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Examiners' Report
June 2015

GCSE Chemistry 5CH3H 01

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Introduction

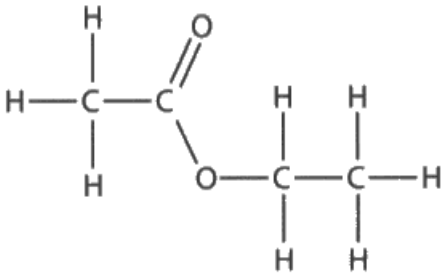
This paper followed the standard format of six questions, with the last two questions containing the extended writing parts. Many excellent responses were seen, from candidates who had a deep knowledge of Chemistry and were able to express themselves with clarity. It was, however, a pity that while, in a large number of cases, the candidate appeared to have an idea about the relevant Chemistry, no sense could be made of their answer. The six mark questions were on the whole well tackled.

Question 1 (a) (i)

Whilst many candidates gave an appropriate formula, with numbers as subscripts, a substantial proportion of candidates need to be able to distinguish between a molecular formula and a structural formula.

Saturated and unsaturated organic compounds

1 The structure of a molecule of an ester, ethyl ethanoate, is shown.



(a) (i) Give the molecular formula of this compound.

(1)

$CH_3COOC_2H_5$

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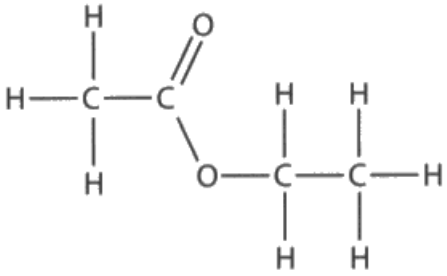
Examiner Comments

This structural formula was a common error.

Saturated and unsaturated organic compounds

1 The structure of a molecule of an ester, ethyl ethanoate, is shown.



(a) (i) Give the molecular formula of this compound.

(1)

$H_8C_4O_2$

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Examiner Comments

This is not the conventional order of symbols.

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Examiner Tip

The order in which you place the element symbols in a molecular formula does not matter in your exam answers.

Question 1 (a) (ii)

The majority of candidates could write a correct word equation. There were, however, some incorrect spellings of ethyl and ethanoate - which was a pity as they were printed on the paper. For ethanoic acid, incorrect responses included carboxylic acid, ethanolic acid and even ethanal and ethene. The most common error was to leave the second product blank, or to give this as carbon dioxide. Candidates are warned not to give symbol equations unless they are sure that they are fully correct - this is credited, but most who tried a symbol equation made an error and so scored 0. Mixed equations, where one/ more words are written as formulae, are not credited.

Question 1 (a) (iii)

The majority of candidates latched on successfully to one or both ideas in the mark scheme. Those who did not score talked about esters being flavourings, and therefore safe, but did not link this to the question and explain why. There also seemed to be confusion, perhaps, with barium sulfate, with answers suggesting that the ester did not dissolve into the blood/ get digested. This was one of the questions where candidate's poor expression sometimes cost them the mark.

(iii) A hazard from the ethyl ethanoate fact sheet is shown in the box.

> Exposure to the vapour of ethyl ethanoate can cause you to feel dizzy or to faint

Suggest why, despite this hazard, it is still safe to use ethyl ethanoate in sweets.

(1)

Ethyl ethanoate is not a vapor in the sweet, so it isn't a hazard. Its a solid.

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Examiner Comments

This answer states that the ester is (in) a solid, and links this simply but clearly to the lack of hazard.

Question 1 (b) (ii)

Most candidates understood that the solid had to be filtered, but did not pay attention to 'pure' and failed to wash the solid. There was a lot of confusion with salt preparation, with heating/ boiling/ evaporating/ crystallising before filtering, or even fractional distillation. In addition, after filtering the soap was regularly heated to dry it.

(ii) The white solid is formed in a mixture with a solution of other substances.

Describe how a pure sample of the white solid can be obtained from this mixture.

(2)

Add a dilute acid to it until it is all reacted, then filter in through a funnel to remove any excess product then evaporate of the water from the solution.

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Examiner Comments

This is an example of the confusion with salt preparation.

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Examiner Tip

Look at question numbering - (b)(ii) links to (b)(i), so this question is about soap preparation, not preparing a salt using an acid.

(ii) The white solid is formed in a mixture with a solution of other substances.

Describe how a pure sample of the white solid can be obtained from this mixture.

(2)

The mixture can be filtered so only the white solid remains, then it can be washed with distilled

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Examiner Comments

In contrast to the previous example, this response is simply and clearly explained.

Question 2 (a) (ii)

Most candidates realised that a flame test was required, although it should be noted that holding the solid over/ around/ above/ under the flame, or 'burning' the solid are not acceptable descriptions. The flame colour for potassium is almost universally known, that for sodium, yellow, not quite as well known. Some candidates tried to give a precipitation test.

(ii) The technician wanted to find out which bottle contained the sodium salt and which bottle contained the potassium salt.

Explain how the technician should do this.

(2)

- FLAME TESTS
- PUT SUBSTANCE ON A WIRE LOOP AND OVER A BUNSEN BURNER
- POTASSIUM WILL GIVE A LILAC FLAME, SODIUM WILL GIVE A YELLOW FLAME

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Examiner Comments

Flame test is correct, but description is not.

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Examiner Tip

Candidates should note that if in a flame test the solid is held over the flame, no result will be seen. The solid must be held **in** the flame.

Question 2 (b) (i)

The formation of a precipitate was well known, although it was sometimes white, green or blue-green. It was a pity that candidates often lost one of the two marks by adding bubbles/ effervescence to the blue precipitate.

(b) When sodium hydroxide solution is mixed with a solution containing copper ions, Cu^{2+}, copper hydroxide, $Cu(OH)_2$, is formed.

(i) Describe what you would **see** when these solutions are mixed.

(2)

A gas would be released and there would be a colour change

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Examiner Comments

Vague answers such as 'a colour change' are not going to score.

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Examiner Tip

Learn all of the tests for gases and ions - they are common questions.

Question 2 (b) (ii)

Given that one reactant and the product were given, it was surprising that not all candidates managed to transfer these into an equation format for one mark. Most did, however, but then most commonly did not appreciate the nature of the ionic equation and used NaOH, sometimes with a charge. Sometimes, spectator ions were given incorrectly, particularly Na, as an atom or ion.

(ii) Write the ionic equation for this reaction.

$Cu^{2+} + 2NaOH^{-} \longrightarrow Cu(OH)_2$

(3)

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Examiner Comments

The inclusion of sodium hydroxide (with or without a charge) was not uncommon.

Question 3 (a) (i)

The question was well answered, with the most popular choice of conditions being anaerobic conditions and a warm temperature/ correctly specified temperature range.

Ethanol

3 (a) Ethanol is produced by the fermentation of glucose.

Yeast is needed for the fermentation reaction.

(i) State **two** other conditions for fermentation.

(2)

Heat must because The temperature must be at the yeast optimum degrees and there must be a good supply of nutrients.

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Examiner Comments

Temperature is relevant, here, but needs to be specified or say 'warm'.

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Examiner Tip

Please specify conditions carefully - what is the optimum temperature?

Question 3 (a) (iii)

This equation was poorly done. It is possible than many candidates did not think through working out the products and writing the formulae. Ethanol was, after all, mentioned in every other part of question 3, yet a huge variety of formulae were given with no similarity to ethanol's formula at all. Photosynthesis and respiration equations were sometimes given.

Question 3 (b) (i)

Most candidates scored at least one mark here by identifying steam. A catalyst was often specified, although this was frequently incorrect - nickel, aluminium oxide, iron being examples. Some simply quoted 'temperature' and 'pressure' without being more specific. There was perhaps some confusion with fermentation, with anaerobic conditions being mentioned.

Question 3 (b) (ii)

Many candidates scored two marks here, for the need for land for growing sugar crops and for the availability of crude oil giving a ready supply of ethene. However, candidates should be careful not to simply repeat the stem - for example, saying that crude oil meant that ethanol could be made from ethene, without linking ethene production clearly to crude oil supplies. Fewer candidates gave an idea of the rate of production or continuous/ batch process, or the idea of purity of product, and almost no-one mentioned atom economy.

Common errors included the need for land to grow yeast, and a confusion of the concentration of the product with the yield.

(ii) A country has large reserves of crude oil.

It is a relatively wealthy country with a large population but it has only a small amount of fertile land.

Explain why the country would prefer to produce its ethanol from ethene rather than by fermentation.

(3)

Fermentation requires a lot of land to grow sugar crops such as sugar cane. If this country grew sugar crops to ~~gain~~ have a source of glucose, it would not have much land left for growing its own food crops, therefore being unable to feed its large population. Ethene is obtained by cracking crude oil, and seeing as this country has large reserves of crude oil, this would be the best option for its ethanol production. Cracking costs a lot of money but this country has the financial resources to be able to do it.

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Examiner Comments

This answer has very clearly explained two points, about land and ethene availability.

Question 4 (a)

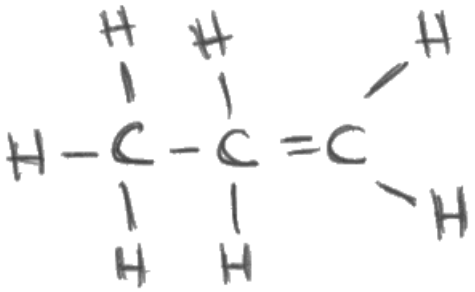
Most candidates managed to draw a three carbon molecule with one double bond. It was disappointing that so many of these had 3- or commonly 5-valent carbons. Worse errors were propane or even including oxygen atoms.

Gases

4 (a) Propene is a gaseous hydrocarbon.

Draw the structure of a molecule of propene, showing all bonds.

(2)



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Examiner Comments

This scored 1 mark only.

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Examiner Tip

When you have drawn a molecular structure for an organic compound take time to count the bonds around each atom. In this example one carbon has 5 bonds so there must be an error.

Question 4 (b) (ii)

There were some strong answers here showing a good understanding of equilibrium. Some candidates said that only ammonia (or sadly 'ammonium') would be present or even gases such as carbon dioxide and oxygen. The explanation was given most often in terms of this being a reversible reaction. It should be noted that 'equilibrium' does not necessarily imply a continuing process and was not credited - but 'dynamic equilibrium' was.

Some candidates did not appreciate the 'explain' and stated the gases correctly without explaining why all three were present.

(ii) The minimum volumes of nitrogen and hydrogen that must react completely to form 5000 dm^3 of ammonia are calculated.

These volumes are mixed and left, under appropriate conditions, until the reaction reaches equilibrium.

Explain which gas or gases will be present when equilibrium is reached.

(2)

Ammonia gas is present, and nitrogen and hydrogen because both reactions are happening at same rate and in both directions

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Examiner Comments

A succinctly expressed answer, getting straight to the point.

Question 4 (b) (iii)

There was a pleasing response to this question with a very good number of candidates predicting a higher yield. Many went on to successfully explain this in terms of a shift of the position of equilibrium to the right, due to a decrease in the number of molecules/ volume. There were some irrelevant explanations linked to whether the reaction was exothermic or endothermic.

(iii) The Haber process is carried out under a pressure of about 200 atm.

Explain the effect on the **equilibrium yield** of ammonia, if the process is carried out at a pressure higher than 200 atm.

(2)

You will get a higher yield of ammonia as a higher pressure favours the reaction that produces fewer molecules and therefore less volume of gas. The equilibrium will shift to the right as there are fewer molecules of ammonia

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Examiner Comments

This answer would have been even better saying 'fewer molecules of ammonia..... than nitrogen and hydrogen' but nevertheless it clearly answers the question.

Question 4 (b) (iv)

Some excellent responses were seen, although many candidates did not answer the question and talked about the position of equilibrium instead. The phrase 'rate of attainment' was not well appreciated. Those who understood that this was a rates question did not always express themselves well - talking about a greater chance of successful collisions, for example, rather than about the collision frequency.

(iv) Explain the effect on the **rate of attainment of equilibrium**, if the process is carried out at a pressure higher than 200 atm.

(3)

It will increase, this is because the gases will be packed into a smaller space so more collisions will happen per second, therefore more successful collisions will occur, and equilibrium will be attained at a faster rate, because rate of reaction is faster.

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Examiner Comments

An example of a well thought-through answer.

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Examiner Tip

In questions of this type start with start with a statement such as 'it will increase' and then go on to the explanation.

The candidate very correctly says that the 'collisions per second' (or frequency of collisions) will increase.

Question 5 (a)

Some very well laid out answers were seen, as in the example shown, and some not so clear answers that were correct. Unfortunately, the working for many with an incorrect answer was unclear making it difficult or impossible for examiners to award part marks.

Common errors included the incorrect formula mass - 75.5 (CaCl) or 115.5 (Ca_2Cl), and dividing by 500 (cm^3) rather than 0.5 (dm^3).

Water

5 (a) A solution is made by dissolving calcium chloride in water.

11.1 g of calcium chloride are dissolved in water.

The volume of the solution is made up to 500 cm^3.

Calculate the concentration, in mol dm^{-3}, of calcium chloride, $CaCl_2$, in this solution.

(relative atomic masses: Cl = 35.5, Ca = 40.0)

(3)

conc. = moles / vol.

$\frac{500}{1000} = 0.5\ dm^3$

Mr = $(40 + (35.5 \times 2)) = 111$

moles = $\frac{11.1}{111} = 0.1$ moles

conc. = $\frac{0.1}{0.5} = 0.2$

concentration = 0.2 mol dm^{-3}

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Examiner Comments

The correct answer, 0.2, is on the answer line.

This example is ideally set out.

Question 5 (b) (i)

The predictable use of a burette or measuring cylinder was seen here, but a less understandable confusion of a teat pipette and volumetric pipette was also noted. The most common second mark was for using a pipette filler. Others gave descriptions of a titration but did not direct themselves to the question.

Question 5 (c)

Some really well structured and explained answers were seen, some giving a lot of additional chemical knowledge about the ions causing hard water. In general, candidates scored well. The effect of boiling was well known, but not all answers followed on by testing the boiled waters with soap. Some good answers indicated scale formation, but others incorrectly thought that only temporary hard water would leave a residue when boiled.

Some candidates were confused about types of hard water, saying that temporary hard water requires much more soap to lather than soft water (true), but that permanently hard water required even more soap. Another confusion was between scale and scum. (In general scum was not mentioned much, and some of the weaker answers would have been shored up by a mention of this). Other candidates tried to test for ions that caused hardness, such as by using flame tests.

*(c) Some salts dissolved in water cause the water to be hard.

When mixed with a small volume of soap solution, hard water does not form a lather.

You are provided with three unlabelled samples of water.

- one is soft water
- one is permanent hard water
- one is temporary hard water

You are provided with soap solution and the usual laboratory apparatus.

Describe tests that you should carry out on each sample to identify the type of water in each sample.

(6)

To find out which is hard water and which is ~~soft~~ Soft you should try and lather the soap solution with the samples of water. Whichever sample lathers and doesn't form scum that should be the Soft water. To investigate which sample is ~~temporary~~ temporary or permanent hard water you should boil the

water, ~~if~~ after you boil it and lather it, the temporary hard water should now lather. which means the other sample is hard ~~water~~ water, which can be softened using an ion exchange column. (replaces the magnesium and calcium ions with sodium ions)

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Examiner Comments

This is a clearly laid out answer which logically goes through the method and directly answers the question.

Question 6 (a) (i)

This part was well answered.

Question 6 (a) (ii)

The loss of mass at the anode and the gain of the mass at the cathode were very well described, with some excellent further detail. However, some candidates mixed up the electrodes, and some thought that the loss of mass at the anode was only due to sludge formation.

Question 6 (a) (iv)

Some really excellent answers were seen, although many talked about free electrons rather than ions. It was a pity that quite a few started well with free ions but then added delocalised electrons as well. Some tried to hedge their bets with 'charged particles' (not credited). The examiners wanted to see an explicit mention of the ions moving, rather than phrases such as 'ions carry the current'. Some candidates talked about copper, being a metal, conducting as 'metals conduct'.

(iv) Copper sulfate solution is the electrolyte used in this electrolysis process.

Explain how copper sulfate solution conducts electricity.

(2)

Copper sulfate is in solution, so there are electrons free to move in the solution, which will carry the charge.

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Examiner Comments

A common error.

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Examiner Tip

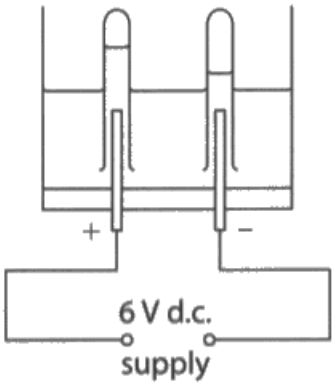
Remember when a solution conducts electricity it is the ions that are moving not the electrons.

Question 6 (b)

This question was harder than 5b, but nevertheless some truly excellent answers were seen with half equations and discussions of preferential discharge. The formation of hydrogen from its ions was well described. The formation of oxygen was sometimes described from oxide ions, understandably, or even hydroxide ions forming oxygen and hydrogen. It is important to realise that in these extended writing questions the 'level' of answer is looked for, and perfection is not required. It is interesting to note the idea of the 'simpler' hydroxide ion being discharged was mentioned by some - an explanation for this is not required by the specification, but many candidates went into pleasing depth. The terms oxidation and reduction were deployed effectively. Candidates should be made aware that in a gas test a (brief) description is required - just 'the squeaky pop test' is not worth a mark.

Candidates should be careful of terminology in questions such as this - being clear to distinguish between hydrogen (gas) and hydrogen ions, for example.

(b) Sodium sulfate solution is electrolysed in the apparatus shown.



Sodium sulfate solution contains sodium ions, Na^+, sulfate ions, SO_4^{2-}, hydrogen ions, H^+, and hydroxide ions, OH^-.

Hydrogen is produced at one electrode and oxygen is produced at the other electrode.

Explain how these products are formed from the ions in the electrolysis process, indicating how you would identify the products.

You may give ionic equations in your answer.

(6)

Because OH^- ions are simpler than SO_4^{2-} ions, the OH^- ion travels to the positive anode as opposite ~~te~~ charges attract. Here it ~~to~~ is discharged, so it loses its electrons to form oxygen molecules. The hydroxide ion is oxidised $4OH^-_{(aq)} \longrightarrow O_{2(g)} + 2H_2O_{(l)} + 4e^-$

The You can identify that oxygen gas is produced as it will re-light a glowing splint.

Hydrogen ions are discharged at the cathode instead of sodium ions, as sodium is more reactive ~~and so is~~ than hydrogen. H^+ ions gain electrons, and share electron pairs to form hydrogen molecules.

~~$2H^+_{(aq)} + 2e^- \rightarrow H_{2(g)}$~~ $2H^+_{(aq)} + 2e^- \rightarrow H_{2(g)}$

This is a reduction reaction as hydrogen gains electrons. You can test for H_2 gas as it will ~~to~~ extinguish a lighted splint and make a squeaky pop.

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Examiner Comments

A well-constructed answer.

Paper Summary

Based on their performance on this paper, candidates are offered the following advice:

- Write word equations when asked for them and learn the difference between molecular and structural formulae.
- Learn the tests for gases and ions and the associated equations.
- Learn carefully the conditions for all of the processes in the specification.
- When using information from the question, such as the question on ethanol production, be careful to explain the science and not just repeat what is printed.
- Practise carefully how to describe changes in rates of reaction for gaseous reactions when pressure changes.
- Consider how an electrical current is transmitted in a metal, in graphite and in an aqueous or liquid ionic compound.
- Learn which processes (oxidation or reduction) occur at which electrode.

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