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AS LEVEL

Examiners' report

CHEMISTRY B (SALTERS)

H033

For first teaching in 2015

H033/02 Summer 2022 series

Version 1

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Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate answers are also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from OCR.

Advance Information for Summer 2022 assessments

To support student revision, advance information was published about the focus of exams for Summer 2022 assessments. Advance information was available for most GCSE, AS and A Level subjects, Core Maths, FSMQ, and Cambridge Nationals Information Technologies. You can find more information on our website.

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Paper 2 series overview

Candidates sitting the paper will not have sat an exam at GCSE level and this would have been their first exam. The level of responses given by candidates was indicative of this, with some candidates expressing themselves well and other candidates struggling to express themselves. The paper was made from a range of questions which allowed the candidates to differentiate themselves. There were questions where candidates were able to gain easy marks, with other questions where very few candidates were able to interpret the question and gain the marking point. Overall, a number of differentiated questions were present in the paper. There was an error identified in the paper itself, with the information expressed in Question 3 (d) potentially confusing to candidates. This error was identified early on in the marking process and changes were made to help the candidates to achieve on this question in relation to their interpretations. Generally, a wide range of scores were achieved by students, with them ranging from almost full marks to very low scores.

Candidates who did well on this paper generally did the following:	Candidates who did less well on this paper generally did the following:
• were able to analyse practical results • recalled practical procedures and improvements • understood periodic trends and were able to apply these • showed clear understanding of calculations and were able to manipulate these using available data.	• did not have a clear understanding of practical procedures • made errors in calculations and using the data • had difficulties recalling key terms and definitions • missed out key words from descriptions.

Question 1 (a) (i)

1 The element magnesium is an important Group 2 metal. Its presence in distant stars has been shown using atomic emission spectra.

(a) (i) The atomic **emission** spectrum of an element shows a series of coloured lines on a black background.

Describe how the appearance of the **absorption** spectrum of the element is similar to **and** different from its **emission** spectrum.

Similar ....

....

Different ....

.... **[2]**

This was a good question to get the candidates started on the paper. Generally, more candidates scored the second marking point than the first. Many candidates described both absorption and emission, whereas not all candidates were able to recognise the idea of lines being in similar places.

Question 1 (a) (ii)

(ii) What evidence for the structure of atoms is provided by atomic spectra?

....

.... **[1]**

This proved to be a challenging question for some candidates with many omitting the word 'electrons'. This question has been answered better in previous years.

Question 1 (b) (i)

(b) Ionisation enthalpies have also been used to develop theories about atomic structure.

(i) Write an equation for the reaction that represents the first ionisation enthalpy of magnesium.

Include state symbols.

[2]

Most candidates were able to interpret the question and produce Mg^+. A common error on this question was the omission of state symbols or incorrect state symbols being used, with candidates using solid rather than gas. This was a good question to differentiate the candidates' abilities.

Question 1 (b) (ii)

(ii) The first ionisation enthalpies of the elements of Period 3 show a general increase across the period.

Explain this increase.

....

....

....

....

....

.... **[3]**

Most candidates were able to identify the idea that protons increase across the group for the first marking point. The second marking point differentiated the candidates as not all were able to identify that electrons are added to the outer electron shell or that shielding remains the same. Many candidates missed the third marking point due to omitting the word 'outer' when explaining that the attraction between outer electrons and the nucleus causes an increase in ionisation energy. There were a high number of candidates referring to group trends rather than period trends.

Question 1 (c)

(c) The mass spectrum of magnesium shows that it has three stable isotopes as shown below.

Isotope	Abundance / %
^{24}Mg	78.60
^{25}Mg	10.11
^{26}Mg	11.29

Calculate a value for the relative atomic mass of magnesium based on these data.

Give your answer to **two** decimal places.

relative atomic mass = ... **[2]**

This was a good calculation which allowed candidates to gain confidence in their calculations. This was answered well with most candidates scoring both marking points. However, candidates need to make sure they note the bold '**two'** and state their answer to two decimal points to gain both marks.

Question 1 (d)

(d) Magnesium-24 is formed in some stars by nuclear fusion of two identical carbon nuclei.

Complete the nuclear equation for the formation of this isotope.

$$2 \qquad \rightarrow \quad {}^{24}_{12}\mathbf{Mg}$$ **[1]**

This was a good question for candidates to build up marks. Some candidates placed the numbers after the C rather than before, but this was allowed on the mark scheme after standardisation.

Question 1 (e)

(e) A student is asked to prepare a sample of hydrated magnesium chloride crystals (containing water of crystallisation) starting from solid magnesium oxide.

The student adds magnesium oxide to hot hydrochloric acid until the oxide is in excess.

The student then evaporates the mixture until just a solid is left.

Explain why this procedure would **not** produce hydrated magnesium chloride crystals and give a correct method.

....

....

....

....

....

.... **[4]**

This question highlighted that a number of candidates were unclear on practical procedures. Many candidates described recrystallisation rather than the production of waters of crystallisation and this limited their score. The first marking point was not scored well, as many candidates did not recognise or state that the magnesium chloride produced by the student was still contaminated with magnesium oxide. The process of evaporation was not described well by many candidates, but this could have been due to the question stating evaporation rather than stating the solid was left to evaporate all the solution. See exemplar 1 for a well answered response.

.

Assessment for learning

A number of candidates did not fully understand the process of the waters of crystallisation practical or were confusing this practical with recrystallisation. Make sure candidates practice practical questions after the practical regarding errors and improvements and relate these to the practical completed.

Question 1 (f)

(f) Calcium and barium are two other Group 2 elements.

A student places a small piece of calcium into 100 cm^3 of cold water in a beaker. A steady fizzing occurs, the calcium disappears and a white, cloudy mixture of pH 11 is left. The temperature increases by 26 °C.

The student then repeats the experiment with an equal amount of barium.

Describe **two** differences that the student would observe when comparing the reaction of barium with that of calcium.

1 ....

....

2 ....

....

[2]

This was a good question where candidates were differentiated in their understanding of the group 2 elements. A common answer relates to the idea of temperature change increasing or the reaction being more violent, with some candidates correctly identifying that the pH of the solution will increase or the solution will be clearer due to barium hydroxide being soluble. Some candidates, however, did not score well on this question, stating the temperature would be less, the pH more acidic or the reaction would be less vigorous.

Question 1 (g)

(g) Another student is provided with samples of magnesium carbonate and strontium carbonate and asked to identify which is which. The student heats equal amounts of each carbonate in separate test tubes using the same Bunsen flame. The student measures the time taken for the gas evolved to turn limewater cloudy.

The student says that the time taken will be shorter when strontium carbonate is heated because strontium is more reactive than magnesium.

Comment on the student's statement, giving the correct chemistry where necessary.

....

....

....

....

....

.... **[3]**

This is a question where the higher-grade candidates could score and differentiate themselves. The candidates needed explain why the statement is incorrect but needed to give the correct explanation for the correct substance. Many candidates explained that magnesium was less thermally stable, rather than stating magnesium carbonate. They also stated that magnesium distorted the carbonate because it is a smaller atom rather than the magnesium ion distorting the carbonate ion due to ionic size being smaller. Candidates could only score the first marking point for either agreeing or disagreeing with the student's statement if they correctly identified marking points 2 and/or 3.

Question 1 (h)

(h) Complete the electronic configuration for the magnesium **ion**, Mg^{2+}.

$1s^2$ .... **[1]**

Generally, another question where candidates were able to be given an easy mark. There was some confusion on the ion, with some candidates quoting the ion electronic configuration for a transition metal.

Question 2 (a) (i)

2 Heterogeneous catalysts are used on a large scale for catalytic cracking in industry.

(a) A student sets up the apparatus shown in **Fig. 2.1** to investigate the cracking of 'liquid paraffin'.

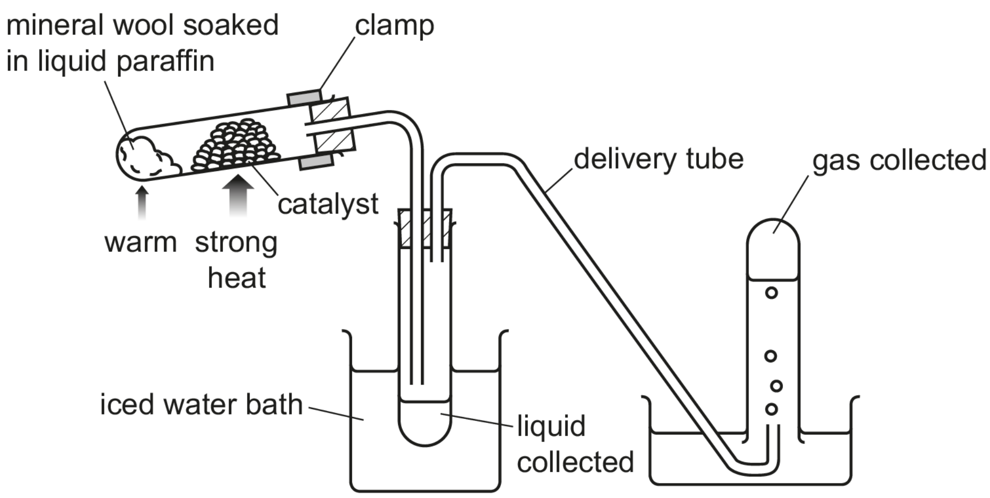


Fig. 2.1

(i) Explain why the catalyst is described as **heterogeneous**.

....

.... **[1]**

> This question was answered well by candidates sitting the paper. They had a clear understanding of what a heterogenous catalyst was and how the state of the catalyst relates to the state of reactants.

Question 2 (a) (ii)

(ii) The catalyst gets coated with carbon over time and becomes less effective.

Give the general name of a substance that reduces the function of a catalyst in this way.

.... **[1]**

> There was a mixture of answers for this question. Generally, candidates scored well with this question with the statement of a poison or catalytic poison, but some candidates confused chemical catalysts with biological catalysts and stated inhibitor as their answer.

Question 2 (a) (iii)

(iii) The compounds below **might** be found in the apparatus in **Fig. 2.1** when it is in use.

Match the appropriate formula with the places from **Fig. 2.1**:

C_2H_4 C_6H_{14} $C_{12}H_{26}$

Liquid paraffin ....

Liquid collected ....

Gas collected .... **[1]**

.This was a well answered question with most candidates getting the organic compounds in the correct order, with only a small portion of candidates misunderstanding the question and scoring 0.

Question 2 (a) (iv)

(iv) The gas collected is found to turn bromine water from orange/brown to colourless.

What can the student deduce from this?

....

.... **[1]**

A large percentage of the candidates understood the implication of the bromine water decolourising and were able to identify an alkene was present. Some candidates explained this as unsaturated or stated that a C=C double bond was present. Only a handful of candidates lost this point by stating alkane or just stating a double bond without being specific as to the type.

Question 2 (b) (i)

(b) In cordless hair straighteners, butane is passed over a platinum coil that acts as a heterogeneous catalyst.

Butane reacts with oxygen in the air and releases thermal energy.

(i) Explain how a catalyst increases the rate of a chemical reaction.

....

.... **[1]**

This question was answered well with the candidates having a clear understand of how a catalyst increases the rate of a chemical reaction. Some candidates were able to explain half of the definition and state a decrease in activation energy but missed the idea of an alternate pathway or vice versa.

Question 2 (b) (ii)

(ii) Complete the missing stages in the mechanism of heterogeneous catalysis given below.

Stage 1 Reactants diffuse to and are adsorbed onto the catalyst surface.

Stage 2 ....

....

Stage 3 ....

....

Stage 4 Products are desorbed from the catalyst surface and diffuse away.

[1]

Candidates clearly understood how the catalyst works, but needed to give the idea of reactant bonds breaking and new products being formed. There were some misconceptions in candidate explanations, including discussion of bonds between reactants breaking, molecules being broken or the bond being made with the surface rather than forming a new product.

Question 2 (b) (iii)

(iii) Butane reacts with oxygen according to the following equation.

$C_4H_{10} + 6\frac{1}{2}O_2 \rightarrow 4CO_2 + 5H_2O$

Calculate the volume of oxygen, in m^3 (measured at RTP), required for the complete reaction of 1.0 g butane with oxygen.

Give your answer to an **appropriate** number of significant figures.

volume of oxygen = ... m^3 **[4]**

This was a question that differentiated the candidates' abilities to use mole calculations. Some candidates incorporated the ideal gas equation into their calculation with mixed results, with them using the incorrect value for pressure or room temperature. This limited the marks they were able to achieve. Other candidates missed out the stage where moles calculated was multiplied by 6.5, or they used 24000 rather than 24 to find the volume of gas in dm^3.

Question 2 (c) (i)

(c) Catalytic reactions also occur in the stratosphere where chlorine radicals are formed from the breakdown of chlorofluorocarbons, CFCs.

Chlorine radicals take part in the catalytic cycle shown:

$Cl + O_3 \rightarrow ClO + O_2$

$ClO + O \rightarrow Cl + O_2$

(i) Give the overall equation for the reaction that occurs in the cycle.

[1]

Most candidates were able to determine the overall reaction as $O_3 + O \rightarrow 2\ O_2$. However, some candidates stated the equation the wrong way around, while others included Cl or ClO into their equation.

Question 2 (c) (ii)

(ii) What is acting as a catalyst in this catalytic cycle and what **type** of catalysis is involved?

....

.... **[1]**

Candidates became a little confused with this question. A large portion of candidates were able to identify chlorine as the catalyst, with others identifying oxygen, ClO, ozone or sunlight. Homolytic catalysis was generally recognised by candidates, although some stated heterolytic or even homologous.

Question 2 (d)

(d) A CFC has the following percentage composition by mass:

C, 11.7%; F, 18.8%; C*l*, 69.5%.

The relative molecular mass of this CFC is 204.

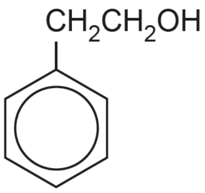
Calculate the molecular formula of this CFC.

molecular formula = ... **[3]**

Candidates had a clear understanding of the empirical formula calculation with a large portion of candidates achieving the first two marking points. A smaller portion of candidates were then able to manipulate the data and find the molecular formula of the CFC, achieving the third marking point.

Question 3 (a) (i)

3 This question concerns some reactions of compound **A**.

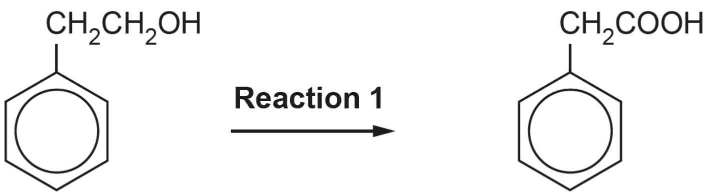


Compound A

Compound **A** is found in extract of orange blossom. A group of chemists carry out some reactions with this compound.

(a) Reaction 1

Compound **A** can be converted to an acid, compound **B**, as shown.



Compound A **Compound B**

(i) Explain why the alcohol functional group in compound **A** is classified as **primary**.

.... **[1]**

The candidates, generally, had a clear understanding of what a primary alcohol was, but many candidates continued their answers below the answer line. There is a clear understanding that, in a primary alcohol, the carbon where the alcohol is attached is attached to one other carbon, but some candidates referred to this as R groups and were not given the marking point.

Question 3 (a) (ii)

(ii) Give the reagents and conditions required for **reaction 1**.

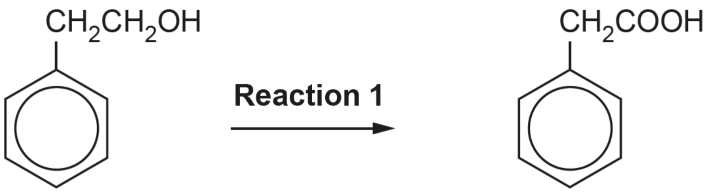
Reagents ....

Conditions ....
[1]

Despite this being a question which required direct recall, many candidates did not gain the marking point. The common error was that the word 'acidified' was missing from the reagent answer, with a smaller portion of candidates not identifying that reflux is required.

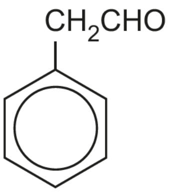
Question 3 (a) (iii)

Reaction 1 (repeated)



Compound A **Compound B**

(iii) **Reaction 1** occurs via the formation of compound **C**.



Compound C

The chemists use infrared spectroscopy to find out whether the conversion of compound **A** into compound **B** (**reaction 1**) is complete after 10 minutes. They set up a reaction mixture and analyse it after 10 minutes.

The infrared spectrum of the mixture shows absorptions at the wavenumbers shown in **Table 3.1**.

Type of absorption	**Wavenumber / cm^{-1}**
sharp	1200
several in a range	1500–1600
sharp	1710
sharp	1730
broad	2900
broad	3300

Table 3.1

Use the information from **Table 3.1** to determine whether the conversion is complete after 10 minutes.

Give the relevant bonds for any wavenumbers you refer to.

....

....

....

.... **[3]**

This question allowed the candidates to differentiate themselves. Many candidates only referenced a range of wavenumbers for a corresponding bond and this resulted in them scoring 0. Also, where specific peaks are identified, the candidate did not identify the bond causing the peak or vice versa, again scoring 0. Candidates needed to score marking point 2 and identify the presence of the aldehyde in order to gain the first marking point and state the reaction is incomplete. Generally, candidates either scored 0 or 2/3 MP's.

Exemplar 1

The conversion is not complete after 10 minutes because although the 2900 cm^{-1} peak indicates the presence of a carboxylic acid ~~C=O~~-O-H bond, the presence of the 1730 cm^{-1} peak indicates the presence of aldehydes due to this peak correlating with an aldehyde C=O bond. Therefore, some compound C remains as this is an aldehyde. The broad peak at 3300 cm^{-1} could indicate a O-H bond within a carboxylic acid (compound B) but also could indicate an alcohol O-H bond, like the OH bond in compound A. Therefore, the reaction is not yet fully complete as some aldehyde (C) & ~~even~~ possibly A could remain. **[3]**

Exemplar 1 is a successful response to this question.

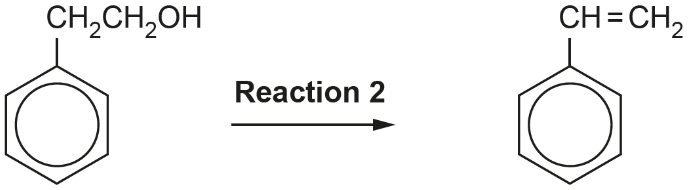
Misconception

? Candidates tended to focus on the ranges of wavenumbers rather than specific wavenumbers and their corresponding bonds. A number of candidates missed out on the first marking point as they presumed the reaction was complete due to the presence of the carboxylic acid rather than incomplete due to the presence of the aldehyde.

Question 3 (b)

(b) Reaction 2

Compound **A** can be dehydrated as shown.



What **type** of reaction is this dehydration?

.... **[1]**

This was another recall question but candidates found it challenging. Many did not recognise the reaction as elimination.

Question 3 (c)

(c) Reaction 3

Compound **A** can be reacted with hydrochloric acid.

An incomplete equation is shown below.

Complete the balanced equation for this reaction.

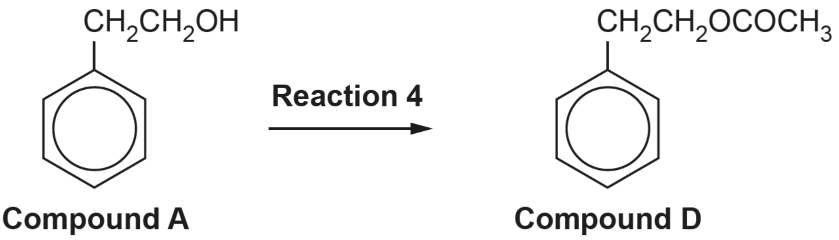
[1]

Many candidates answered this question below the question rather than adding the reagent and product to the equation, although were still given the mark. However, many candidates stated the formula for the aromatic compound incorrectly. Thankfully, this was ignored, or it would have limited candidate scores.

Question 3 (d)*

(d)* Reaction 4

Compound **A** can be converted to an ester, compound **D**, as shown.



A student attempts to carry out **reaction 4** using two different methods.

In one method the student uses equimolar amounts of compound **A** and ethanoic acid.

In the other method, equimolar amounts of compound **A** and ethanoic anhydride are used.

At the end of each reaction the mixture is analysed using thin-layer chromatography. The results of this analysis are shown below in **Fig. 3.1**.

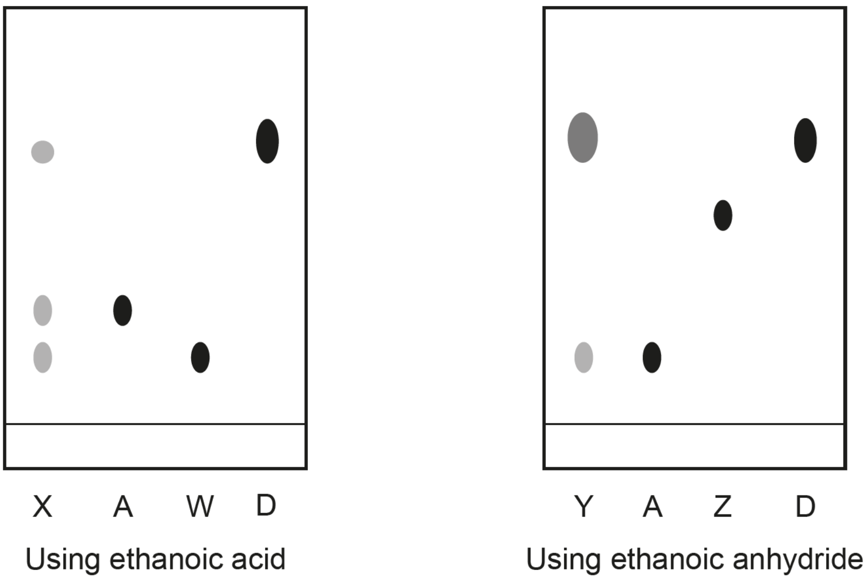


Fig. 3.1

Key to chromatograms in Fig. 3.1

X = recrystallised product from ethanoic acid

Y = recrystallised product from ethanoic anhydride

A = Compound **A**

W = ethanoic acid

Z = ethanoic anhydride

D = Compound **D**

Describe how the student would run the chromatograms once the substances have been spotted onto the thin-layer plates.

Use **Fig. 3.1** to explain how well ethanoic acid and ethanoic anhydride work at carrying out **reaction 4**.

....

....

....

....

....

.... **[6]**

The chromatogram in this question contained an error and this caused some confusion for a small number of candidates. In the chromatogram labelled 'Using ethanoic anyhydride', the spot in the column labelled A should have been level with the corresponding spot in the column labelled A in the chromatogram labelled 'Using ethanoic acid'. Changes were made to the mark scheme to limit the impact of this error and allow candidates the opportunity to achieve marks for this question.

The description of the chromatogram was, in some cases, detailed and in others, vague. It would be advised for candidates to revisit this practical and make sure they know the stages for completing a chromatogram.

Regarding the analysis of the chromatograms, a number of candidates misread the information provided, and on reading the labels interpreted the chromatograms as showing the solvent used rather than the reactant used to make the ester. Those who were able to interpret the chromatograms did so well, identifying and interpreting the key parts. However, only a small portion of candidates were able to draw a conclusion regarding the synthesis reaction and this was a requirement for a level 3 response.

Most candidates tended to focus on either the process for producing a chromatogram or an analysis of the chromatograms provided, and this limited them to a Level 2 or lower response. On the whole, this was a question that stretched the candidates and allowed for differentiation between the levels of response.

Exemplar 2

Once the substances are spotted onto a silica thin-layer plate, the student should ~~dip~~ put the plate ~~into~~ a beaker containing solvent so that the TLC plate just dips into the solvent (and the solvent level is lower than the spots). They should place a lid on the beaker ~~at~~ to prevent the solvent evaporating off and to create a saturated solvent atmosphere. When the solvent front nears the top of the plate, they should remove the plate, mark how far the solvent reached and dry in a fume cupboard. Use a suitable locating agent (e.g. iodine or UV light) to locate the spots of the ~~compounds and~~ products (X and Y) and compare to the spots of the compounds (A, D, W + Z) Figure 3.1 shows us that ethanoic anhydride works best for reaction 4 because following the thin layer chromatography, we can see that there was more of compound D ~~Z~~ (the product) in the recrystallised product Y than in the recrystallised product X. Using ethanoic anhydride, ~~all of the~~ the concentration of compound A decreased and all **[6]**

Additional answer space if required.

of the ethanoic anhydride reacted, suggesting it was in excess, whereas ~~th~~ using ethanoic acid, the concentrations of the reactants (A and W) decreased but less product was made. This suggests that the reaction took place at a higher rate using ethanoic anhydride.

Exemplar 2 is a successful response to this question.

Assessment for learning

Despite the confusion in the question candidates were able to identify the practical and attempted to analyse the results. More practice on practical procedure, steps involved in the practical procedure and interpretation in results would allow more candidates to score Level 2 and Level 3 marks on this question.

Question 4 (a) (i)

4 Vehicles using petrol as fuel will still be on the roads for some time to come.

It is important that developments continue to improve fuel efficiency and further reduce harmful emissions.

(a) Petrol is a complex mixture of compounds, mainly hydrocarbons.

(i) One of the hydrocarbons in petrol is octane, C_8H_{18}.

Write an equation for the complete combustion of octane.

[1]

This was a question where candidates were able to pick up the mark and gain confidence after the previous Level of Response question. On the whole, candidates were able to write the correct products as well as balance the equation and identify that 12.5 O_2 were required.

Question 4 (a) (ii)

(ii) Oxides of nitrogen (NO_x) which can lead to acid rain are also produced in a petrol engine.

Give the conditions in the engine that cause the usually unreactive nitrogen to react with oxygen.

....

.... **[1]**

Another question where candidates were able to score well. Most candidates were able to identify the need for high temperature, although some candidates stated 'hot' conditions. High pressure was not required although most candidates stated this as well.

Question 4 (b)

(b) 4.3 g of another liquid hydrocarbon present in petrol produce 554 cm^3 of vapour at 60 °C and 250 kPa.

Use these data to work out the M_r of the hydrocarbon.

M_r = ... **[4]**

Candidates were able to use the ideal gas equation, but there were issues when it came to converting units. This was particularly clear with the conversion of volume to cubic metres. Some candidates also did not convert temperature from Celsius to Kelvin. Candidates were able to gain ECF for using the answer of moles from the ideal gas equation to calculate the molecular mass. Some candidates were confused over the steps being used and using explanations in the calculation steps would aid them in the process.

Question 4 (c) (i)

(c) The alcohol methanol is a liquid oxygenate that is used in petrol to reduce the amount of incomplete combustion that occurs.

(i) Methanol burns in oxygen as shown in **equation 4.1**.

$CH_3OH(g) + 1\frac{1}{2}O_2(g) \rightarrow CO_2(g) + 2H_2O(g) \quad \Delta_c H_{298} = -676\,kJ\,mol^{-1}$ **Equation 4.1**

Some average bond enthalpy data are given in **Table 4.1**.

Bond	Average bond enthalpy / $kJ\,mol^{-1}$
C–O	+358
O–H	+464
O=O	+498
C=O	+805

Table 4.1

Calculate a value for the average bond enthalpy of the C–H bond in methanol.

Use the data in **Table 4.1** and the value of $\Delta_c H_{298}$ in **equation 4.1**.

average bond enthalpy of C–H = ... $kJ\,mol^{-1}$ **[3]**

Generally, candidates understood the principle of this calculation. Some candidates made common errors in calculating the bond breaking and bond making, one of them being the use of the C-O bond enthalpy rather than C=O for carbon dioxide. Candidates were able to score marking points 1 or 2 if the correct calculation for bond making or bond making was completed, and if the candidate correctly divided their answer by 3 they were able to obtain the third marking point vis an ECF.

Question 4 (c) (ii)

(ii) The **standard** enthalpy change of combustion of methanol ($\Delta_c H^{\ominus}_{298}$) is **not** the same as the value given in **equation 4.1**.

Give a reason for this.

....

.... **[1]**

Misconception

Very few candidates were able to score on this question. Candidates seemed to misread the question, presuming it was a comment on the practical rather than the data used. Many candidates stated that the difference was due to non-standard conditions rather than bond enthalpies being averages, or that reactants were in non-standard states.

Question 4 (c) (iii)

(iii) There are two carbon-oxygen bonds listed in **Table 4.1**.

Explain why the C=O double bond is shorter than the C–O single bond.

....

.... **[2]**

Many candidates described the differences in the bonds using pi and sigma bonds. Candidates tended to be unclear in their explanations for the difference in bond length. A number of candidates were able to identify an increase in the number of electrons in the bond, but few were able to use this information to explain, in combination with nuclear attraction, the shortening of the C=O bond.

Question 4 (d)

(d) A student carries out an experiment to measure $\Delta_c H$ for methanol, CH_3OH. The student burns the methanol in a spirit burner below a beaker containing 100 cm^3 water, as shown in **Fig. 4.1** on page 18.

The following measurements are recorded:

mass of spirit burner and methanol before combustion	12.58 g
mass of spirit burner and methanol after combustion	11.62 g
temperature of water before combustion	17.0 °C
temperature of water after combustion	45.0 °C

Use these measurements to calculate a value for $\Delta_c H$ of methanol in $kJ\,mol^{-1}$.

$\Delta_c H$ of CH_3OH = ... $kJ\,mol^{-1}$ **[3]**

Candidates were able to work through the calculation here well and calculate the enthalpy of combustion. However, many candidates did not convert the final answer from positive to negative and through this lost the final marking point. Some candidates used the mass of fuel burnt rather than the mass of water in the initial calculation and this limited them to 1 mark.

Question 4 (e)*

(e)* The student uses the following procedure to obtain the measurements in **part (d)**.

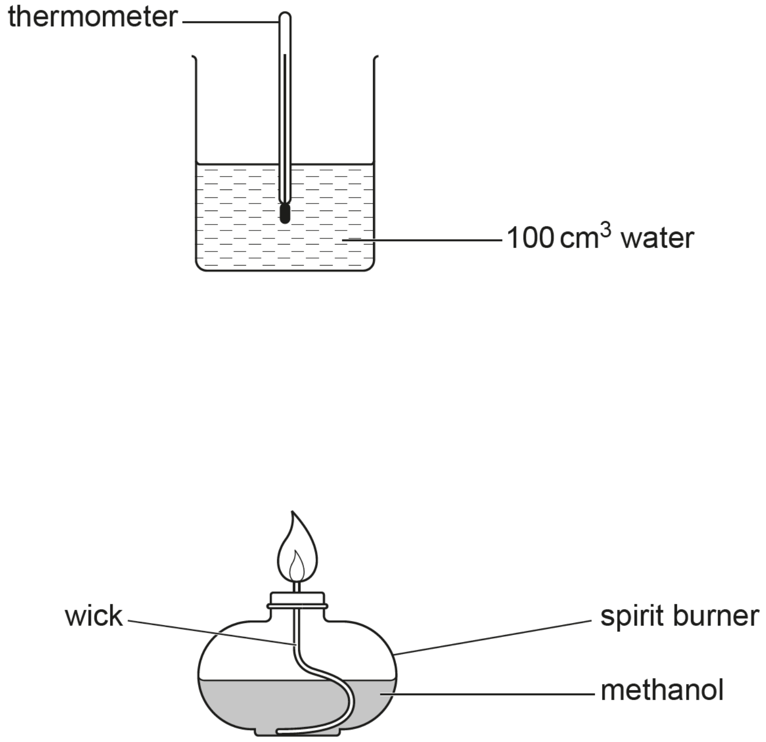


Fig. 4.1

Procedure:

1 The mass of a spirit burner containing methanol is measured and recorded.

2 100 cm^3 of water is measured into a 250 cm^3 glass beaker using the graduations on the beaker.

3 The temperature of the water is measured and recorded.

4 The apparatus is set up as shown in **Fig. 4.1**, with the beaker being held in position using a clamp, boss and stand (not shown).

5 The wick of the spirit burner is ignited.

6 When the temperature of the water in the beaker has risen by about 30 °C, the flame on the spirit burner is blown out.

7 After the water is emptied out of the beaker and the apparatus has been put away, the mass of the spirit burner is measured and recorded again.

The student wants to improve the accuracy of the calculated enthalpy change of combustion by changing the method.

Suggest and explain possible improvements to the procedure on page 18.

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.... **[6]**

Candidates were able to interpret the question and show an understanding of the errors that could occur in the practical. The question was good for separating the level the candidates are working at, and candidates tended to score higher on this question compared to the previous levelled question in the paper. However, there were suggestions made by candidates which showed confusion between enthalpy of combustion and enthalpy of reaction, with candidates suggesting a polystyrene cup as an improvement rather than a calorimeter. Some candidates focused on changes in equipment, such as the balance and thermometers, rather than improvements to the method. Some candidates were able to suggest and explain improvements, and it is clear that these candidates had previously completed the practical. Generally, this was a good question to finish the paper on.

Exemplar 3

Use copper calorimeter instead of beaker so energy is transferred quicker, add a lid and draft excluder to reduce energy loss [energy loss decreases ΔH]
Put the lid on the spirit burner instead to put it out to avoid any fuel vapor and energy being lost
Measure the mass of the fuel burner straight away as methanol is volatile and will evaporate
~~can~~ all of these would ~~[illegible] ΔH~~ make ΔH more accurate however not perfect as you can't exactly account for incomplete combustion
Measure the water using a measuring cylinder or glass pipette for more accurate volume readings
~~heat the water until it doesn't change by~~
make sure to stir water to avoid hot ~~[illegible]~~ areas within it [6]

Exemplar 3 is a successful response to this question.

Assessment for learning

Candidates were able to suggest improvements regarding the practical but a number focused on the equipment rather than the practical itself. More practice on what procedure is used and why the procedure is completed in a particular way will allow candidates to fully analyse an incorrect method and suggest sensible suggestions to allow them to gain L2 and L3 marks.

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