions which, if it means none, is not true.

$$(CH_3)_3CCl + H_2O \rightarrow (CH_3)_3COH + H^+ + Cl^-$$

(i) Suggest what the initial pH of the mixture would be. Justify your answer.

(1)

The pH of mixture initially would be some where near neutral or exactly neutral, due to lack of presence of OH^- ions and H^+ ions which would determine the pH of mixture.

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Examiner Comments

Since the pH of neutral water varies with temperature the word 'neutral' does not necessarily mean pH 7. Further, if there are no hydrogen ions at all the idea of pH is irrelevant.

$$(CH_3)_3CCl + H_2O \rightarrow (CH_3)_3COH + H^+ + Cl^-$$

(i) Suggest what the initial pH of the mixture would be. Justify your answer.

(1)

pH = 7. ~~There is only water~~ There are no H^+ formed to alter the pH at this stage

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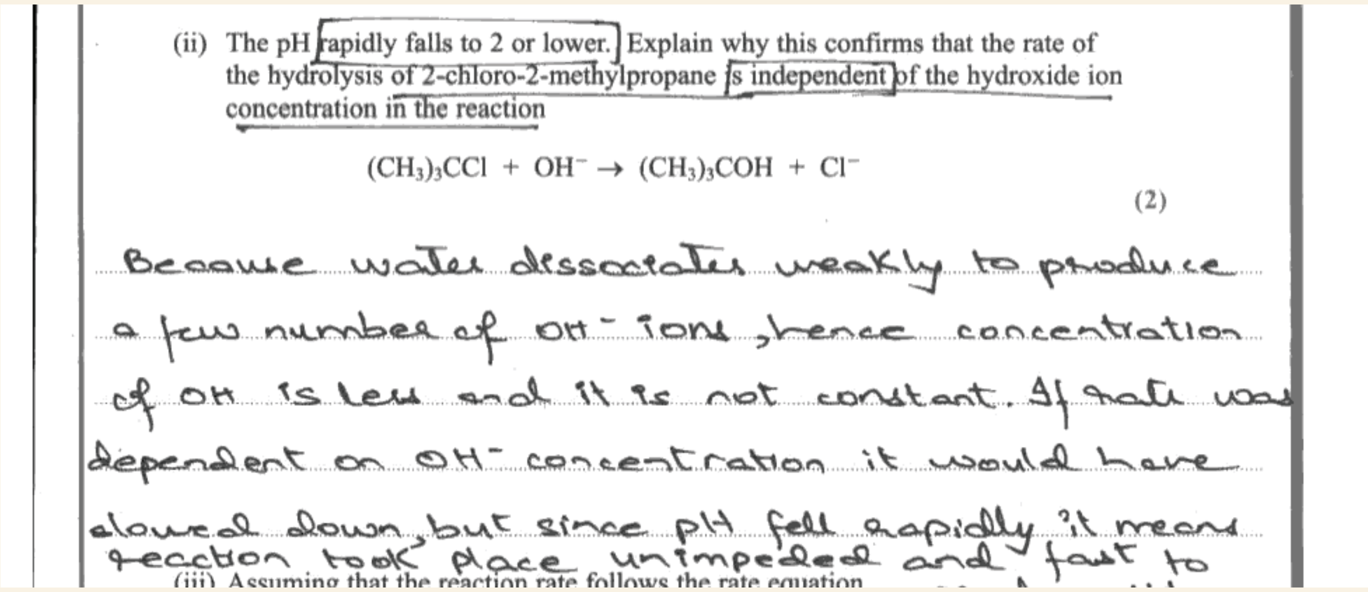
Examiner Comments

The candidate has given the value of the pH. There is also a recognition that no H^+ ions have been **formed** as distinct from no H^+ being present, in other words that there is only water and the halogenoalkane present. Therefore this answer scores.

Question 2 (d) (ii)

The majority of candidates were unable to visualise the reaction system and did not therefore appreciate that in water the concentration of hydroxide ions is very low. Nevertheless the reaction of the halogenoalkane in water is **still** rapid. Therefore the rate must be independent of the hydroxide ion concentration. There was a good deal of speculation about one ion neutralising another, or other reactions which were not possible given the initial reaction mixture.



(ii) The pH rapidly falls to 2 or lower. Explain why this confirms that the rate of the hydrolysis of 2-chloro-2-methylpropane is independent of the hydroxide ion concentration in the reaction

$$(CH_3)_3CCl + OH^- \rightarrow (CH_3)_3COH + Cl^-$$

(2)

Because water dissociates weakly to produce a few number of OH^- ions, hence concentration of OH is less and it is not constant. If rate was dependent on OH^- concentration it would have slowed down, but since pH fell rapidly it means reaction took place unimpeded and fast to

(iii) Assuming that the reaction rate follows the rate equation

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Examiner Comments

This candidate has understood the main point of the question. Although the phrase 'the concentration of OH is less' is not entirely clear and the charge has been left off the ion it is still the case that the system has been understood and is thus worth the two marks given.

(ii) The pH rapidly falls to 2 or lower. Explain why this confirms that the rate of the hydrolysis of 2-chloro-2-methylpropane is independent of the hydroxide ion concentration in the reaction

$$(CH_3)_3CCl + OH^- \rightarrow (CH_3)_3COH + Cl^-$$

(2)

The ~~rate~~ pH falls rapidly indicating that this reaction occurs at a fast rate. Therefore ~~th~~ the OH^- is not involved in the slow-determining step and so the 2-chloro-2-methylpropane is ~~not~~ independent of the hydroxide ion

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Examiner Comments

This answer simply repeats the question. 'Therefore' is not linked to any statement of the initial hydroxide ion concentration.

(ii) The pH rapidly falls to 2 or lower. Explain why this confirms that the rate of the hydrolysis of 2-chloro-2-methylpropane is independent of the hydroxide ion concentration in the reaction

$$(CH_3)_3CCl + OH^- \rightarrow (CH_3)_3COH + Cl^-$$

(2)

because OH is being used up and added to the halogeno alkane. H^+ is produced and thats why the PH falls

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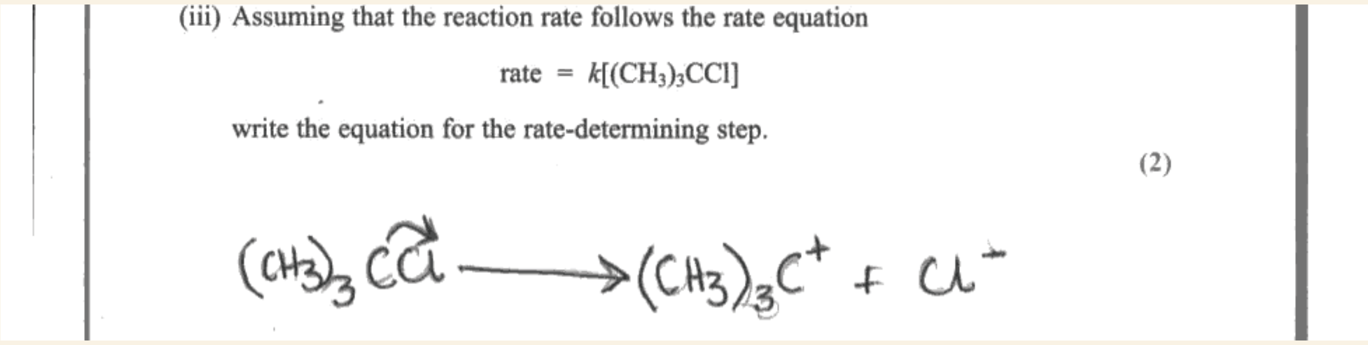
Examiner Comments

This answer is an example of many that explained why the pH falls but not why it falls **rapidly**.

Question 2 (d) (iii)

This question asks for the equation of the rate-determining step when hydroxide ions react with 2-chloro-2-methylpropane. The two comments given below illustrate some potential pitfalls, but the majority of candidates did well in this question.

This is an example of a clear answer to the question which shows a balanced equation.



(iii) Assuming that the reaction rate follows the rate equation

$$\text{rate} = k[(CH_3)_3CCl]$$

write the equation for the rate-determining step.

(2)

$$(CH_3)_3CCl \longrightarrow (CH_3)_3C^+ + Cl^-$$

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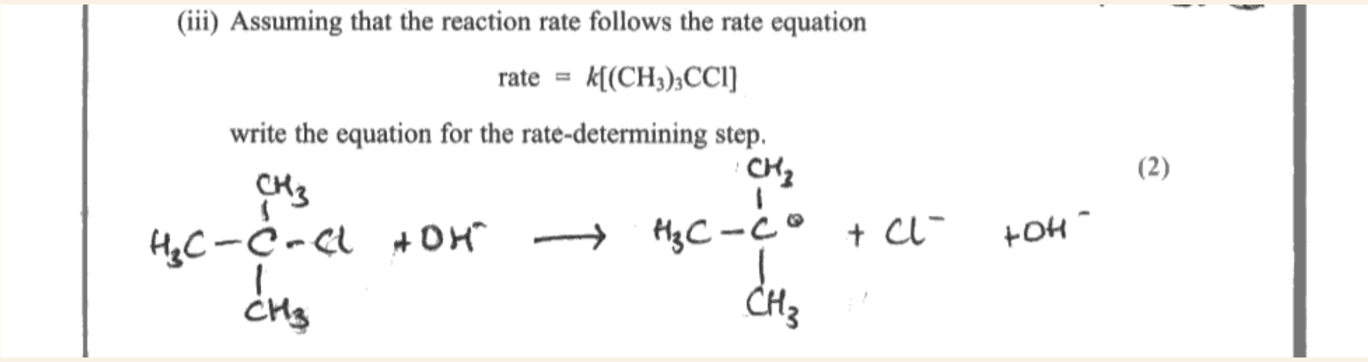
Examiner Comments

If the requirement of this question had been to show the arrow it would not have scored full marks. The C-Cl bond would have had to be shown with the arrow going from the centre of the bond to the chlorine atom. This is not relevant to the marking here but is important in general.



(iii) Assuming that the reaction rate follows the rate equation

$$\text{rate} = k[(CH_3)_3CCl]$$

write the equation for the rate-determining step.

(2)

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Examiner Comments

This example scores zero for two reasons. Firstly the hydroxide ion should not appear. Although it is shown on both sides of the equation and has done nothing it is nevertheless irrelevant. It is not involved in the rate determining step and should not be there. The charge on the ion is also not clear. Either one or the other would not have prevented credit in this answer, but both of them together do.

Question 3 (a)

This question tests the understanding of the processes involved in organic synthesis so is a thoroughly practical question. Many candidates scored well although there were some parts which attracted few correct answers. In the second part of (ii) many candidates implied that the reaction goes to completion whereas it is an equilbrium. In (vii) the question asked why anhydrous calcium chloride was added in step 8 of the preparation. The question should have referred to step 7. This regrettable error had no effect on the answers that were offered for this part of the question. No candidate commented on any confusion. Relatively few candidates knew that wet organic liquids are cloudy but dry ones are clear. There was also little understanding of the function of anti-bumping granules in providing a surface on which bubbles can grow and therefore prevent sudden violent boiling of the liquid. However at least one candidate knew that this phenomenon is called **succussion**.

(a) (i) Explain why the concentrated sulfuric acid is added slowly with **cooling**.

(1)

This is because the reaction is vigorous and exothermic, ~~and cooling prevents~~

(ii) Explain why the mixture is heated **under reflux** for **about 30 minutes**.

(2)

Under reflux so that the mixture does not evaporate and escape.

For about 30 minutes ~~so~~ both the reactant have completley reacted.

(iii) What is the **main** function of the sulfuric acid in this reaction?

(1)

It acts as a catalyst, and oxidizing agent.

(iv) Suggest the identity of **two** impurities that might be present in the crude distillate from step 4.

(2)

Impurities can be water and H_2SO_4 or some of the reactants which have not reacted and are left behind.

(v) What data would you need about propyl ethanoate to be sure that the instruction in step 5 to discard the lower layer is correct?

(1)

The density of propyl ethanoate.

(vi) Step 5 requires that you release the pressure at intervals. Explain why the pressure in the funnel increases.

(2)

This is because sodium carbonate reacts with H_2SO_4 (neutralization) and CO_2 gas is given off which creates pressure in the funnel.

(vii) Explain why anhydrous calcium chloride is added in step 8 and state how the appearance of the liquid changes when this stage is complete.

(2)

This is added to remove any water that is present in the ester, the

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Examiner Comments

This candidate understands a good deal of the craft skills needed in organic preparations. The heating time is misinterpreted, however, and the effect of a drying agent on the appearance of the product and the reason for using anti-bumping granules were not appreciated.

(a) (i) Explain why the concentrated sulfuric acid is added slowly with **cooling**.

(1)

As the reaction is ~~highly~~ exothermic, to prevent the reaction mixture from becoming too hot, cooling is done. slow addition is to prevent a vigorous reaction.

(ii) Explain why the mixture is heated **under reflux** for **about 30 minutes**.

(2)

Under reflux As the organic compounds, CH_3COOH and propan-1-ol are very volatile, the condenser brings back any evaporated reactants back to the flask.

For about 30 minutes Heating ~~is~~ ~~a~~ longer is necessary to ensure all the reactants have reacted (as organic solvents may not not mix well).

(iii) What is the **main** function of the sulfuric acid in this reaction?

(1)

It behaves as a catalyst.

(iv) Suggest the identity of **two** impurities that might be present in the crude distillate from step 4.

(2)

propan-1-ol and ethanoic acid.

(v) What data would you need about propyl ethanoate to be sure that the instruction in step 5 to discard the lower layer is correct?

(1)

The density of the propyl ethanoate layer & the aqueous layer.

(vi) Step 5 requires that you release the pressure at intervals. Explain why the pressure in the funnel increases.

(2)

~~The sulfuric acid~~ The crude ester is highly volatile, thereby when it ~~changes~~ vaporizes to the gas state within the ~~separ~~ ~~sealed~~ airtight separating funnel, pressure builds up. If any acid impurities are present, CO_2 may build up in the ~~flask~~ funnel, increasing pressure.

(vii) Explain why anhydrous calcium chloride is added in step 8 and state how the appearance of the liquid changes when this stage is complete.

(2)

It is a drying agent and removes any moisture in the ester. ~~B~~ when step 8 is complete the ~~~~ cloudy liquid changes to a very clear liquid.

(viii) What is the reason for adding anti-bumping granules in step 8?

(1)

To prevent the formation of bubbles and thereby reduce the risk of liquids splashing.

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Examiner Comments

This answer scores highly - 10/12. The candidate clearly understands much of what is involved in this preparation. The reaction is an equilibrium but the implication in the second part of (ii) is that it can go to completion, which is incorrect. In (vi) the second part of the answer is good and would have scored full marks but for the incorrect statement about the ester at the start. Unusually the reason for using anti-bumping granules is known.

Question 3 (b) (i)

Many candidates were able to calculate the required amounts of ethanoic acid and propan-1-ol used in the experiment. Some, as illustrated by the third example below, made no reference to the volumes of each compound used in the preparation, so came to the correct conclusion but by spurious reasoning. A few candidates answered to an absurd number of significant figures - some as many as seven.

This example gives the correct answer to a sensible number of significant figures.

(b) (i) Use the data in the table below to show, by calculating the numbers of moles, which reactant is in excess.

(2)

Substance	Density/g cm^{-3}	Molar mass/g mol^{-1}
Ethanoic acid	1.05	60.1
Propan-1-ol	0.804	60.1

concentration of acid

no. of moles of acid in 50 cm³ = $\frac{1.05}{60.1} \times \frac{g\ cm^{-3}}{g\ mol^{-1}}$

$50 \times 1.747 \times 10^{-2}$ = 1.747×10^{-2} mol cm^{-3}

= 0.874 moles

Concentration of alcohol

moles of alcohol in 50 cm³ solution = $\frac{0.804}{60.1}$

$50 \times 1.338 \times 10^{-2}$ = 1.338×10^{-2} mol cm^{-3}

= 0.669 moles

ethanoic acid is in excess in mixture.

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Examiner Comments

Examiners need to be able to follow calculations so candidates need to say what they are doing. The candidate has done so and has also made it very clear what the answers are.

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Examiner Tip

Words are very important in calculations. The reader needs to see the thought processes which give rise to the answers.

(b) (i) Use the data in the table below to show, by calculating the numbers of moles, which reactant is in excess.

(2)

Substance	Density/g cm^{-3}	Molar mass/g mol^{-1}
Ethanoic acid	1.05	60.1
Propan-1-ol	0.804	60.1

Mass of Ethanoic acid = 1.05 × 50 = 52.5 g

moles = $\frac{mass}{RMM}$ = $\frac{52.5}{60.1}$ = 0.87 moles

Mass of Propan-1-ol = 0.804 × 50 = 40.2 g

moles = $\frac{40.2}{60.1}$ = 0.67 moles

So ethanoic acid is excess.

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Examiner Comments

This is another crisp, clear, intelligible answer. Two s.f. is perfectly good for this type of calculation.

(b) (i) Use the data in the table below to show, by calculating the numbers of moles, which reactant is in excess.

(2)

Substance	Density/g cm^{-3}	Molar mass/g mol^{-1}
Ethanoic acid	1.05	60.1
Propan-1-ol	0.804	60.1

Ethanoic acid :- $\frac{1.05 \text{ gcm}^{-3}}{60.1 \text{ gmol}^{-1}}$ → ~~0.0175 mol dm^{-3}~~

0.0175 mol cm^{-3}

Propan-1-ol :- $\frac{0.804 \text{ gcm}^{-3}}{60.1 \text{ gmol}^{-1}}$ → = 0.0134 mol cm^{-3}

0.0175 > 0.0134

∴ Ethanoic acid is in excess.

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Examiner Comments

Although this candidate has come to the correct conclusion it comes through a calculation that has no reference to the quantities used in the experiment.

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Examiner Tip

This candidate has included units in the calculation, which is always a good idea. They show that the answers cannot be correct since they are concentrations, not numbers of moles.

Question 3 (b) (ii)

Many candidates tackled this question with confidence and made their intentions clear in a similar fashion to the example given. There were some who were less assured and put numbers in to random calculations with no explanation, so that the examiner had little chance of following what was being done.

(ii) The mass of the ester collected was 35.0 g. Calculate the percentage yield of the ester propyl ethanoate.

Assume the molar mass of propyl ethanoate is 102 g mol^{-1}.

(2)

moles of ester

$= \frac{35}{102}$

= 0.343 moles

No. of moles formed if all reactants react

0.669 moles

% yeild $= \frac{0.343}{0.669} \times 100$

= 51.3%

ResultsPlus

Examiner Comments

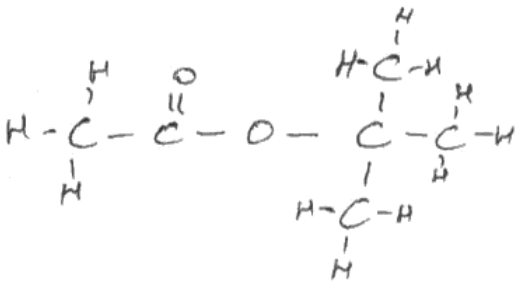
This is an excellent example of a crisp, clear, intelligible answer. At no time is there any doubt as to what is in the candidate's mind.

Question 3 (c) (i)

Common errors in the drawing of structures such as this one are to choose the wrong alcohol or to have too many bonds, usually to carbon. These points are illutrated below. All of these examples have the common feature of impeccable drawing. It is a skill that candidates need to practise again and again so that they develop an instinct for what is correct and what is not.

(i) Draw the structural formula for the ester that is formed from the reaction of ethanoic acid with 2-methylpropan-2-ol.

(1)



ResultsPlus

Examiner Comments

This is an excellent example of a beautifully clear structure drawn with no room for doubt and which the examiner can assess instantly.

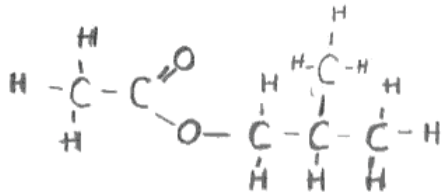
ResultsPlus

Examiner Tip

Candidates should try to have a picture of the structure clearly in their mind before they draw it, rather than experimenting on paper. This candidate clearly does have that picture.

(i) Draw the structural formula for the ester that is formed from the reaction of ethanoic acid with 2-methylpropan-2-ol.

(1)



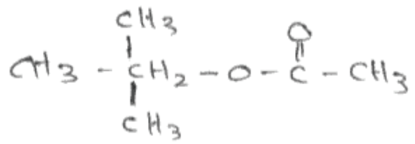
ResultsPlus

Examiner Comments

Although very well drawn this is the ester which would have arisen from the use of 2-methylpropan-1-ol. It was a error which was relatively common with candidates who did not score the mark.

(i) Draw the structural formula for the ester that is formed from the reaction of ethanoic acid with 2-methylpropan-2-ol.

(1)



ResultsPlus

Examiner Comments

Also a very well drawn structure, this candidate has made a serious error with the valency of the central carbon. These are not uncommon and candidates need to take great care and examine their structures critically.

Question 3 (c) (ii)

This question was answered very well by many candidates with two of the best examples given below. There are several ways of answering this question with oxidation being the most common. The Lucas test, involving reaction with concentrated HCl and zinc chloride, was offered by at least one candidate who scored full marks. A surprisingly large number of candidates opted for the iodoform reaction, which of course works for propan-2-ol but not for propan-1-ol. Sadly they did not score any marks.

(ii) Suggest a simple test-tube experiment that the student could carry out on the original alcohol to see if the suspicion could be correct. Give the reagents used and the expected result for both propan-1-ol and 2-methylpropan-2-ol. Explain why the results are different.

(4)

Acidified ~~potassium~~ $KMnO_4$ is added ~~the~~ each alcohol ~~and shaken~~ in a test tube and shaken. The solution turns purple to colourless for propan-1-ol but remains purple for ~~p~~ 2 methyl propan-2-ol.
$KMnO_4/H^+$ is an oxidising agent and is reduced to colourless Mn^{2+}. As tertiary alcohol cannot be oxidised solution remains purple.

ResultsPlus

Examiner Comments

This example uses potassium manganate(VII) as oxidising agent and goes meticulously through the steps needed to score the four marks. The examiner is left in no doubt as to what is intended.

This candidate was lucky in that the first part of the answer about ester production was irrelevant - it did not contradict anything written later. The answer goes on to give a textbook answer to the question which is clear and well worth its four marks.

(ii) Suggest a simple test-tube experiment that the student could carry out on the original alcohol to see if the suspicion could be correct. Give the reagents used and the expected result for both propan-1-ol and 2-methylpropan-2-ol. Explain why the results are different.

(4)

Inorder to differentiate between propan-1-ol and 2 methyl propan-2-ol, add ethanoic acid to both the alcohols, both of them give a fruity smell. Now react the propan-1-ol with acidified $K_2Cr_2O_7$ in the presence of dilute sulphuric acid, the colour changes from orange to green. But when 2 methyl propan-2-ol is reacted with acidified $K_2Cr_2O_7$ it will not give the colour change because it is a tertiary alcohol and it doesnot oxidises to give the colour change, where the propan-1-ol is a primary alcohol and it does oxidise giving colour change.

ResultsPlus
Examiner Comments

This clip is included as a warning that candidates should avoid giving two answers when one is wanted. If, as here, the answer is correct but irrelevant, there is no consequence. If the initial answer had been incorrect or contradicted the second, there would have been no credit.

(ii) Suggest a simple test-tube experiment that the student could carry out on the original alcohol to see if the suspicion could be correct. Give the reagents used and the expected result for both propan-1-ol and 2-methylpropan-2-ol. Explain why the results are different.

(4)

Add acidified $K_2Cr_2O_7$ into the alcohol. If it turns from orange to green, its propan-1-ol, if not it is 2-methyl propan-2-ol (tertiary.)

ResultsPlus
Examiner Comments

This is a typical answer that does not go right to the end - everything is there apart from the reason for the difference in behaviour of the two alciohols. The examiner will suspect that the candidate knows - but examiners do not guess. Candidates must make their answer explicit.

Paper Summary

The examples quoted have been chosen to show some of the best characteristics of answers received, as well as some common errors. If candidates give careful thought to these points and put the recommendations into practice, they will score more marks in an exam. **Much** more important is that, they will have a much better understanding of the chemistry.

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