

Examiners' Report
June 2016

GCSE Chemistry 5CH3H 01

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Introduction

Paper 5CH3H is taken by candidates for GCSE Chemistry and for GCSE Further Additional Science. It follows the usual format of six questions. There is a mixture of multiple choice items, short answer items and two extended response (6 mark) items.

There was a good response to this paper overall, with the strongest candidates answering the trickier parts well – calculations and equations but also the ionic equation and the structural formula of the ester, for example. Question 6(d) produced many excellent answers with well argued, logical approaches to the organic identification.

Question 1 (b)

Most candidates gained at least 1 mark on this question and many gained both. The most common correct response was 'boiling the water or evaporation, and the subsequent production of limescale'. Some candidates failed to score the second mark, e.g. 'by forming a precipitate following boiling' or using 'scum' instead of 'scale'.

Some candidates' responses included the use of soap solution, but the main error on the part of those who had read the question involved the inappropriate use, in this context, of sodium hydroxide solution or other ion tests.

Question 1 (c)

This question was generally well answered, with the vast majority naming an ion exchange column or resin and correctly identifying some or all of the ions involved in the exchange. A few, instead of 'ions' being exchanged, used elements or atoms or molecules or compounds, or did not remember which ions were exchanged.

'The addition of sodium carbonate' or 'distillation of the water' were rarely seen responses, although some candidates did suggest 'boiling' as an appropriate response and were confused about its role in water softening.

(c) Explain one method which removes both temporary **and** permanent hardness from water.

(2)

Passing the water through ion exchange resin. Which contains sodium ions or hydrogen ions and these will replace the magnesium ions and ~~calcium~~ Calcium ions in the water



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Examiner Comments

An example of a good response.



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Examiner Tip

This question says "Explain..." so, like this candidate, identify the particles being exchanged as ions to give a correct explanation.

Question 1 (d)

A majority of candidates discussed problems with lathering and the need for more soap (and the additional cost of this). Unfortunately, some stated that, since hard water made it more difficult to form a lather, more water is needed to form a lather ("water is wasted"). Fewer mentioned the formation of scum. Although some candidates referred to limescale there were fewer references to blocked pipes or kettles or other appliances and the consequent reduction in their efficiency.

A small minority of candidates believed that hard water is caused by the presence of aluminium ions and gave its associated disadvantage as contributing to the cause of Alzheimer's disease.

Other incorrect ideas included hard water being unhealthy, rough on the skin or having a bad taste.

It is important that the distinction between scum and limescale is known, and also that in a question such as this the cause and the consequent effect is given.

(d) Explain a disadvantage of having a domestic water supply that is hard.

(2)

It's difficult to form a lather so more is used,
and it forms scum instead. Temporary hard water,
when boiled in a kettle, would soften and the
calcium carbonate would create limescale



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Examiner Comments

This candidate has made valid points but the answer is not clearly expressed.



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Examiner Tip

Be clear in your answer:
More of what is used?
Why is limescale a problem?

(d) Explain a disadvantage of having a domestic water supply that is hard.

(2)

Hard water creates limescale, which can damage dishwashers and washing machines. You also need a lot more soap to create a lather with hard water, so this will cost the household money.



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Examiner Comments

This answer contrasts with the other example.



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Examiner Tip

This candidate has explained the problem:

Problem: limescale

Explanation: damages washing machines

Problem: uses more soap

Explanation: costs more money

Question 2 (a) (i)

The vast majority of candidates gained both marks here. Where marks were lost it was either due to an incorrect colour of the precipitate (usually cream) or stating additional phenomena (e.g. fizzing).

Question 2 (a) (iii)

The difference between qualitative and quantitative is generally very well known. Many candidates gave blood analyses as examples. Some mistook qualitative tests as tests for quality or purity.

(iii) Doctors often request blood tests. The tests they require to be carried out are quantitative tests.

Describe the difference between a **qualitative** and a **quantitative** test.

(2)

Qualitative tells you what is present in the substance and quantitative tells you how much of something is present. Quantitative analysis is used by the police force to see how much alcohol is in the blood (drink driving)



ResultsPlus Examiner Comments

Read through your answers when you have finished. This answer has used qualit(at)ive twice in the first sentence, and so has contradicted itself.



ResultsPlus Examiner Tip

The use of examples – in this case alcohol levels in blood – can be a good idea, but unfortunately this is a quantitative test.

Question 2 (b)

There was a good response to this question, with many answers awarded all the marks. Those candidates who scored zero did so as a result of using an incorrect reagent, flame tests or by giving the test for iodide ions. Occasionally the use of litmus was recommended. There was good chemistry seen and often (as a bonus) correctly explained in such responses. The main reason for the loss of 1 mark was the failure to use 'excess' of sodium hydroxide solution.

(b) Describe a test to show that aluminium iodide contains aluminium ions.

(3)

To test for aluminium ions you can add sodium hydroxide (NaOH) to the aluminium iodide mixture. When you add a few drops of NaOH a white precipitate should form, however this would also occur in a test for calcium ions, for a unique test add a few more drops of NaOH. If aluminium ions are present the precipitate should dissolve, leaving a colourless liquid.



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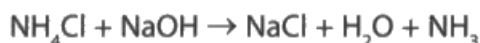
A well described and explained answer. (The candidate should have referred to sodium hydroxide solution, but this was not penalised).

Question 3 (a)

Many candidates gained 1 mark for calculating $M_r(\text{NaOH})$ as 40, but then went on to work out the M_r of ammonia as well. An inverted calculation of $40/4$ was often seen. Numeracy skills are at a premium when allied to chemistry (or otherwise). Many candidates just added up all the masses or worked on ammonium chloride instead of sodium hydroxide.

Of those that did progress, the main error was to fail to multiply by the mole volume of the gas (24 dm^3).

- 3 (a) Ammonia gas, NH_3 , is formed by reacting ammonium chloride, NH_4Cl , with sodium hydroxide, NaOH .



In an experiment 4.0 g of sodium hydroxide react completely with ammonium chloride.

Calculate the maximum volume, in dm^3 , of ammonia gas formed at room temperature and pressure.

(relative atomic masses: H = 1.0, N = 14, O = 16, Na = 23, Cl = 35.5

one mole of any gas occupies 24 dm^3 , measured at room temperature and pressure)

(3)

Volume = Moles \times Molar volume

1 : 1

$\text{NH}_4\text{Cl} : \text{NaOH}$

~~4.0g~~ : ~~4g~~ 4g

0.1 moles : 0.1 moles

$23 + 16 + 1 = 40\text{g}$ $\frac{4}{40} = 0.1$ 2.4 dm^3

$24 \text{ dm}^3 = \text{molar volume}$

maximum volume of ammonia = 2.4 dm^3



ResultsPlus Examiner Comments

This calculation is set out clearly for the examiner to follow.

Whilst the answer is correct, so scores full marks, had there been an error it would have been straightforward to award part marks.



ResultsPlus Examiner Tip

Set out working clearly.

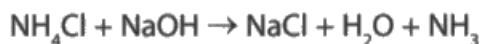
This answer clearly shows:

1:1 mole ratio

M_r of NaOH and subsequent mole calculation of 0.1 moles

volume = moles \times 24

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one mole of any gas occupies 24 dm^3 , measured at room temperature and pressure)

(3)

$$\begin{aligned} \text{NH}_3 &= 14 + (1 \times 3) = 17 && \frac{V}{M \times 24} \\ \text{NaOH} &= 23 + 16 + 1 = 40 \\ 40 \div 17 \times 4 &= 9.4 \end{aligned}$$

$$V = 9.4 \times 24 = 225.6$$

maximum volume of ammonia = 225.6 dm^3



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Examiner Comments

This answer was incorrect but was awarded part marks because the working was clear enough.

Question 3 (b) (i)

There were many perfect answers here, although it was noted that some candidates did not notice that the question was worth 2 marks and merely stated that a dynamic equilibrium is a reversible reaction with nothing further written.

Some candidates used poor terminology, such as reactions 'cancel each other out' – it is important that correct scientific explanations are given.

A reasonably common misconception was that, at equilibrium, the amount of reactants equals the amount of products.

Question 3 (b) (ii)

This question proved challenging to some candidates. Many wrote about 'compromise' and then related their responses to danger and/or expense rather than the consequence of temperature change in terms of the position of equilibrium.

Thus, some were able to state that a higher temperature would reduce the yield of ammonia, but only a minority of these could explain this in terms of the higher temperature favouring the endothermic reaction (or vice-versa).

There were even some comments about denaturing enzymes at 450°C.

- (ii) Explain why a temperature of 450°C is used for this process even though a higher temperature would increase the rate of production of ammonia.

(2)

A higher temperature increases rate of reaction but gives a smaller yield as it shifts the position of equilibrium to the left, in endothermic direction, so at equilibrium more of the reverse (backwards) reaction happens so it decreases the yield of ammonia as less ammonia is produced. The temperature had to be compromised to get an acceptable yield at an



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Examiner Comments

There is no need to mention rate – it is in the question
– but this is a good answer.

Question 3 (c)

This item was surprisingly poorly answered. Many students did not understand the ionic basis of acid-alkali reactions, so many responses gave the name of a compound, rather than an ion.

- (c) When ammonia gas is dissolved in water, an alkaline solution is formed.

State the name and the formula of the ion which causes the solution to be alkaline.



name Hydroxide Hydroxide

formula OH



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Examiner Comments

An incorrect formula for hydroxide.



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Examiner Tip

Ions must have charges!

Question 4 (b) (i)

Many candidates did not fully direct their answer to the question – the **use of this apparatus**. Most candidates scored 2 or 3 marks, forgetting either the DC supply and/or the naming of a suitable electrolyte. There were some unnecessary (albeit usually correct) descriptions of oxidation and reduction and/or movement of ions, discussing the process, rather than the use of the apparatus.

Some candidates who correctly described the electrodes then did not go on to describe an electrolyte, or suggested incorrect electrolytes such as copper hydroxide or hydrochloric acid.

Several candidates thought that the anode 'attracted impure copper' and that the electrolyte was 'impure copper'. Some confused the anode with the cathode.

Some candidates annotated the diagram and were credited.

Question 4 (b) (ii)

Many candidates recognised that the deposit (often called sludge) was due to impurities; some described how the impurities had no charge so were not attracted to an electrode. A few did refer to the impurities containing gold or silver. Fewer scored both marks, the candidates not explaining that the impurities were released when the copper ions were removed from the anode.

There was evidence of a lack of understanding with "impure copper atoms" or ions, whatever such a particle might be. Hence, some answers said that the deposit was impure copper rather than the impurities themselves. Some even suggested that it was electrons that were deposited under the anode.

Question 4 (c) (i)

Most candidates knew about reduction, but fewer stated that it was due to the gain of electrons. Some stated that lead (which is the product) gained electrons rather than lead ions, an understandable error, but one that must be avoided. Some candidates described the wrong species being reduced (some form of bromine or even copper).

- (c) (i) In the electrolysis of molten lead bromide, PbBr_2 , the half equation for the reaction occurring at the cathode is



Explain what **type** of reaction is shown in this equation.

(2)

The lead is reduced, forming pure lead.



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Examiner Comments

This example illustrates the need to describe the particles correctly.



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Examiner Tip

Refer to the species as atoms, ions etc. In this case, lead *ions* are reduced to form lead *atoms*.

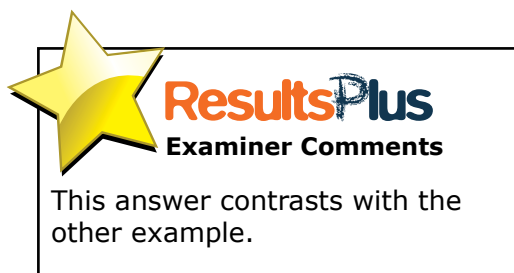
- (c) (i) In the electrolysis of molten lead bromide, PbBr_2 , the half equation for the reaction occurring at the cathode is



Explain what **type** of reaction is shown in this equation.

(2)

This is a reduction reaction because the lead ion gains electrons to become a lead atom.



Question 4 (c) (ii)

Ionic equations are difficult and some candidates answered this question incorrectly.

On the left, bromine atoms and Br^{2-} ions appeared in place of bromide ions.

On the right, Br_2^- or bromide ions appeared.

Question 5 (a) (i)

There is a misunderstanding of the formation of esters and their structure/formula(e). The product given was often a (mangled) carboxylic acid or alcohol.

Sometimes not all the H atoms were accounted for or an extra O was given, possibly by candidates not noticing that water was given as one of the products. Too many formulae had incorrect bonds and/or functional groups, with penta – and even hexa-valent carbon as well as hydrogen in the middle of carbon chains. The correct molecular formula was sometimes seen.

Question 5 (a) (ii)

There were many correct responses seen, including 'dissolving' which was allowed. Too many lists were present, when an incorrect answer cancelled out a correct one, especially precipitates of many hues, and also colour changes and confusion with limewater going cloudy.

Question 5 (c)

This question was mostly high scoring, with some excellent and accurate descriptions of titration, with many knowing the correct indicator to use. Many knew the importance of obtaining concordant results.

Some said that they would filter the salt before evaporation. Crystallisation was less well covered, although most managed at least a basic description of getting a salt (by evaporation). However, only a few mentioned heating until incipient crystallisation occurs, by reaching a saturated solution, followed by leaving to crystallise. With crystallisation, there were good references to mixing the acid and alkali without the indicator. Weaker candidates did not recognise that sodium ethanoate was in aqueous solution, and gave a description of precipitation and/or the washing of crystals in distilled water before final drying.

Suggestions for teaching:

- Pipette was correctly named (and spelled), but the burette less so
- The volume of alkali added to a flask was often omitted
- Sometimes a specific volume of acid was added to the burette, rather than just filling
- There is still a desire to use Universal Indicator
- Some got the colours for the indicators incorrect
- Some students discussed precipitation
- It is recommended that all candidates should have the opportunity to carry out or at least observe this experiment

***(c) Sodium ethanoate solution can be formed by neutralising sodium hydroxide solution with dilute ethanoic acid.**

Pure crystals of sodium ethanoate can be obtained from this solution.

The volumes of sodium hydroxide solution and dilute ethanoic acid required to form the pure sodium ethanoate solution must be found by titration.

Describe how you would prepare a pure solution of sodium ethanoate from sodium hydroxide solution and dilute ethanoic acid, and how you would obtain pure, dry sodium ethanoate crystals from this solution.

(6)

A known volume of sodium hydroxide would be measured out using a pipette and a pipette filler, for ^{an} example: 25 cm^3 . Then, ~~the~~ a burette would be filled with dilute ethanoic acid, up until ~~the~~ ^{the liquid} bottom when it is just above the point zero, then allow to drain so the bottom of the curve on the liquid is at zero. The sodium hydroxide measured with the pipette would be put in a flask, with a few drops of methyl orange, turning the solution orange. ~~After~~ the burette should then be placed over the flask, and this concludes the preparation for the titration.

A rough titration should be conducted first, where the burette should be allowed to drain into the flask until the flask solution turns red, where the burette tap should be closed as the solution has neutralised. The titration should then be re prepared as explained above, but this time, noting the amount of acid needed to neutralise the base, ~~and~~ start letting the burette acid out of the tap drop by drop within $3\text{-}5\text{ cm}^3$ of the result. Keep doing this until you get concordant results, within a decimal point of accuracy, then re do the titration,

without indicator (methyl orange) and stop the
gap once the amount of acid drained was the
same as the average of the previous concordant
results. You now have the volume of
dilute ethanoic acid needed to neutralise
(and form sodium ethanoate) for 25cm³ of
sodium hydroxide solution. You now also
have a pure sodium ethanoate solution.
Now you should put the pure sodium
ethanoate solution in an evaporating basin
and heat it over a Bunsen burner, evaporating
the water and crystallising the sodium
ethanoate. This should leave you with a
pure, dry sample of sodium ethanoate
crystals.



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A good example of a six mark answer.

Describe how you would prepare a pure solution of sodium ethanoate from sodium hydroxide solution and dilute ethanoic acid, and how you would obtain pure, dry sodium ethanoate crystals from this solution.

(6)

Using a pipette and pipette filler, pour 50 cm³ of ~~sodium~~ ethanoic acid, into a burette. Pour the acid into the burette below eye level, so that it doesn't ~~here~~ damage your eyes if there are spillages. Using a measuring cylinder pour sodium hydroxide solution into ~~the~~ a conical flask. Add a few drops of phenolphthalein ~~and the~~ to the sodium hydroxide solution, and it should turn pink. Open the tap, so that the acid is poured into the solution drop by drop. When ~~there is to~~ the ~~and the~~ solution turns from pink to colourless, ~~stop the~~ turn the tap off, and measure the ~~the~~ amount of acid left and ~~subtract~~ subtract it from the ~~the~~ initial reading. Repeat the titration, until the results are concordant, and record the ~~the~~ amount of acid used. ~~Pour the ethanoic acid~~ Measure out the amount of acid used and repeat the titration, but without using an indicator. The solution would be sodium ethanoate. ^{*}Heat the solution, so that the water evaporates, ~~was~~ leaving sodium ethanoate crystals. Dry the crystals to obtain pure, dry sodium ethanoate crystals.



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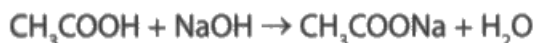
This scored six – although it is not perfect – and is included for teachers to use with their classes.

Question 5 (d)

Some candidates found this calculation difficult. Many did not recognise the 1:1 ratio, and instead discussed a 1:2 ratio leading to an incorrect response of 50 cm³. Many did not divide by 1000 to get the concentration of ethanoic acid correct.

Some scored the mark for the correct ratio or for calculating the moles of acid, but were unable to complete the calculation.

- (d) In an experiment 25.0 cm³ of 0.0100 mol dm⁻³ ethanoic acid, CH₃COOH, was titrated with 0.0200 mol dm⁻³ sodium hydroxide solution, NaOH.



Calculate the volume, in cm³, of 0.0200 mol dm⁻³ sodium hydroxide solution needed to neutralise the ethanoic acid in this experiment.

(3)

$$\begin{array}{r} 25 \text{ cm}^3 \\ 0.0100 \text{ mol dm}^{-3} \\ 0.00025 \text{ mol} \\ \hline 0.00025 \\ 0.0200 \\ \hline = 0.0125 \\ \times 1000 \end{array}$$

volume of sodium hydroxide solution needed = 12.5 cm³



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An example of a correct answer.

Question 6 (b) (i)

Nearly all of the candidates understood that whisky had a greater concentration of ethanol than beer. However, only some went on to clearly explain why this caused danger. Responses were sometimes vague about drunkenness or even that the more alcohol had a 'bigger effect'. Some candidates confused reaction time with reaction speed. With alcohol, reaction times are longer or reaction speeds are slower. 'Slower reaction times' was not accepted. Only a small number of candidates referred to poorer vision, dizziness or depressant effect.

(b) Ethanol is an alcohol.

Ethanol is present in various alcoholic drinks, such as wine, beer and whisky.

(i) It is dangerous to drive after having an alcoholic drink.

Suggest why it is more dangerous to drive a car after drinking 25 cm³ of whisky than it is after drinking 25 cm³ of beer.

(2)

The alcohol concentration in whisky is greater, so it will slower your reaction time more than beer would (of the same volume).



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Examiner Comments

This scored only 1 because reaction time is longer (or reaction speed slower) is the correct response.

Question 6 (b) (ii)

Most candidates scored this mark, although some candidates did not know what a homologous series was.

Question 6 (c)

The formula for propene was not known by all, and some put water on the incorrect side of the equation (with some equations having - H₂O on the left hand side which was not accepted). Candidates must be more careful about using capital/small letters and using subscripts.

Question 6 (d)

This was a well answered question with many candidates awarded 6 marks, and the vast majority of candidates gaining at least 4. The main error was the confusion between alkanes and alkenes, which should have been revised for the C1 paper. There were also some contradictions in responses and candidates should be encouraged to re-read their work, particularly on 6 mark questions. Poor handwriting meant that on occasions it was difficult to discern the difference between ethane and ethene.

One good approach was to identify the two hydrocarbons, and then distinguish them, followed by the two compounds containing oxygen. Many answers were communicated fluently and concisely, and candidates often appeared to enjoy solving the puzzle using their chemical knowledge.

Paper Summary

On the basis of performance in this paper, candidates are offered the following advice:

- Practise writing balanced equations, taking care with subscripts
- Practise, using past papers, examples of calculations
- In calculations lay out your answers step by step, making clear what has been evaluated in each step
- Be able to explain how changes in temperature and pressure affect the position of equilibrium
- Learn the ionic nature of acid-base neutralisation
- Practise drawing structures of organic molecules, particularly esters
- Learn the difference between heating to dryness and crystallisation.

Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:

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