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Examiners' Report
January 2012

GCE Chemistry 6CH08 01

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Introduction

To score high marks on this paper candidates need to be familiar with standard practical techniques. Questions focus on observations, measurement and the logical deduction of valid conclusions from data.

Question 1 (a)

Most candidates correctly gave the formula of the aldehyde and the ketone, though weaker answers had them the wrong way round.

In the second part of the question, most candidates recognised that there were three peaks and so the spectrum must be that of B. Many failed to get the second mark because they gave no evidence that the spectrum cannot be that of A or incorrectly stated that A would have two peaks, failing to recognise the symmetry of the ketone. The best answers added a correct explanation of the splitting pattern and commented that A's single peak would be a singlet.

Answer ALL the questions. Write your answers in the spaces provided.

1 Three compounds **A**, **B** and **C** are subjected to a series of chemical tests. Some information about these compounds is given below.

- The three compounds are isomers with molecular formula C_3H_6O.
- **A** and **B** contain only one functional group, but **C** contains two separate functional groups.
- None of the three compounds contains a ring of atoms.
- In each of the three compounds the oxygen atom is bonded to only one carbon atom.

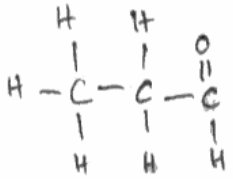
(a) (i) **A** and **B** are tested separately with 2,4-dinitrophenylhydrazine solution and both give an orange precipitate.

When **A** and **B** are heated separately with a mixture of potassium dichromate(VI) and dilute sulfuric acid, the solution containing **B** turns from orange to green. The solution containing **A** remains orange.

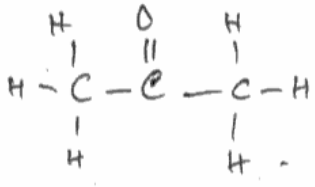
Use these results and the information at the start of the question to deduce displayed formulae for **A** and **B**.

(2)

A



B



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Examiner Comments

The correct substances are given, but the wrong way round.

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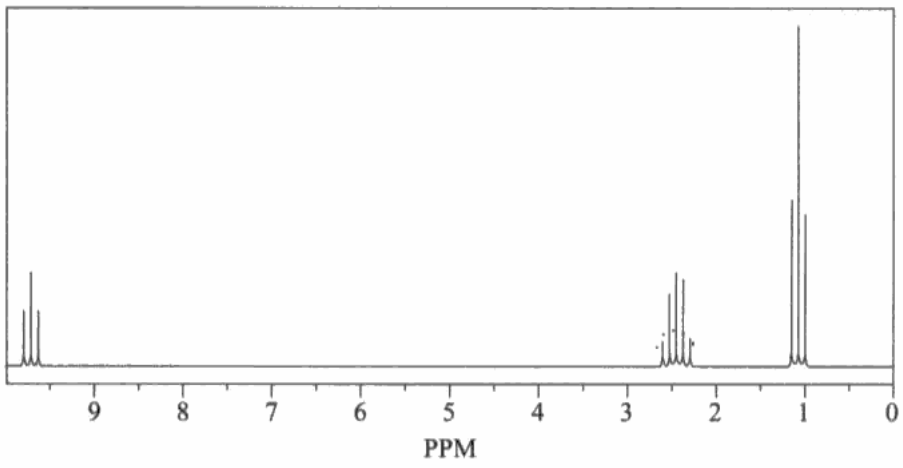
Examiner Tip

Read the question carefully!

(ii)



State whether this is the nmr spectrum of **A** or **B**. Justify your answer.

Explain how the nmr spectrum of the other isomer will differ.

(2)

B. B has 3 peaks at ratio 1:2:3.

ResultsPlus
Examiner Comments

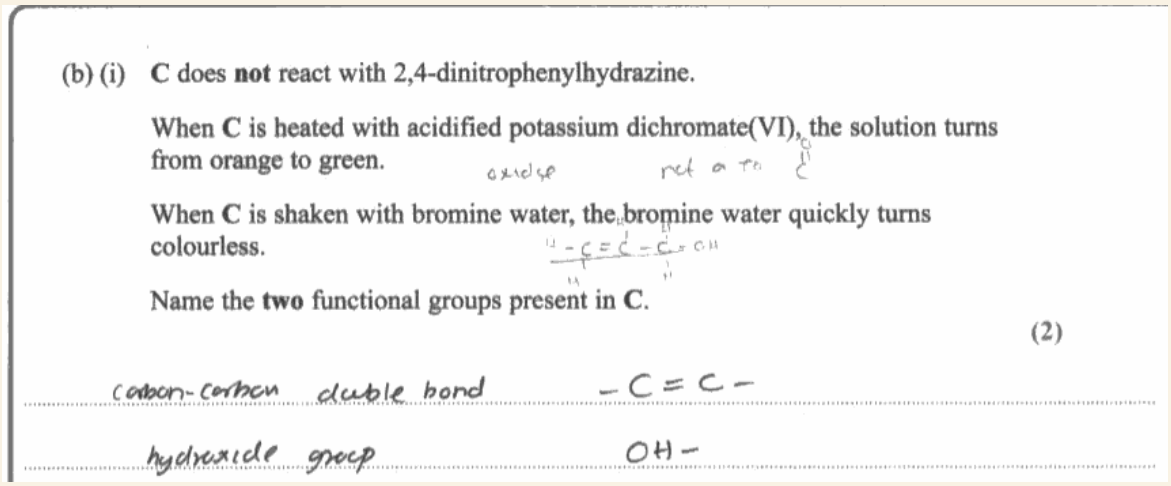
B is correctly identified, but no mention is made of A, so one mark is lost.

ResultsPlus
Examiner Tip

In a comparison question, always discuss both items being compared.

Question 1 (b) (i)

Many candidates lost a mark here by stating that one functional group was OH. This does not answer the question which asked for a *name* and is also ambiguous because alcohols and carboxylic acids contain the OH group.



(b) (i) **C** does **not** react with 2,4-dinitrophenylhydrazine.

When **C** is heated with acidified potassium dichromate(VI), the solution turns from orange to green.

oxidise not a ketone

When **C** is shaken with bromine water, the bromine water quickly turns colourless.

Name the **two** functional groups present in **C**.

(2)

carbon-carbon double bond –C=C–

hydroxide group OH–

ResultsPlus
Examiner Comments

Hydroxide" is the name of an ion, not a functional group.

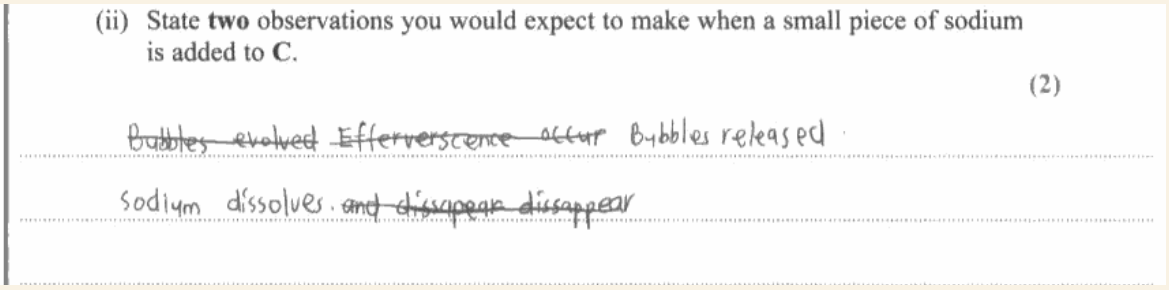
ResultsPlus
Examiner Tip

The alcohol functional group can be named as "alcohol" or "hydroxy".

Question 1 (b) (ii)

This was generally well answered though the weaker candidates confused the reaction of sodium with an alcohol with the reaction with water so described the sodium melting and moving about on the surface.

This concise answer has two valid points, so scores full marks.



(ii) State **two** observations you would expect to make when a small piece of sodium is added to **C**.

(2)

~~Bubbles evolved~~ ~~Efferverscence occur~~ Bubbles released

Sodium dissolves. ~~and disappear~~ ~~dissappear~~

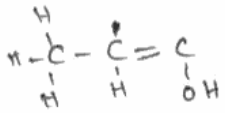
ResultsPlus
Examiner Comments

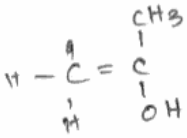
Concise answers can score well.

Question 1 (b) (iii)

This was well answered. Candidates were not expected to know that enol forms are not generally stable.

(iii) Draw **two** possible displayed formulae for **C** which are consistent with the above information. **(2)**





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Examiner Comments

The left hand formula is one hydrogen atom short.

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Examiner Tip

Check that all the carbon atoms have four bonds.

Question 2 (a)

This was generally well answered though nickel or chromium salts were often given.

Question 2 (b)

Most candidates correctly identified the ammonia.

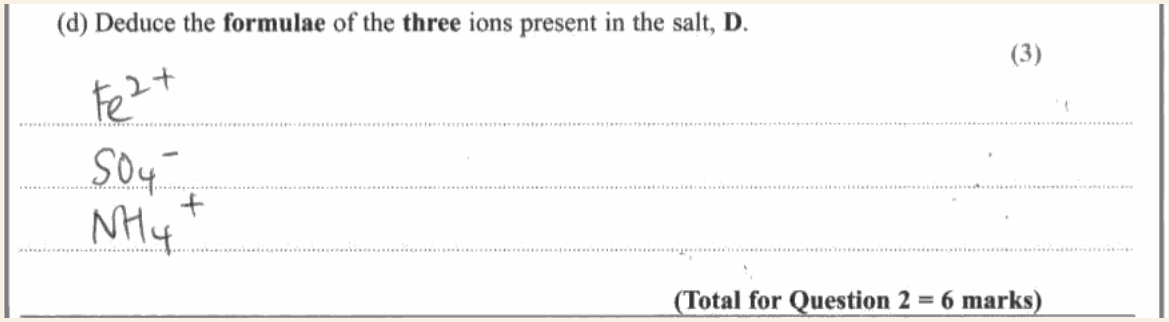
Question 2 (c)

This standard test was well known, most candidates obtained the mark.

Question 2 (d)

Many candidates gave a complete formula rather than the formula for the ions. Some credit was given if the formula unambiguously contained the correct ions.

Ni^{2+} and Cr^{3+} were often wrongly identified as responsible for the green colour. Weaker candidates confused ammonia with the ammonium ion.


(d) Deduce the **formulae** of the **three** ions present in the salt, **D**.

(3)

Fe^{2+}

SO_4^-

NH_4^+

(Total for Question 2 = 6 marks)

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Examiner Comments

Almost correct, but the sulfate ion has only one charge.

Cr^{3+} is the wrong ion and the ammonium ion is one hydrogen short.

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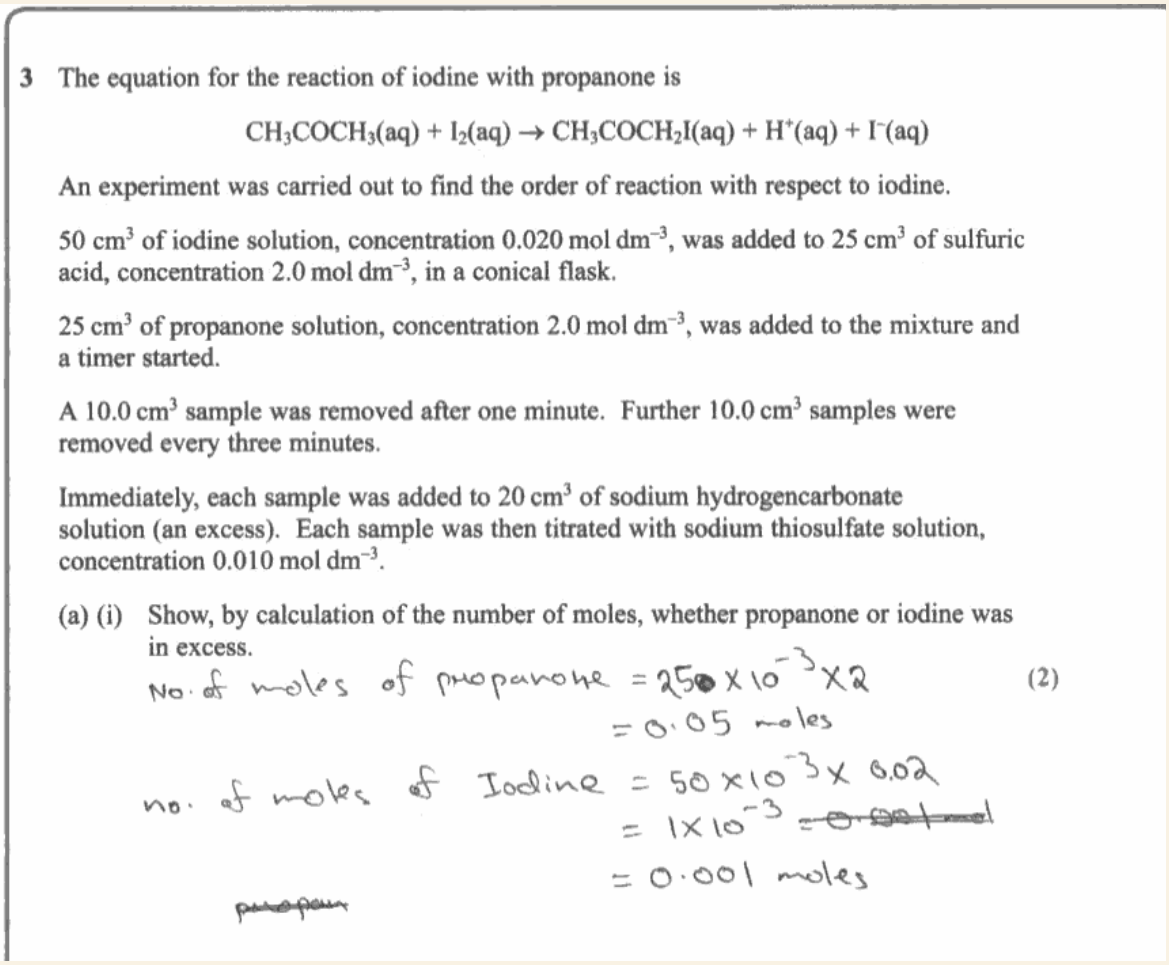
Examiner Tip

Learn the charges on common ions.

Learn the formulae of common ions

Question 3 (a) (i)

This was generally very well answered though a few candidates threw away the second mark by failing to state which reagent was in excess.



3 The equation for the reaction of iodine with propanone is

$$CH_3COCH_3(aq) + I_2(aq) \rightarrow CH_3COCH_2I(aq) + H^+(aq) + I^-(aq)$$

An experiment was carried out to find the order of reaction with respect to iodine.

50 cm^3 of iodine solution, concentration 0.020 mol dm^{-3}, was added to 25 cm^3 of sulfuric acid, concentration 2.0 mol dm^{-3}, in a conical flask.

25 cm^3 of propanone solution, concentration 2.0 mol dm^{-3}, was added to the mixture and a timer started.

A 10.0 cm^3 sample was removed after one minute. Further 10.0 cm^3 samples were removed every three minutes.

Immediately, each sample was added to 20 cm^3 of sodium hydrogencarbonate solution (an excess). Each sample was then titrated with sodium thiosulfate solution, concentration 0.010 mol dm^{-3}.

(a) (i) Show, by calculation of the number of moles, whether propanone or iodine was in excess. (2)

No. of moles of propanone $= 25 \times 10^{-3} \times 2$
$= 0.05$ moles

no. of moles of Iodine $= 50 \times 10^{-3} \times 0.02$
$= 1 \times 10^{-3}$
$= 0.001$ moles

ResultsPlus
Examiner Comments

The hard work is done, but the answer does not say which reagent is in excess, so loses a mark.

ResultsPlus
Examiner Tip

Make sure you fully answer the question.

Question 3 (a) (ii)

Most candidates correctly identified a pipette as the appropriate device.

Question 3 (a) (iii)

Many candidates again suggested a pipette, failing to appreciate that the sodium hydrogencarbonate was in excess so its volume did not require precise measurement.

Question 3 (a) (iv)

Only the best candidates appreciated that the purpose of the sodium hydrogencarbonate was to remove the acid. Many understood that the reaction should be quenched but gave no indication of how this should be done.

(iv) Suggest why each sample was added to sodium hydrogencarbonate solution. Explain your answer.

(2)

Sample was added to Sodium hydrogen carbonate solution in order to stop the reaction.

Sodium hydrogen carbonate quenches the reaction so that the reaction stop and ~~none of~~ the ~~con~~ concentration doesnot change.

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Examiner Comments

The idea of quenching or stopping the reaction is given twice, but no explanation of how this is done is included, so only one mark is scored.

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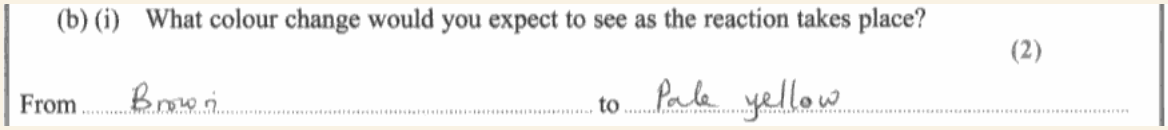
Examiner Tip

In a two mark question, give two different points in your answer.

Question 3 (b) (i)

Many candidates confused the colour change during the reaction with the end point of the titration.


(b) (i) What colour change would you expect to see as the reaction takes place?

(2)

From Brown to Pale yellow

ResultsPlus
Examiner Comments

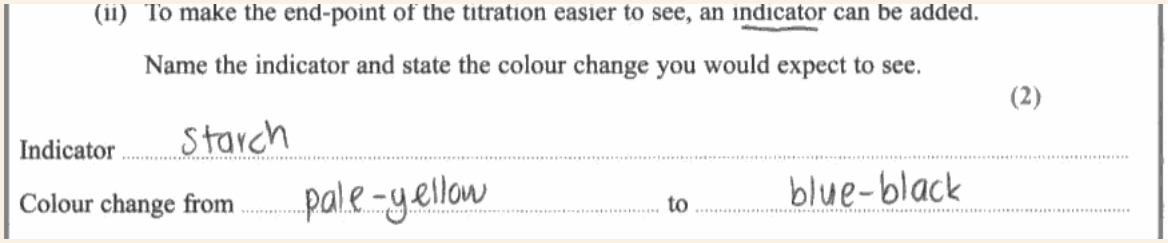
This is correct - the iodine is initially brown and will not necessarily all be used up, so the solution may become pale yellow.

ResultsPlus
Examiner Tip

Always try to ensure that your answers make chemical sense!

Question 3 (b) (ii)

Most candidates correctly identified the required indicator as starch but many then reversed the end point colour change.



(ii) To make the end-point of the titration easier to see, an indicator can be added.

Name the indicator and state the colour change you would expect to see.

(2)

Indicator starch

Colour change from pale-yellow to blue-black

ResultsPlus
Examiner Comments

Correct indicator but the colour change is completely wrong.

ResultsPlus
Examiner Tip

Try to understand the process rather than just memorising colour changes. That way you will avoid errors.

Question 3 (b) (iii)

Most candidates were aware that the starch is added when the solution is pale yellow. Weaker candidates suggested that it should be added before the titration begins.

(iii) At what stage in the titration should this indicator be added?

(1)

The solution is a yellow

ResultsPlus
Examiner Comments

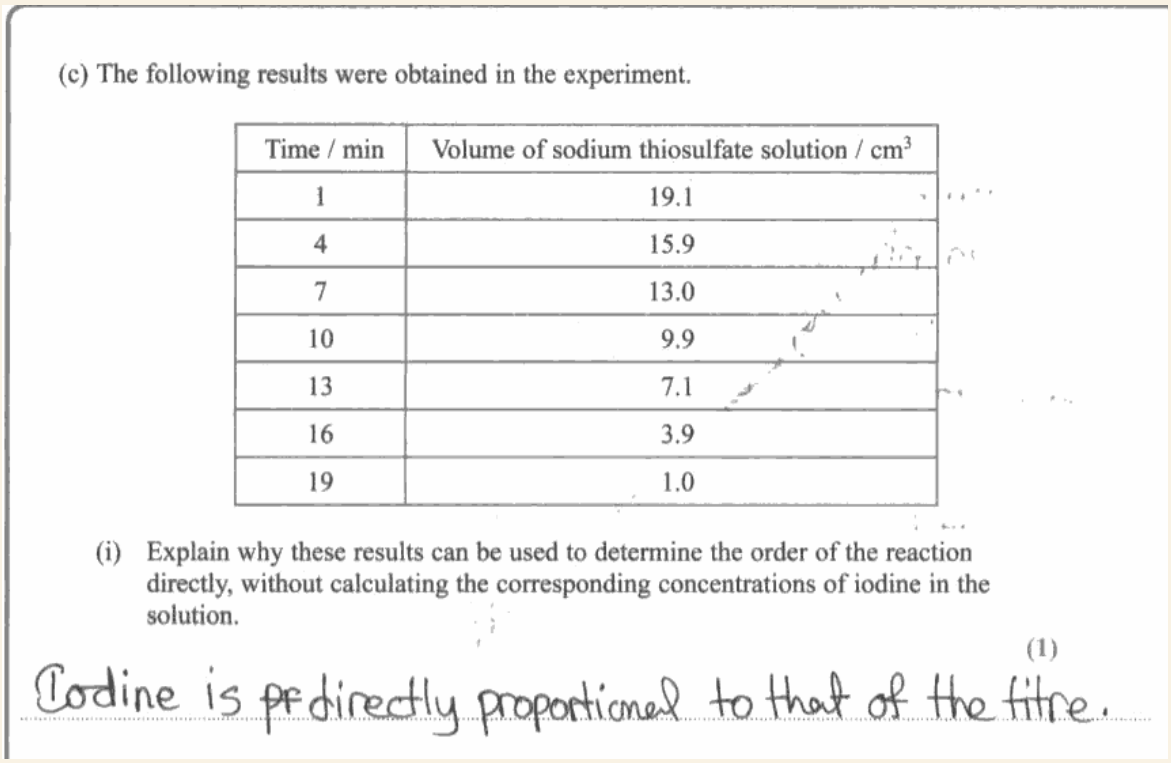
"Yellow" is too imprecise - the starch is added just before the end point when the colour is "pale yellow".

ResultsPlus
Examiner Tip

Don't be vague!

Question 3 (c) (i)

Many candidates spoiled a promising answer by stating the concentration of the iodine was proportional to the **concentration** rather than the **volume** of the sodium thiosulfate.



(c) The following results were obtained in the experiment.

Time / min	Volume of sodium thiosulfate solution / cm^3
1	19.1
4	15.9
7	13.0
10	9.9
13	7.1
16	3.9
19	1.0

(i) Explain why these results can be used to determine the order of the reaction directly, without calculating the corresponding concentrations of iodine in the solution.

(1)

Iodine is ~~pr~~ directly proportioned to that of the titre.

ResultsPlus
Examiner Comments

As it stands, this answer is meaningless - it is the **concentration** of the iodine that is proportional to the titre.

ResultsPlus
Examiner Tip

Be precise about quantities and concentrations.

Question 3 (c) (ii)

The graph was usually well plotted though marks were lost when candidates missed the units from the axis labels or failed to draw a line of best fit.

Question 3 (c) (iii)

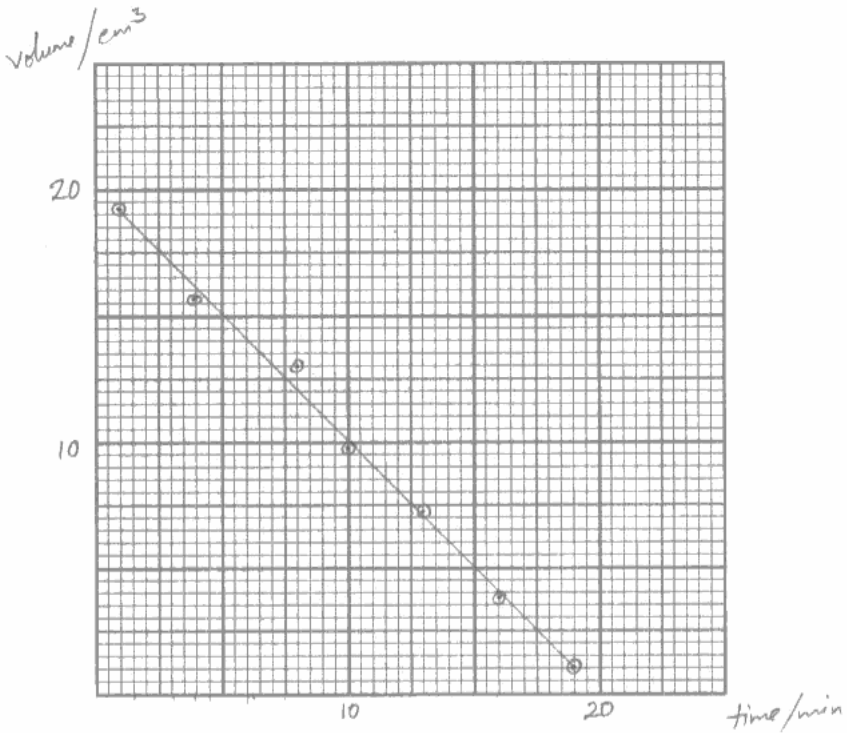
In part (c)(iii), some answers correctly identified the reaction as order zero because the graph was a straight line, but failed to explain the significance of the straight line (that the rate was constant) so lost the second mark.

Question 3 (d)

In part 3(d), if candidates had previously suggested that the order was one or two, they lost the mark unless they made it clear that their order was inconsistent with suggested rate determining step.

(ii) Plot a graph of the volume of sodium thiosulfate solution on the vertical axis against time on the horizontal axis.

(2)



(iii) Use your graph to deduce the order of the reaction with respect to iodine.

Explain how you arrived at your answer.

(2)

Second order. The gradient of the graph is negative.

ResultsPlus
Examiner Comments

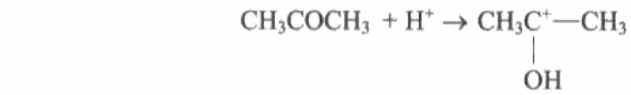
One point is clearly mis-plotted - so a mark is lost.

In part (iii), the order is wrong.

ResultsPlus
Examiner Tip

Choose a simple scale and plot the points carefully.

(d) The following rate-determining step for the reaction between propanone and iodine is suggested.



$$CH_3COCH_3 + H^+ \rightarrow CH_3C^+(OH)—CH_3$$

Explain why your order of reaction with respect to iodine is consistent with this rate-determining step.

(1)

Iodine is not present in the rate determining step, which is consistent with the order.

(Total for Question 3 = 17 marks)

ResultsPlus
Examiner Comments

A good clear answer.

ResultsPlus
Examiner Tip

Always try to express your answer clearly like this.

Question 4 (a)

Only the best candidates managed to explain how heating under reflux works. However most could find at least one reason why it is necessary.

4 2-ethanoylaminobenzoic acid, $C_9H_9NO_3$, is a compound which emits flashes of light when its crystals are crushed or scraped. It is prepared under strictly supervised conditions.

The steps of the experimental procedure are as follows.

1. Place 3.5 g of 2-aminobenzoic acid, $C_7H_7NO_2$, in a dry 50 cm^3 flask fitted with a reflux condenser.
2. Add 7.0 cm^3 of ethanoyl chloride (an excess) by pouring it carefully down the condenser.
3. Heat slowly to boiling and reflux for 15 minutes.
4. Allow to cool and then add 5 cm^3 of water.
5. Bring the solution back to boiling by heating slowly.
6. Allow the solution to cool slowly at room temperature.
7. Collect the crystals of 2-ethanoylaminobenzoic acid by suction filtration.
8. Recrystallize the 2-ethanoylaminobenzoic acid from a 50% ethanoic acid/water mixture.

(a) Explain how the process of heating under reflux works and why it is often necessary to heat under reflux, as in **step 3**.

(3)

It is It works by placing a condenser in the flask, standing vertically. In the ~~flask~~ The flask must be round ~~bottled~~ bottomed for the heat that is supplied under it, should be equally distributed. It is necessary to heat under reflux because organic compounds take long to reaction their own.

ResultsPlus
Examiner Comments

This answer does not explain clearly how heating under reflux works. The only mark obtained is for the idea that otherwise the reaction rate is too slow.

ResultsPlus
Examiner Tip

Try to make your answers clear and logical.

4 2-ethanoylaminobenzoic acid, $C_9H_9NO_3$, is a compound which emits flashes of light when its crystals are crushed or scraped. It is prepared under strictly supervised conditions.

The steps of the experimental procedure are as follows.

1. Place 3.5 g of 2-aminobenzoic acid, $C_7H_7NO_2$, in a dry 50 cm^3 flask fitted with a reflux condenser.
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(a) Explain how the process of heating under reflux works and why it is often necessary to heat under reflux, as in **step 3**.

(3)

The process of reflux works in a way that when the reactants are heated continously and when they evaporate, they are condensed and fall back for more heating. This is because the reaction is slow and because the ethanoyle chloride is ~~has a low b~~ evaporates easily.

ResultsPlus
Examiner Comments

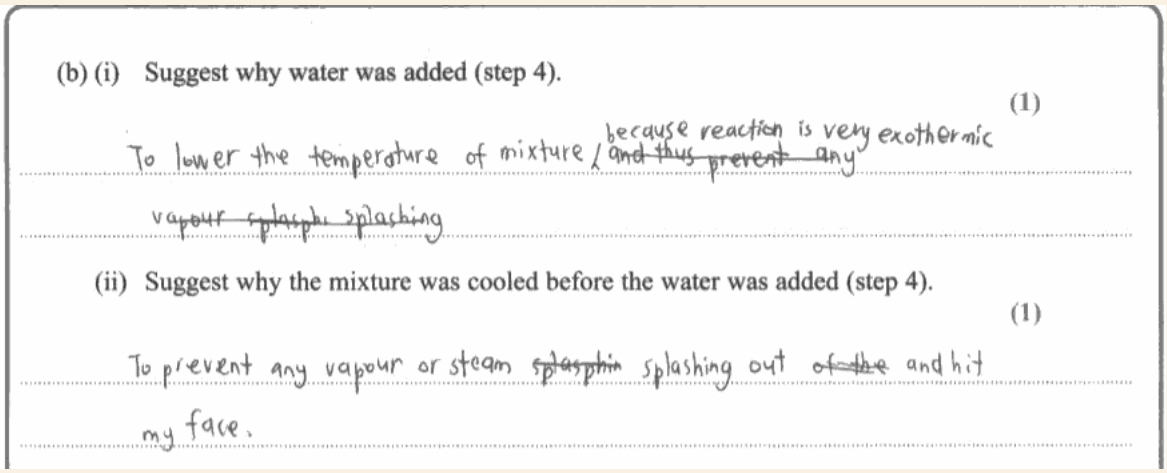
This answer gets one mark for explaining the process and one for the idea that otherwise the reaction is slow.

Question 4 (b) (i)

Part (b)(i) proved to be very challenging. Many candidates thought that the addition of water was a step in the purification process.

Question 4 (b) (ii)

In part (b)(ii), very few candidates appreciated the link between 4(bi) and 4(bii). However, many still managed to gain the mark by appreciating that the reaction may be exothermic.



(b) (i) Suggest why water was added (step 4).

(1)

To lower the temperature of mixture / because reaction is very exothermic and thus ~~prevent~~ any vapour ~~splash~~ splashing

(ii) Suggest why the mixture was cooled before the water was added (step 4).

(1)

To prevent any vapour or steam ~~splashin~~ splashing out ~~of the~~ and hit my face.

ResultsPlus
Examiner Comments

The answer in (b)(i) is incorrect but the comment that the reaction is exothermic is credited in part (b)(ii).

(b) (i) Suggest why water was added (step 4).

(1)

This is to remove the excess ethanoyl chloride that might be left unreacted in the mixture.

(ii) Suggest why the mixture was cooled before the water was added (step 4).

(1)

For safety measures, adding water to a boiling mixture could result in hazardous consequences

ResultsPlus
Examiner Comments

The answer in (b)(i) is correct but the answer in (b)(ii) is too vague to gain any credit.

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Examiner Tip

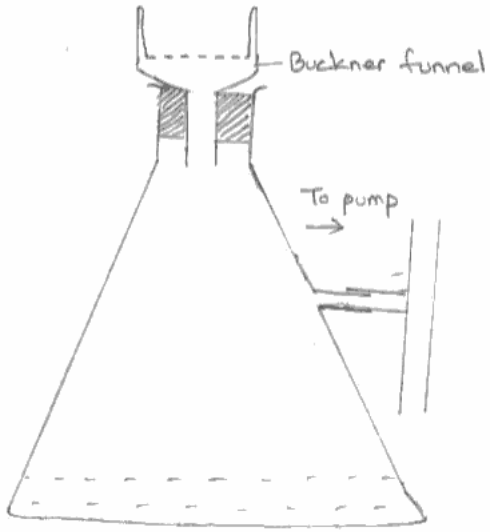
Don't be vague!

Question 4 (c) (i)

Most candidates were aware of the technique. Marks were lost when it was not made clear that filter paper is needed in the funnel.

(c) (i) Draw a fully labelled diagram of the apparatus used for suction filtration (step 7).

(3)



ResultsPlus
Examiner Comments

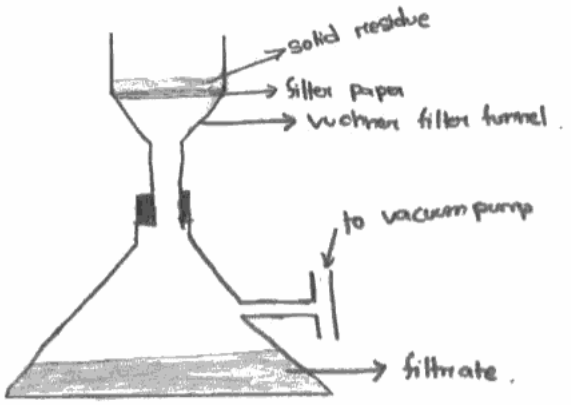
A good diagram - but the filter paper is missing, so only two marks are gained.

ResultsPlus
Examiner Tip

Include all necessary equipment.

(c) (i) Draw a fully labelled diagram of the apparatus used for suction filtration (step 7).

(3)



ResultsPlus
Examiner Comments

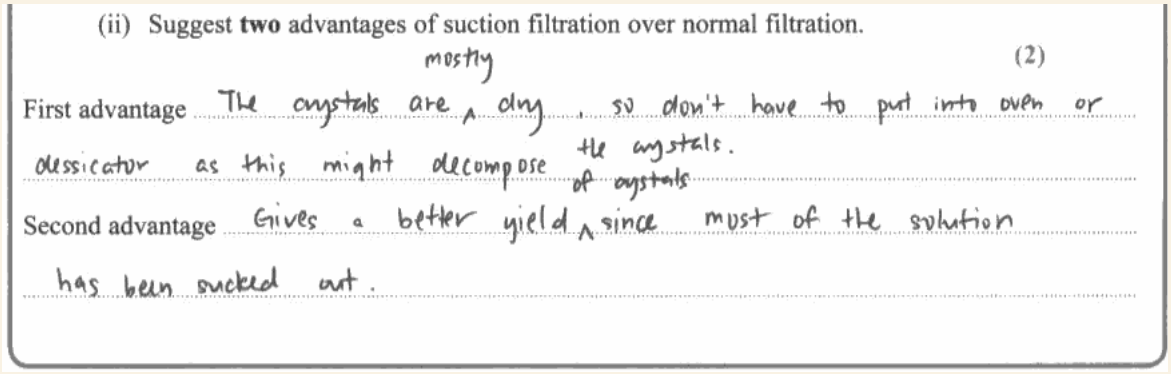
An excellent answer.

ResultsPlus
Examiner Tip

Labelling a diagram helps to make it clear.

Question 4 (c) (ii)

Most candidates appreciated that filtration would be faster. Far fewer realised that the crystals would be much drier. A large number wrongly thought that the crystals would be purer or would be obtained in higher yield.



(ii) Suggest **two** advantages of suction filtration over normal filtration. (2)

First advantage The crystals are mostly dry, so don't have to put into oven or dessicator as this might decompose the crystals. of crystals

Second advantage Gives a better yield since most of the solution has been sucked out.

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Examiner Comments

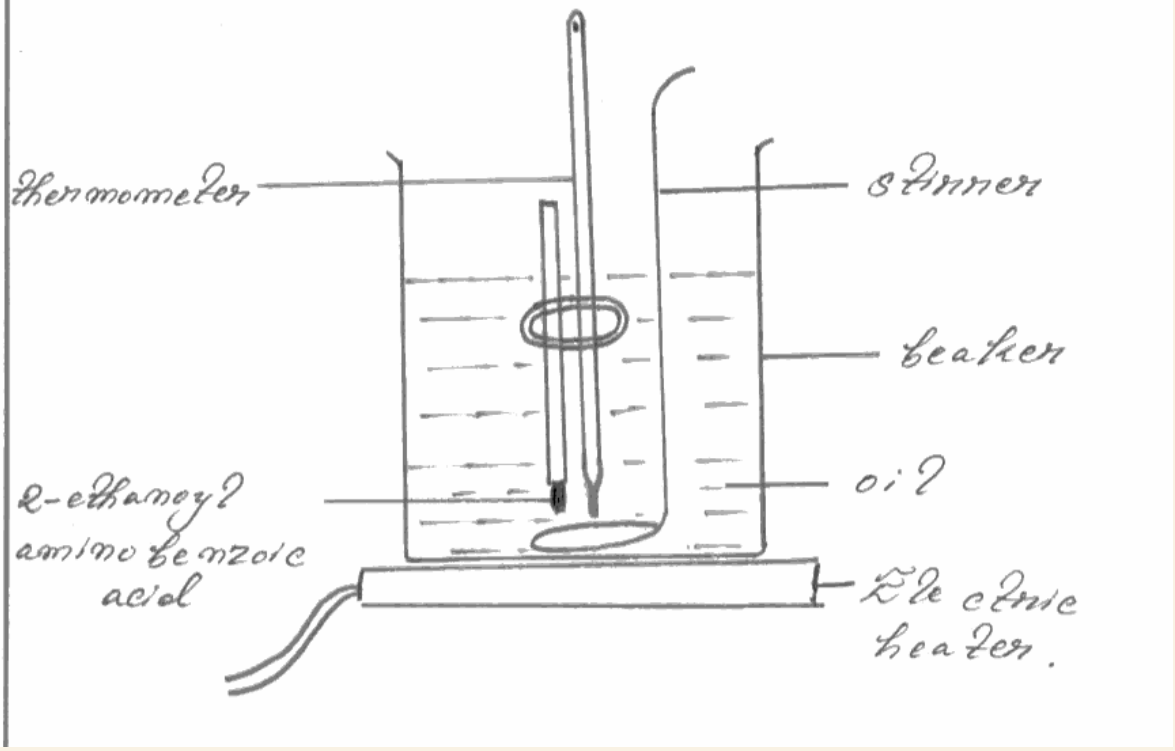
The first advantage is correct but improving filtration does not increase the yield of crystals.

Question 4 (d) (i)

Only a minority of candidates could correctly draw the apparatus. Many inserted extra glass tubes between the capillary tube and the thermometer which would have restricted heat flow and made the result less accurate.

(d) (i) Draw a fully labelled diagram of the apparatus you would use to determine the melting temperature of the 2-ethanoylaminobenzoic acid crystals.

(2)



ResultsPlus
Examiner Comments

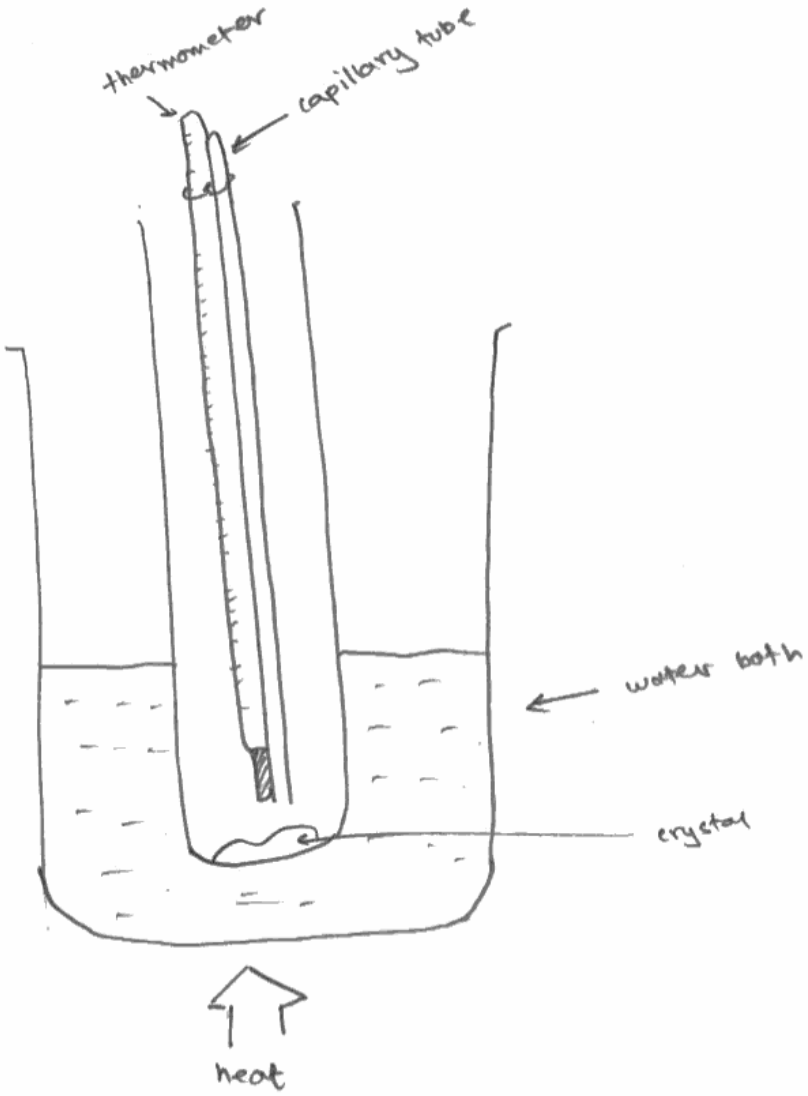
An excellent answer.

ResultsPlus
Examiner Tip

Clearly labelled diagrams show that you really understand the apparatus.

(d) (i) Draw a fully labelled diagram of the apparatus you would use to determine the melting temperature of the 2-ethanoylaminobenzoic acid crystals.

(2)



ResultsPlus
Examiner Comments

The crystals are in the wrong place and the extra test tube serves no purpose - so no marks.

ResultsPlus
Examiner Tip

Think about the purpose of the equipment you are describing.

Question 4 (d) (ii)

Many candidates struggled to express clearly the idea of a *sharp* melting point, frequently confusing the range of temperature over which the crystals melted with the acceptable range of divergence from the data book value. Such answers usually gained one of the two marks, but did not merit full credit.

the crystals were pure.

(2)

The melting temperature is similar as in data booklet. High melting temperature.

ResultsPlus
Examiner Comments

One correct point but "high melting temperature" has no meaning in itself.

(ii) Give **two** aspects of the melting temperature determination that would indicate the crystals were pure.

(2)

i) If the crystals all melted within a short range of temperature this indicates purity of the crystals.

ii) If the melting temperature is similar to the expected melting temperature of the compound hence it is pure.

ResultsPlus
Examiner Comments

An excellent answer.

ResultsPlus
Examiner Tip

Try to express yourself clearly like this.

Question 4 (e)

The calculation was generally well done but many candidates lost a mark by truncating their intermediate results to one or two significant figures, thus making the final answer inaccurate. Candidates are advised to write intermediate results to one more significant figure than they intend to use in the final answer or, even better, to carry the intermediate values forward in their calculators.

(e) In the equation for this reaction, the mole ratio of 2-aminobenzoic acid, $C_7H_7NO_2$, and 2-ethanoylaminobenzoic acid, $C_9H_9NO_3$, is 1:1.

In an experiment, 3.5 g of 2-aminobenzoic acid produced 2.35 g of recrystallized 2-ethanoylaminobenzoic acid.

Calculate the percentage yield of the product for this reaction.

(3)

Moles of 2-amino benzoic acid = $\frac{3.5}{(12\times7)(1\times7)+14+32}$

= 0.0255 moles.

∴ Moles of 2-ethanoylamino benzoic acid = 0.0255 moles.

∴ Expected mass = $0.0255 \times (9\times12+9\times1+14+16\times3)$

$= 0.0255 \times 179$

= 4.565 g.

Percentage yeild = $\frac{2.35}{4.56} \times 100\%$

= 51.34%.

ResultsPlus
Examiner Comments

A good answer but inaccurate rounding of intermediate results has resulted in the final answer being inaccurate and has lost one mark.

ResultsPlus
Examiner Tip

In your workings express results to one more significant figure than you will use in the final answer. This will avoid rounding errors.

Paper Summary

The paper allowed candidates to demonstrate their knowledge of practical techniques. Candidates with the requisite skills were able to score high marks.

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