

A LEVEL

Examiners' report

CHEMISTRY B (SALTERS)

H433

For first teaching in 2015

H433/03 Summer 2022 series

Contents

Introduction	3
Paper 3 series overview	4
Question 1 (a) (i)	5
Question 1 (a) (ii)	5
Question 1 (b)	6
Question 1 (c)	6
Question 1 (d)*	7
Question 2 (a) (i)	7
Question 2 (b)	9
Question 2 (c)*	9
Question 3 (a) (i)	10
Question 3 (a) (ii)	11
Question 3 (a) (iii)	11
Question 3 (b) (i)	12
Question 3 (b) (ii)	12
Question 3 (c) (i)	13
Question 3 (c) (ii)	14
Question 3 (d)	15
Question 4 (a)	17
Question 4 (b) (i)	18
Question 4 (b) (ii)	19
Question 4 (b) (iii)	19
Question 4 (c) (i)	19
Question 4 (c) (ii)	20
Question 4 (d)	21

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](#).

Would you prefer a Word version?

Did you know that you can save this PDF as a Word file using Acrobat Professional?

Simply click on **File > Export to** and select **Microsoft Word**

(If you have opened this PDF in your browser you will need to save it first. Simply right click anywhere on the page and select **Save as . . .** to save the PDF. Then open the PDF in Acrobat Professional.)

If you do not have access to Acrobat Professional there are a number of **free** applications available that will also convert PDF to Word (search for PDF to Word converter).

Paper 3 series overview

H433/03 is one of the three examination units for GCE Chemistry B. This largely synoptic unit links together different areas of chemistry within different contexts, some practical, some familiar and some novel. To do well on this paper, candidates need to be comfortable applying their knowledge and understanding to unfamiliar contexts and be familiar with a range of practical techniques.

H433/03 is much more application based than the other two A level Chemistry Components, H433/01 and H433/02, which have a greater emphasis on knowledge and understanding of the assessment outcomes from the specification.

H433/03 also contains more questions set in a practical context, including an insert based on a practical procedure, than H433/01 and H433/02.

This particular exam series, coming in the wake of the COVID outbreak and the difficulty centres and centres experienced in being able to deliver hands on practical activities, resulted in many students providing less structured answers to those questions requiring a knowledge of practical procedure or analysis of practical observations.

Examiners were well aware of this and, while striving to maintain consistent standards of assessment, actively tried to give marks where possible.

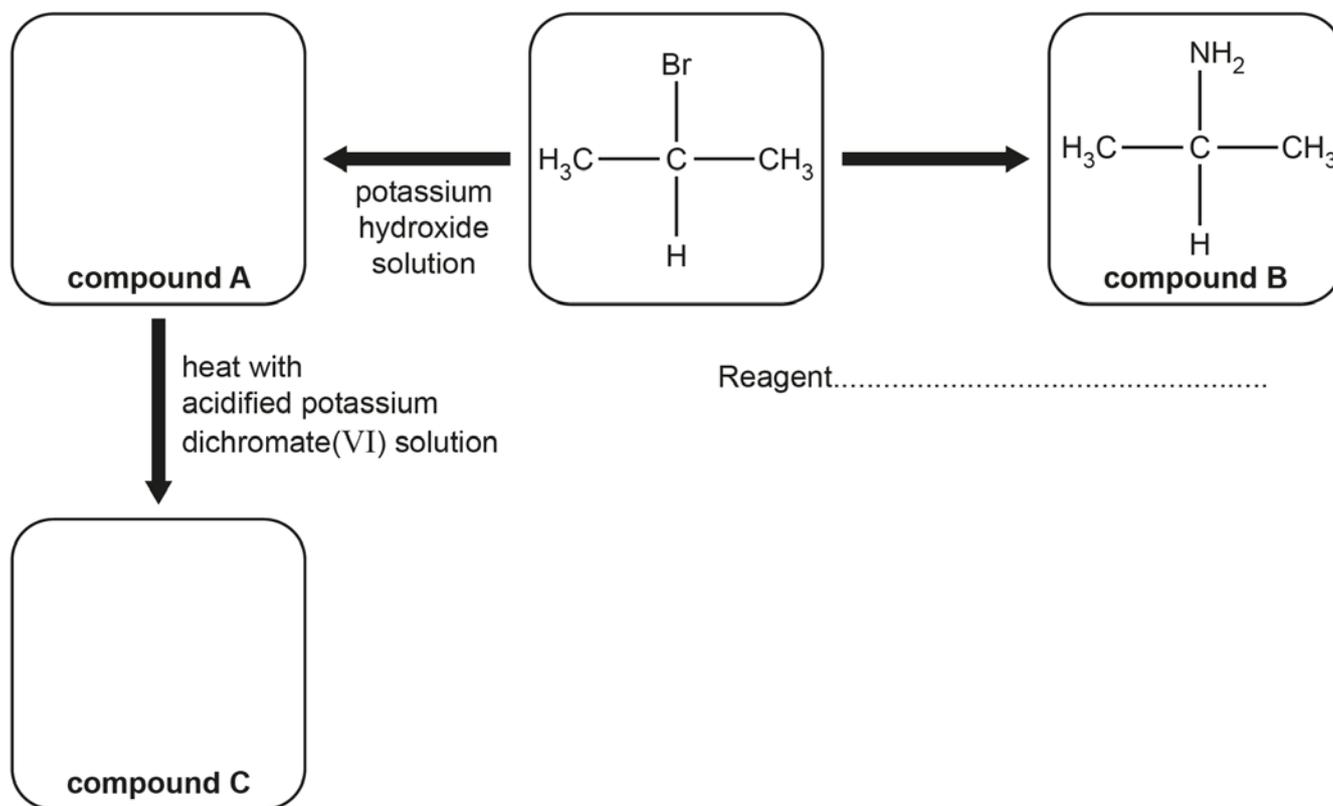
Candidates who did well on this paper generally did the following:	Candidates who did less well on this paper generally did the following:
<ul style="list-style-type: none">• Recognised that the detail required in longer text based answers was commensurate with the marks available.• Carefully laid out the steps involved in calculations; thus minimising marks lost on any slip made in the calculation• Linked the procedure or observations in questions involving practical investigations to the important underlying chemistry	<ul style="list-style-type: none">• Gave explanations for the longer answer questions which were not logically sequenced and missed fine detail• Struggled to link essential chemistry to practical observations• Gave a less successful or indeed no explanation for those questions traditionally regarded as more challenging, e.g. reaction mechanisms and/or electrochemistry

Question 1 (a) (i)

1 This question is about haloalkanes and their reactivity.

(a) Haloalkanes are useful intermediates for preparing a range of organic compounds.

A flowchart showing the synthesis of three organic compounds is shown below.



(i) Complete the flowchart showing the structures of compounds **A** and **C**.

On the dotted line show the reagent needed to form compound **B**.

[3]

There were many good responses. The structure of compound C, a ketone, proved the most difficult.

Question 1 (a) (ii)

(ii) Which homologous series does compound **B** belong to?

..... [1]

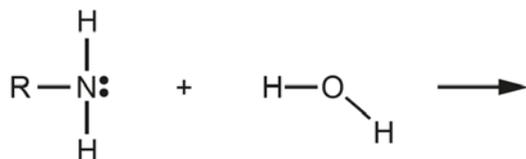
The majority of answers were correct. Wrong choices included amides and amino acids.

Question 1 (b)

(b) Compound **B** behaves as a base.

Complete the diagram of a mechanism that shows how a molecule of compound **B** reacts with water to give a basic solution.

Show 'curly arrows'.



[2]

This question produced a wide range of answers. The 'curly arrows', as ever proved difficult for many candidates. The lack of a positive charge on the alkyl ammonium cation product caught many students out. This question proved discriminating.

Question 1 (c)

(c) Some haloalkanes act as greenhouse gases that absorb infrared radiation in the troposphere.

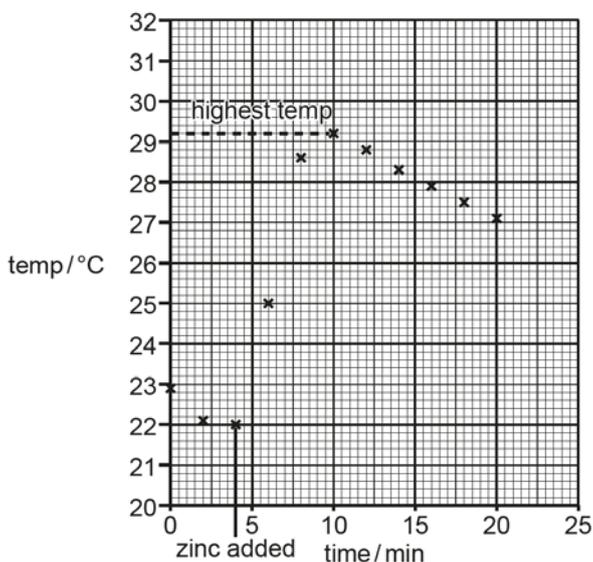
Give the source of this infrared radiation.

..... [1]

Answers often polarised between 'Earth' (correct) or 'Sun' (incorrect).

Question 2 (a) (ii)

- (ii) The student measures the temperature of the contents of the beaker over a period of 20 minutes and plots the data on the graph below.



The student uses the graph to determine the highest temperature as shown.

The student uses this temperature to calculate the heat energy given to the solution per mole of limiting reagent.

Show the student's calculation, giving the answer in kJ mol^{-1} .

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

heat energy given to the solution = kJ mol^{-1} [3]

This question discriminated well. Common mistakes included the use of the wrong mass for the solution and a failure to calculate the heat energy for one mole of 'reaction'. Examiners did allow ecf marks for individual errors correctly carried forward.

Question 2 (b)

(b) Calculate $\Delta_r H^\ominus$ for **Reaction 2.1** using the data shown below.

	$\Delta_r H^\ominus / \text{kJ mol}^{-1}$
$\text{Cu}^{2+}(\text{aq})$	+ 64.4
$\text{Zn}^{2+}(\text{aq})$	-152.4

$$\Delta_r H^\ominus = \dots\dots\dots \text{kJ mol}^{-1} \quad [1]$$

A pleasing majority of candidates calculated this value correctly; however some lost the mark by not including the negative sign.

Question 2 (c)*

(c)* The value obtained from the student's experiment is considerably less exothermic than the value in part (b).

Evaluate the student's experiment, identifying limitations in both the experimental procedure and the measurements taken. You should also comment on how any of the limitations you have identified will affect the final value.

Suggest possible improvements to the procedure, apparatus and measurements. [6]

The vast majority of candidate's knew that heat loss to the environment was the most significant factor causing the final value to be lower than the theoretical. However the stem of the question requires candidate answers to not only identify limitations in both the procedure and the measurements but also suggest possible improvements to the procedure, apparatus and measurements in order to be given the higher marks for this question. The majority of candidates just mentioned heat loss to the environment and the use of polystyrene cups, without considering any other, albeit possibly less significant, factors.

Assessment for learning



In questions such as 2(c) students should be encouraged to consider/interrogate in detail the key formula at the heart of the practical, $q = m \times c \times \Delta T$.

It might be helpful to ask students what each of the symbols actually mean. e.g. 'q' is the heat energy in Joules transferred in the reaction – is this per mole of reaction?

m is mass/g – of what? Water, solution, zinc?

c is specific heat capacity – water or solution or even container (glass/polystyrene)?

ΔT is temperature change (conversion to Kelvin scale makes no difference) – has the graph been used in the best way

Question 3 (a) (i)

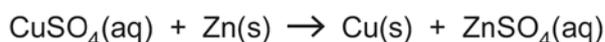
3 This question is about redox and electrochemical cells.

Table 3.1 shows standard electrode potentials, some of which will be needed for the rest of this question.

Half reaction	Standard electrode potential, E^\ominus / V
$\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Zn}(\text{s})$	-0.76
$\text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Fe}(\text{s})$	-0.44
$2\text{H}^+(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{H}_2(\text{g})$	0.00
$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Cu}(\text{s})$	+0.34
$\frac{1}{2}\text{O}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) + 2\text{e}^- \rightleftharpoons 2\text{OH}^-(\text{aq})$	+0.40
$\frac{1}{2}\text{I}_2(\text{aq}) + \text{e}^- \rightleftharpoons \text{I}^-(\text{aq})$	+0.54
$\text{Fe}^{3+}(\text{aq}) + \text{e}^- \rightleftharpoons \text{Fe}^{2+}(\text{aq})$	+0.77
$\text{Ag}^+(\text{aq}) + \text{e}^- \rightleftharpoons \text{Ag}(\text{s})$	+0.80
$\text{Cl}_2(\text{g}) + 2\text{e}^- \rightleftharpoons 2\text{Cl}^-(\text{aq})$	+1.36
$\text{MnO}_4^-(\text{aq}) + 8\text{H}^+(\text{aq}) + 5\text{e}^- \rightleftharpoons \text{Mn}^{2+}(\text{aq}) + 4\text{H}_2\text{O}(\text{l})$	+1.51

Table 3.1

(a) The reaction between zinc metal and aqueous Cu^{2+} ions can be arranged in a cell to produce electrical energy.



A diagram of a copper/zinc cell is shown in **Fig. 3.1**.

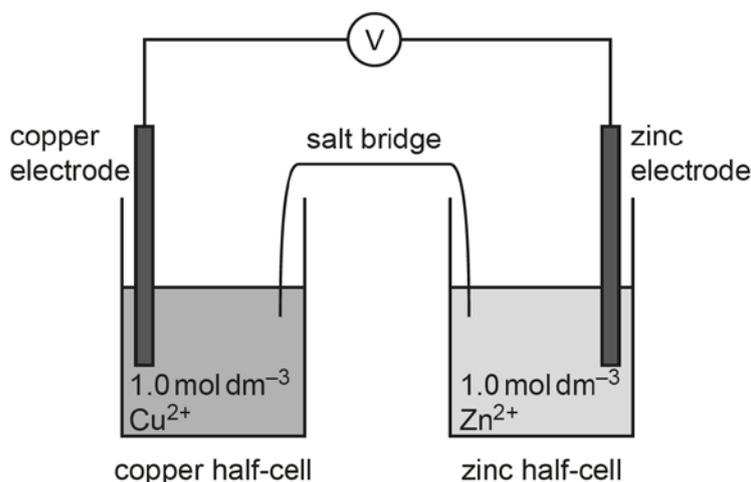


Fig. 3.1

When the cell delivers a current, oxidation takes place in one half-cell and reduction in the other.

- (i) Write half-equations for the reactions that take place in each half-cell.

Show state symbols.

oxidation reaction:

reduction reaction:

[2]

This question was generally well answered.

Question 3 (a) (ii)

- (ii) Explain the purpose of the salt bridge.

.....

 [2]

The movement of ions from the salt bridge into or from the half cells was the key here, but the easier mark of 'completing the circuit' was often missed; again, worth students checking the mark allocation.

Question 3 (a) (iii)

- (iii) Calculate $E^{\ominus}_{\text{cell}}$ for the copper/zinc cell in **Fig. 3.1**.

$$E^{\ominus}_{\text{cell}} = \dots\dots\dots \text{ V [1]}$$

This question was generally well answered.

Question 3 (b) (i)

(b) Standard electrode potentials can be used to decide whether a reaction is feasible.

Predict, with reasons, if any reaction could take place in each of the following situations.

Use the data in **Table 3.1**.

(i) Metallic silver is added to aqueous iron(II) sulfate.

.....
..... [1]

This question proved difficult for many candidates, with vague suggested answers. The question relied on candidates realising that for silver metal to react silver atoms must lose electrons, and this can only happen to a half reaction with a greater positive (less negative) standard electrode potential.

Question 3 (b) (ii)

(ii) Aqueous potassium chloride is added to acidified potassium manganate(VII) solution.

.....
.....
.....
..... [2]

Better answered than Question 3 (b) (i).

Question 3 (c) (i)

- (c) The relationship between the ion concentration and the electrode potential for a metal/ion electrode is given (at 298 K) by **Equation 3.1**, where n is the number of electrons transferred in the half reaction.

$$E = E^\ominus + \frac{0.059 \times \log_{10}[\text{ion}]}{n} \quad \text{Equation 3.1}$$

- (i) Explain how **Equation 3.1** shows that $E = E^\ominus$ under standard conditions.

.....

.....

.....

..... [2]

Only the better candidates explained this logically i.e. standard concentration is 1 mol dm^{-3} and $\log_{10} [1]$ is zero.

Question 3 (c) (ii)

- (ii) Calculate the electrode potential of a $\text{Zn}^{2+}(\text{aq})/\text{Zn}(\text{s})$ half-cell when $[\text{Zn}^{2+}(\text{aq})] = 0.20 \text{ mol dm}^{-3}$.

$E = \dots\dots\dots \text{ V [2]}$

Half reaction	Standard electrode potential, E^\ominus / V
$\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Zn}(\text{s})$	-0.76
$\text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Fe}(\text{s})$	-0.44
$2\text{H}^+(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{H}_2(\text{g})$	0.00
$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Cu}(\text{s})$	+0.34
$\frac{1}{2}\text{O}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) + 2\text{e}^- \rightleftharpoons 2\text{OH}^-(\text{aq})$	+0.40
$\frac{1}{2}\text{I}_2(\text{aq}) + \text{e}^- \rightleftharpoons \text{I}^-(\text{aq})$	+0.54
$\text{Fe}^{3+}(\text{aq}) + \text{e}^- \rightleftharpoons \text{Fe}^{2+}(\text{aq})$	+0.77
$\text{Ag}^+(\text{aq}) + \text{e}^- \rightleftharpoons \text{Ag}(\text{s})$	+0.80
$\text{Cl}_2(\text{g}) + 2\text{e}^- \rightleftharpoons 2\text{Cl}^-(\text{aq})$	+1.36
$\text{MnO}_4^-(\text{aq}) + 8\text{H}^+(\text{aq}) + 5\text{e}^- \rightleftharpoons \text{Mn}^{2+}(\text{aq}) + 4\text{H}_2\text{O}(\text{l})$	+1.51

Table 3.1

This question was well answered.

Exemplar 1

The student is correct as the Zinc wire has a greater electrode potential than the Iron nail. The half reaction at it is $\text{Zn(s)} \rightarrow \text{Zn}^{2+} + 2\text{e}^{-}$, $\frac{1}{2}\text{O}_2(\text{aq}) + \text{H}_2\text{O(l)} + 2\text{e}^{-} \rightarrow 2\text{OH}^{-}(\text{aq})$. Hence no blue ~~is~~ for Fe^{2+} and is pink for OH^{-} which is alkaline. The Copper wire does not prevent rusting as it has a lower electrode potential. The half equations are: $\text{Fe(s)} \rightarrow \text{Fe}^{2+}(\text{aq}) + 2\text{e}^{-}$, $\frac{1}{2}\text{O}_2(\text{aq}) + \text{H}_2\text{O(l)} + 2\text{e}^{-} \rightarrow 2\text{OH}^{-}(\text{aq})$. Hence blue for Fe^{2+} and pink again for OH^{-} which is alkaline. [4]

This exemplar links the observations to the underlying chemistry.

Question 4 (a)

4 This question refers to the Practical Insert that is provided as an insert to this paper.

- (a) Suggest how the students accurately made up a solution of $0.300 \text{ mol dm}^{-3}$ copper(II) nitrate from their standard $0.400 \text{ mol dm}^{-3}$ solution.

Name the apparatus involved.

.....

.....

.....

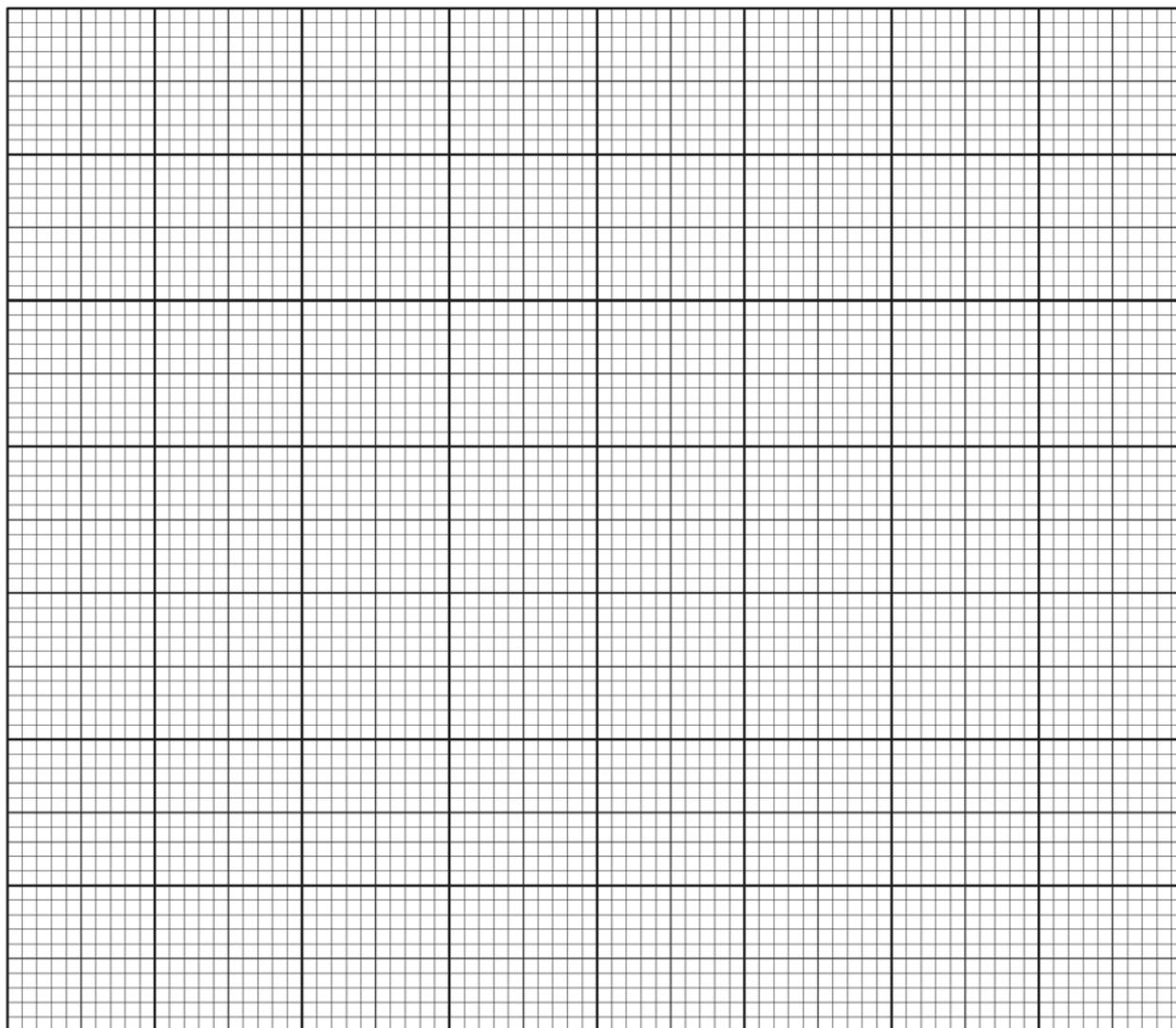
.....

..... [3]

A significant minority of students ignored the instruction to name the apparatus or used apparatus that would not meet the required precision.

Question 4 (b) (i)

- (b) (i) Plot a graph of absorbance against concentration on the graph paper below and draw an appropriate line of best fit. Label the axes. [3]



A common error was for the x axis (concentration) scale not to be linear, and not using 0.0 as a perfectly valid point (helping out with the construction of a sensible line of best fit).

Question 4 (b) (ii)

- (ii) Use your graph on page 12 and data from the insert to calculate the percentage by mass of copper in the brass sample.

percentage by mass of copper in the brass sample = % [3]

More successful responses had little trouble with this calculation.

Question 4 (b) (iii)

- (iii) Explain why an orange filter is placed into the colorimeter before taking the readings.

.....
.....
.....
..... [2]

Most candidates recognised it was the complimentary colour of the copper sulfate solution but missed the second mark. (Gives maximum absorbance.)

Question 4 (c) (i)

- (c) A copper(II) ion is said to form an octahedral complex with water ligands.

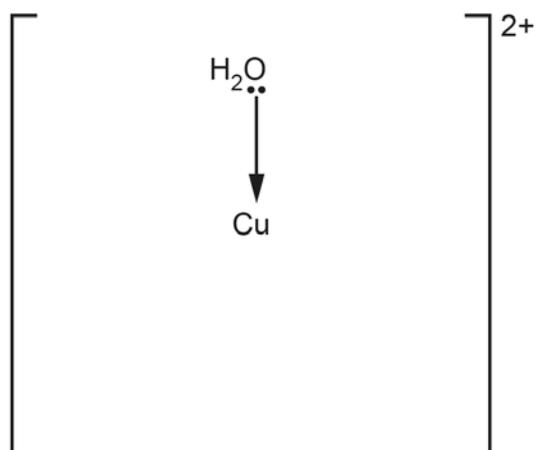
- (i) Explain the term **ligand**.

.....
..... [1]

A significant minority of candidates did not score this mark, giving rather vague answers.

Question 4 (c) (ii)

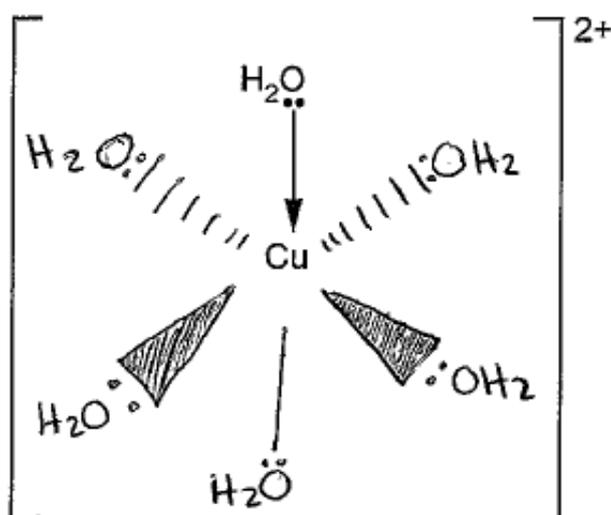
- (ii) Complete the diagram below to show the **shape** of the octahedral copper(II) complex ion with water ligands.



[3]

Examiners were looking for use of 'wedges and dashes' to indicate the 3D nature of complex in order to gain the third mark.

Exemplar 2



The exemplar above shows best use of wedges and dashes to illustrate the 3D nature of the complex ion.

Question 4 (d)

(d) d-block elements form a variety of differently coloured complex ions.

Explain, in terms of electronic structure, why these complex ions are coloured and why different complexes of the same cation have different colours.

.....

.....

.....

.....

.....

.....

..... [4]

Many candidates' answers became quite jumbled in this question. The question did however prove very discriminating.

Misconception

There were at least two common misconceptions that occurred in some candidate answers. The most common being the idea that the colour of a transition complex is due to electrons dropping down electronic energy levels and releasing light energy (i.e. emission), rather than the colour of the complex being the reflected or transmitted frequencies of light not absorbed.

Another misconception also seen, is that the d orbitals form a delocalised upper pi orbital and a lower ground state delocalised pi orbital.

Exemplar 3

when a ligand binds, the d block elements d subshell is split so that an energy gap corresponding to visible light is present, electrons are excited by absorbing energy ($E = hf$) and move to the higher energy level, the complementary colour to that absorbed is seen as the rest of visible light is transmitted. The same cation can have different colours because different ligands bind which cause the d subshell to split by different amounts so energy gap is corresponding to another wavelength of visible light so transmitted complementary colour is different

This candidate response offers a relatively succinct response gaining all 4 marks.

Supporting you

Post-results services

If any of your students' results are not as expected, you may wish to consider one of our post-results services. For full information about the options available visit the [OCR website](#).

Keep up-to-date

We send a weekly roundup to tell you about important updates. You can also sign up for your subject specific updates. If you haven't already, [sign up here](#).

OCR Professional Development

Attend one of our popular CPD courses to hear directly from a senior assessor or drop in to a Q&A session. Most of our courses are delivered live via an online platform, so you can attend from any location.

Please find details for all our courses on the relevant subject page on our [website](#) or visit [OCR professional development](#).

Signed up for ExamBuilder?

ExamBuilder is the question builder platform for a range of our GCSE, A Level, Cambridge Nationals and Cambridge Technicals qualifications. [Find out more](#).

ExamBuilder is **free for all OCR centres** with an Interchange account and gives you unlimited users per centre. We need an [Interchange](#) username to validate the identity of your centre's first user account for ExamBuilder.

If you do not have an Interchange account please contact your centre administrator (usually the Exams Officer) to request a username, or nominate an existing Interchange user in your department.

Active Results

Review students' exam performance with our free online results analysis tool. It is available for all GCSEs, AS and A Levels and Cambridge Nationals.

It allows you to:

- review and run analysis reports on exam performance
- analyse results at question and/or topic level
- compare your centre with OCR national averages
- identify trends across the centre
- facilitate effective planning and delivery of courses
- identify areas of the curriculum where students excel or struggle
- help pinpoint strengths and weaknesses of students and teaching departments.

[Find out more](#).

Need to get in touch?

If you ever have any questions about OCR qualifications or services (including administration, logistics and teaching) please feel free to get in touch with our customer support centre.

Call us on
01223 553998

Alternatively, you can email us on
support@ocr.org.uk

For more information visit

 **ocr.org.uk/qualifications/resource-finder**

 **ocr.org.uk**

 **/ocrexams**

 **/ocrexams**

 **/company/ocr**

 **/ocrexams**

We really value your feedback

Click to send us an autogenerated email about this resource. Add comments if you want to. Let us know how we can improve this resource or what else you need. Your email address will not be used or shared for any marketing purposes.



I like this



I dislike this

Please note – web links are correct at date of publication but other websites may change over time. If you have any problems with a link you may want to navigate to that organisation’s website for a direct search.



OCR is part of Cambridge University Press & Assessment, a department of the University of Cambridge.

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored. © OCR 2022 Oxford Cambridge and RSA Examinations is a Company Limited by Guarantee. Registered in England. Registered office The Triangle Building, Shaftesbury Road, Cambridge, CB2 8EA. Registered company number 3484466. OCR is an exempt charity.

OCR operates academic and vocational qualifications regulated by Ofqual, Qualifications Wales and CCEA as listed in their qualifications registers including A Levels, GCSEs, Cambridge Technicals and Cambridge Nationals.

OCR provides resources to help you deliver our qualifications. These resources do not represent any particular teaching method we expect you to use. We update our resources regularly and aim to make sure content is accurate but please check the OCR website so that you have the most up to date version. OCR cannot be held responsible for any errors or omissions in these resources.

Though we make every effort to check our resources, there may be contradictions between published support and the specification, so it is important that you always use information in the latest specification. We indicate any specification changes within the document itself, change the version number and provide a summary of the changes. If you do notice a discrepancy between the specification and a resource, please [contact us](#).

You can copy and distribute this resource freely if you keep the OCR logo and this small print intact and you acknowledge OCR as the originator of the resource.

OCR acknowledges the use of the following content: N/A

Whether you already offer OCR qualifications, are new to OCR or are thinking about switching, you can request more information using our [Expression of Interest form](#).

Please [get in touch](#) if you want to discuss the accessibility of resources we offer to support you in delivering our qualifications.