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GCSE (9-1)

Examiners' report

GATEWAY SCIENCE CHEMISTRY A

J248
For first teaching in 2016

J248/03 Summer 2018 series

Version 1

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. 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 examination paper can be downloaded from OCR.

Paper J248/03 series overview

J248/03 is the first of two examination components for candidates entered for the Higher Tier of the new revised GCSE examination for Gateway Science Chemistry A. This unit assesses teaching topics C1, C2 and C3 and is 50% of the total GCSE. To do well on this paper, candidates need to demonstrate knowledge and understanding of scientific ideas, techniques and procedures across all three topics. They need to be able to apply their knowledge and understanding to unfamiliar contexts as well as displaying the ability to analyse information. Candidates also need to be familiar with a range of experimental procedures and be able to think about how an experimental method could be improved.

J248/03 has an equal emphasis on knowledge and understanding of the assessment outcomes from the specification and application of this knowledge. There are fewer questions which assess analysis of information and ideas.

Candidate performance

Candidates who did well on this paper generally did the following:

- Constructed and balanced symbol and half-equations for familiar and unfamiliar reactions: 16(b), 17(b), 18(c), 24(c).
- Performed standard calculations following the required rubric (e.g. clear working, components and, where needed, significant figures) relating to relative formula mass: 16(c), bond energy: 21(b), moles and limiting reactants: 22, number of molecules: 26(b), and reacting masses: 26(c).
- Produced a clear, concise and well-structured answer for the Level of Response question: 25.
- Applied knowledge and understanding to questions set in a novel context.

Candidates who found this paper difficult generally did the following:

- Found it difficult to apply what they had learnt to unfamiliar situations.
- Found it difficult to analyse data and then make a judgement, or draw a conclusion, in relation to the data, e.g. 20(b).
- Found it difficult to analyse information to develop experimental procedures or to describe improvements to a specific procedure, e.g. 17(a), 18(a). Lower ability candidates often simply suggested repeating an experiment.
- Showed imprecise use of scientific terminology, e.g. 17(a), 20(b), 26(a).

There was no evidence that time constraints had led to underperforming. Very few questions were left blank by candidates.

Question 5

5 Look at the equation.

$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

Which substance is the **oxidising agent** in this reaction?

A CH_4

B CO_2

C H_2O

D O_2

Your answer ☐ **[1]**

This question required candidates to apply their knowledge of an oxidising agent and assessed AO2. A common error was A, CH_4, with candidates confusing the oxidising agent with the substance that is being oxidised.

Key:

Misconception

Question 8

8 A student separates a dye using thin layer chromatography.

She puts a thin layer of solid alumina onto a glass plate. She puts the dye on the pencil line. She puts the glass plate into a tank containing water.

Which of the following is the **stationary** phase?

A Alumina

B Glass

C Pencil line

D Water

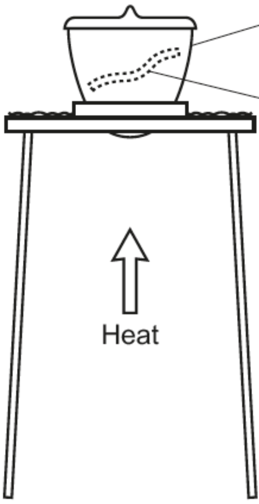
Your answer **[1]**

?

B and D were common misconceptions in this question.

Question 11

11 Magnesium is heated in a crucible.



The mass of the crucible and magnesium **increases**.

Which statement is the **best** explanation for this?

A Oxygen is given off.

B The magnesium melts.

C The magnesium is oxidised to magnesium oxide.

D The magnesium reacts to make magnesium carbonate.

Your answer ☐ **[1]**

?

A was a common misconception in this question.

Question 14

14 What is the approximate size of a nanoparticle?

A 0.07 nm

B 0.40 nm

C 50 nm

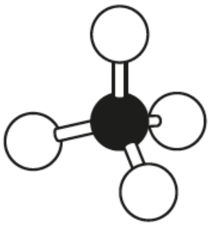
D 1000 nm

Your answer [1]

Examiners saw a mix of all incorrect responses to this question, which was only answered correctly by higher ability candidates.

Question 15

15 Look at the diagram of a methane molecule.



Which statement about methane is correct?

A Electrons are transferred from hydrogen atoms to carbon atoms.

B The covalent bonds in methane are weak.

C The force of attraction between methane molecules is weak.

D The ionic bonds between carbon and hydrogen are very strong.

Your answer [1]

B and D were common misconceptions in this question.

Question 16(a) (i)

16 Magnesium is an element. It is solid at room temperature.

(a) (i) **Solid** magnesium cannot be compressed.

Why?

.... **[1]**

This question required candidates to appreciate that the particles in a solid are close together. When candidates did not gain credit, it was often because they referred to particles having fixed positions and/or not being able to move.

Question 16(a) (ii)

(ii) **Solid** magnesium **cannot** flow, but **liquid** magnesium **can** flow.

Explain why.

....

....

....

.... **[3]**

Good responses to this question described that particles in a solid vibrate around fixed positions, whereas the particles in a liquid can move past each other. Higher ability candidates also described that the forces between particles in a liquid are weaker than in a solid. Lower ability candidates often did not mention particles, referring only to liquid magnesium or solid magnesium. A common misconception was that there are no forces between the particles in a liquid.

Question 16 (a) (iii)

(iii) Magnesium **gas** completely fills any container it is put in.

Explain why.

....

....

.... **[2]**

This question required candidates to give a response in terms of particles in a gas being far apart and moving quickly. This means that the particles can spread out because of the weak forces between them. Like question 16(a)(ii), a common misconception was that there are no forces between the particles in a gas. Candidates who did not gain full credit needed to write about the particles in the gas, rather than the gas as a whole.

Question 16 (b)

(b) Magnesium reacts with water. Magnesium hydroxide, $Mg(OH)_2$, and hydrogen, H_2, are made.

Write a balanced symbol equation for this reaction.

.... **[2]**

Many candidates were able to write the correct balanced symbol equation for the reaction of magnesium with water. One mark was credited for the correct reactants and products and one mark for the correct balancing. The balancing mark was dependent on the correct formulae, but one mark was allowed for a balanced equation with minor errors in subscripts or formulae. For example, MG + $2H^2O \rightarrow 2Mg(OH)_2$ + H_2, would gain one mark. When candidates did not gain marks, it was often because they tried to balance the equation by writing Mg_2 or MgOH.

Question 17 (a)

17 A student has a solution of hydrochloric acid, HC*l*, and a solution of sodium hydroxide, NaOH.

He wants to make a pure, dry sample of sodium chloride.

(a) Describe how he can do this.

Include the apparatus he should use and his method.

....

....

....

....

....

....

....

.... **[4]**

This question required candidates to plan an experimental procedure and tested AO3. Higher ability candidates described a titration of the acid with the alkali, using an indicator. They went on to describe repeating the titration to obtain concordant results before repeating again without the indicator. Finally, they described evaporating off the water and crystallising the sodium chloride. Candidates who were credited with full marks obviously had first-hand experience of carrying out a titration. Others described simply mixing the acid and the alkali, often without an indicator, before evaporating the water.

Exemplar 1

Include the apparatus he should use and his method.

He ~~can~~ carry out a rough titration with indicator ~~[illegible]~~ by driping hydroclrric acid into the solution of sodium hydroxide until the indicator gives a sharp change in colour. Then using the titre repeat to get a more acurate titre and finally use that value to ~~[illegible]~~ drip hydrochloric acid into the sodium hydroxide without indicator then heat the solution to the point of crystalisation the once crystals form he can dry them to get a pure ~~d~~ dry sample of sodium chloride he would need a h... **[4]**

(b) Write a **balanced symbol** equation for the reaction.

$HCl + NaOH \rightarrow NaCl + H_2O$ **[1]**

This response describes a titration using an indicator, which does not need to be named. The candidate appreciates the need to repeat the experiment to get an accurate titre. They then describe repeating without the indicator and heating the solution to form crystals of sodium chloride. The answer gains full marks; it has covered more than four of the marking points on the mark scheme.

Question 17 (c)

(c) The student also investigates other reactions.

The table shows the salts he can make from different starting materials.

Complete the table.

Acid used	**Other starting material**	**Salt made**
Sulfuric acid	Copper oxide	....
....	Zinc carbonate	Zinc nitrate
Hydrochloric acid	....	Magnesium chloride

[3]

A common misconception was that the salt made from sulfuric acid and copper oxide is copper sulfide.

Question 17 (d)

(d) What **type** of reaction happens when sulfuric acid reacts with copper oxide?

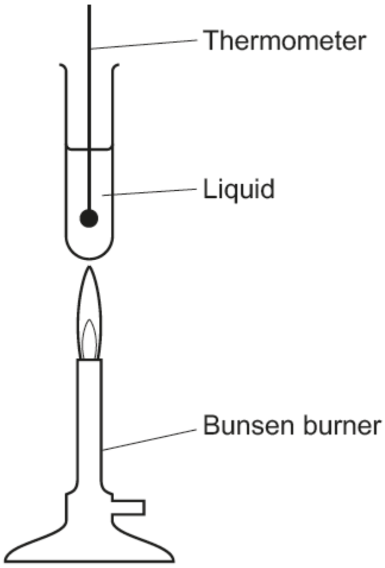
....

.... **[1]**

Higher ability candidates recognised the reaction between sulfuric acid and copper oxide as neutralisation. Examiners saw a range of incorrect answers such as redox, oxidation, reduction, displacement and exothermic.

Question 18 (a)

18 A student is measuring the boiling point of some liquids.



She measures the boiling point of water, petrol and ethanol.

(a) The student's method is not safe.

Explain why it is not safe and explain how she could improve her method to make it safer.

....

....

.... **[2]**

Good responses to this question appreciated the flammability of petrol and/or ethanol and suggested the use of a water bath or heating mantle. Candidates who did not gain credit suggested ideas about clamping the apparatus or putting a lid on the test tube.

Question 19 (b)

(b) These two atoms of chlorine are **isotopes**.

Explain why these two atoms of chlorine are isotopes.

....

.... **[1]**

?

A common misconception was that isotopes have different relative atomic masses.

Question 19 (c)

(c) Look at the information about other atoms and ions.

Atom or ion	Atomic number	Mass number	Number of protons	Number of neutrons	Number of electrons	Electronic structure
S	16	32	....	16	16	....
B	5	11	5	....	....	2.3
F^-	9	19	....	....	10	2.8
Li^+	3	7	3	4	....	....

Complete the table. **[4]**

Many candidates gained full marks for this question. Marks were most often lost for the ions, F^- and Li^+. 10 protons and 9 neutrons were common errors for F^-. For Li^+, candidates who did not gain credit often wrote 3 electrons with an electronic structure of 2.1.

Question 19 (d) (i)

(d) (i) The electronic structure of sodium is 2.8.1. The electronic structure of oxygen is 2.6. Sodium and oxygen react together to make sodium oxide.

Sodium oxide is an **ionic** compound.

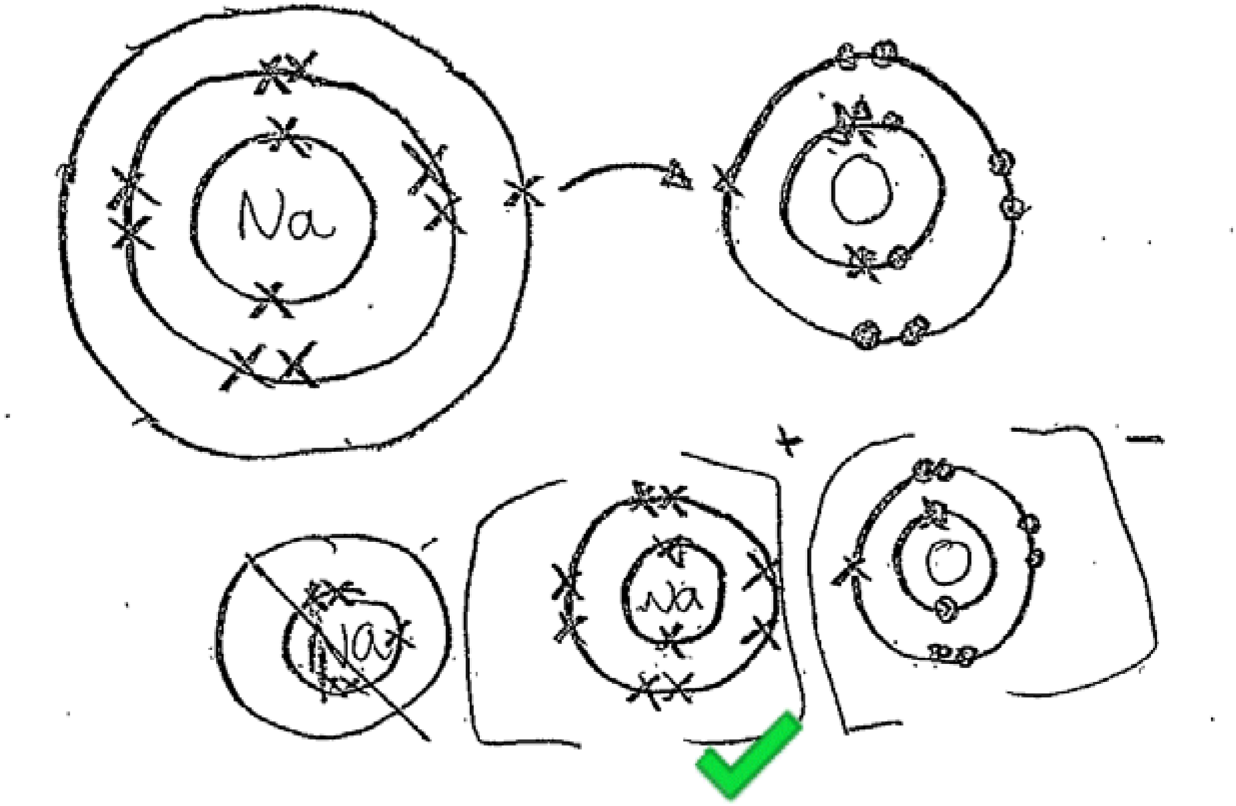
Draw 'dot and cross' diagrams to show the ions made when sodium reacts with oxygen.

Show the charges on the ions.

[3]

The question required candidates to draw a correct 'dot and cross' diagram, including the charges on the ions. Many excellent diagrams were seen by examiners. Others lost marks as the oxide ion was often drawn with one electron missing and, consequently, had an incorrect charge. Lower ability candidates tended to draw diagrams showing the sharing of electrons.

Exemplar 2



This response scores 1 mark for drawing the sodium ion correctly. The oxide ion is incorrect. The charges needed to be correct on both ions to credit the third mark. This response reflects the observation that the oxide ion was often drawn with one electron missing. It is worth centres noting that had the candidate just drawn the top diagram showing the transfer of an electron this would not have been credited as the same electron is shown twice.

Question 20 (a)

20 A student has a mixture of three substances.

Look at some information about these substances.

Substance	**Melting point (°C)**	**Boiling point (°C)**	**Solubility in water**
Sand	1710	2230	Insoluble
Sodium chloride	801	1413	Soluble
Water	0	100	

(a) Describe how the student can separate the mixture to get pure samples of all **three** substances.

Explain why each method of separation works.

....

....

....

....

....

....

.... **[4]**

Good responses to this question described filtering to remove the sand as sand is insoluble in water. They then described distilling the filtered mixture so that the pure water was collected as it condensed, leaving the sodium chloride in the flask. Others needed to include more detail in their answer and often did not describe the idea that the solid sodium chloride stays in the flask once the pure water has evaporated. Lower ability candidates often suggested separating the three substances by fractional distillation.

Question 20 (b)

(b) The student separates two solid substances **A** and **B**.

She wants to check that they are **pure**.

She measures the melting points of four samples of solid **B**.

Look at her results.

Sample	Melting point (°C)
1	109
2	105
3	104–108
4	110–112

The student knows that a pure sample of solid **B** has a melting point of 110 °C.

She concludes that sample 4 is the purest sample of solid **B**.

Do the results support her conclusion?

Explain your answer using evidence from the table.

....

....

....

.... **[3]**

This question assessed AO3 and required candidates to analyse the information in the table and draw conclusions. The best responses appreciated that the results did not support the candidate's conclusion and that sample 1 is likely to be the purest. They then explained their conclusion using ideas about pure samples having a specific melting point and impurities lowering a substance's melting point. Candidates who did not gain full credit needed to develop a more detailed explanation.

Question 21 (a)

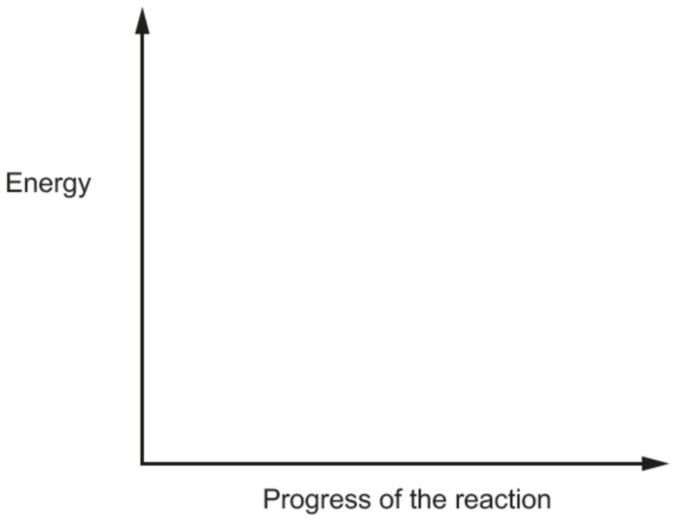
21 Anhydrous copper sulfate reacts with water to make hydrated copper sulfate.

$$CuSO_4 + 5H_2O \longrightarrow CuSO_4.5H_2O$$

Anhydrous copper sulfate + Water ⟶ Hydrated copper sulfate

The reaction is **exothermic**.

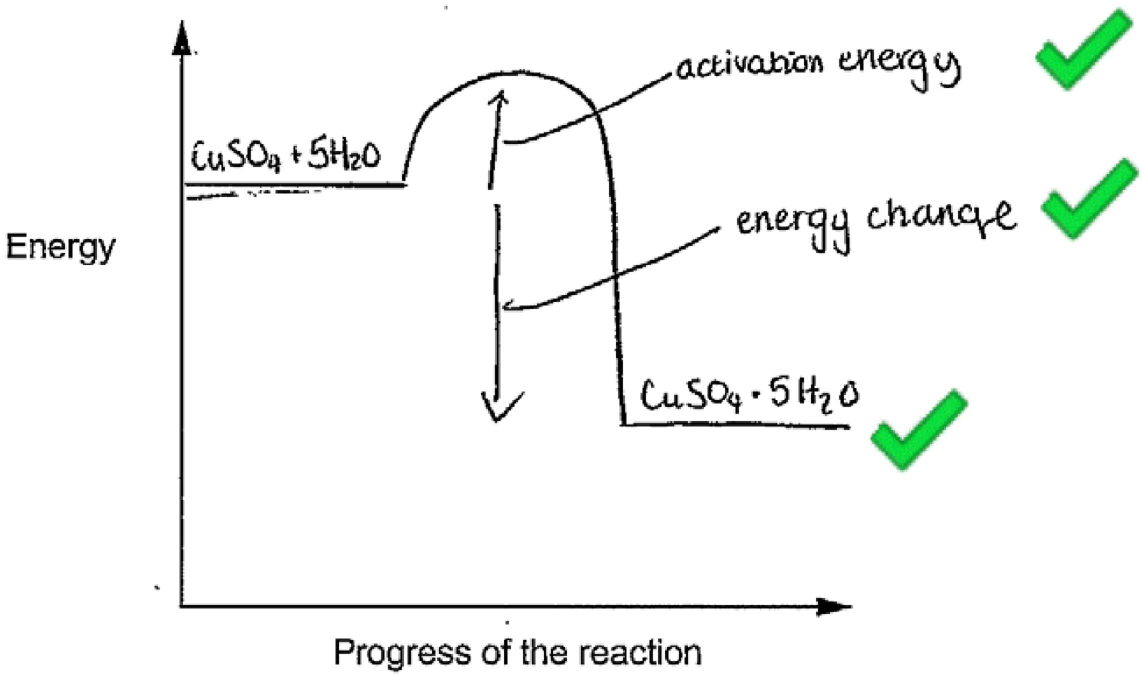
(a) Draw and label a reaction profile for this reaction.



[3]

Many candidates correctly labelled the reactants and products, with the products shown below the reactants. They also drew the correctly shaped curve. Candidates who did not gain full marks usually indicated the energy change and the activation energy with either a double headed arrow or a line without any arrow.

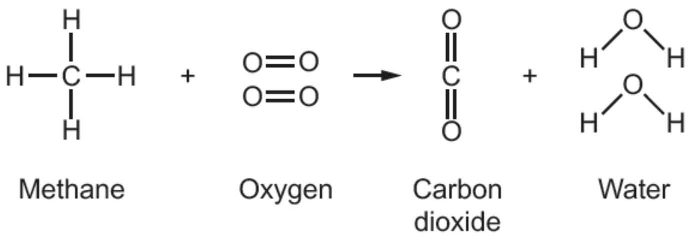
Exemplar 3



This response illustrates a correctly drawn and labelled reaction profile. The candidate's answer illustrates the comment that examiners only gave credit for correctly drawn single headed arrows, as is the correct convention for reaction profile diagrams.

Question 21 (b)

(b) Two students investigate the burning of methane in oxygen.



Look at the table of bond energies.

Bond	**Bond energy (kJ/mol)**
O–H	459
C=O	799
O=O	494
C–H	

The reaction is exothermic and 802 kJ of energy are given out when 1 mole of methane burns.

The students have looked up the bond energies. They have different values for the C–H bond energy.

Student A thinks the C–H bond energy is 432 kJ/mol. Student B thinks the C–H bond energy is 411 kJ/mol.

Who is correct?

Use the bond energies and the energy given out in the reaction to calculate the C–H bond energy.

Answer = ... kJ/mol **[3]**

Some of the responses were excellent, with clearly shown working out that was easy for the examiner to follow. If candidates did not obtain an answer of 411 kJ/mol examiners looked to award marks for working out. It is worth centres stressing to candidates that this is only possible when an answer is clearly set out.

Question 22

22 Copper oxide can be reduced to copper by reaction with hydrogen.

$CuO + H_2 \longrightarrow Cu + H_2O$

A reaction mixture contains 1.59 g of copper oxide and 0.20 g of hydrogen.

1.27 g of copper and 0.36 g of water are made.

Calculate the number of moles of each substance to determine the **limiting reactant** in this reaction.

Explain your choice.

The relative atomic mass of Cu is 63.5, of O is 16 and of H is 1.

Number of moles of CuO = ...

Number of moles of H_2 = ...

Number of moles of Cu = ...

Number of moles of H_2O = ...

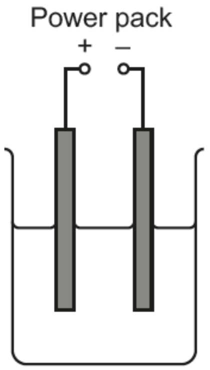
The limiting reactant is .... because ....

.... **[4]**

Good responses correctly calculated the number of moles. They then explained that copper oxide is the limiting reactant because it is the reactant present in the smaller quantity. Others gained the marks for calculating the number of moles but not the interpretation marks. This was usually because they interpreted the moles of H_2 (0.1) as being smaller than the moles of CuO (0.2).

Question 24 (a)

24 A student is investigating the electrolysis of copper sulfate solution.



He does two experiments.

Experiment **1** uses platinum electrodes. Experiment **2** uses copper electrodes.

(a) Complete the table to show the products at each electrode.

Experiment	**What happens at cathode (–)**	**What happens at anode (+)**
1	....	Oxygen made
2	Copper deposited	....

[2]

Common misconceptions in this question were that platinum is deposited at the anode and oxygen or sulfur are made at the cathode.

Question 24 (b)

(b) Copper electrodes are **non-inert** electrodes.

What is meant by non-inert electrodes?

.... **[1]**

A common misconception was that non-inert electrodes are unreactive.

Question 24 (d)

(d) The student also electrolyses sodium chloride solution using platinum (inert) electrodes.

At the cathode, hydrogen gas is made rather than sodium metal.

Explain why.

....

.... **[2]**

This question required candidates to know that hydrogen is less reactive than sodium; as a result, hydrogen is discharged before sodium. Many candidates stated the first point, but not the second.

Question 25

25* Look at the data about some substances.

Substance	Melting point (°C)	Boiling point (°C)	Does it conduct electricity?	Density (g/cm^3)
A	0	100	no	1.0
B	>3000	>4000	no	3.5
C	801	1413	Solid does not conduct but conducts when melted or when dissolved in water	2.2

Explain the type of **bonding** present in each substance **A**, **B** and **C**.

Relate the type of bonding to the **properties** of each substance.

....

....

....

....

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....

....

.... **[6]**

This 6-mark, Level of Response, question assessed AO2 and AO3. At level 3 (5 - 6 marks) candidates needed to analyse the data to identify the type of bonding present in all three substances. They also needed to provide a correct explanation for their choice of bonding. Some of the responses were excellent, with clear explanations of the choice of bonding. Other answers needed to develop their explanation using their knowledge and understanding of ionic and covalent structures. A common misconception was that substance C does not conduct electricity when ~~molten~~ solid as the electrons, rather than ions, cannot move. Lower ability candidates often thought that the bonding in substance B was metallic due to its very high melting and boiling points.

Exemplar 4

Relate the type of bonding to the **properties** of each substance.

L3

Substance C has ionic bonds as it has strong intermolecular attraction giving it high melting and boiling points and when molten conducts electricity as the ions are free to moove. Substance A has covalant bonds as it has weak inter-molecular bonds giving it a low melting and boiling point and it does not conduct even when molten as it has no electrons or ions free to moove. Substance B has giant covalant lattice bonds as it has an extremilly high melting and boiling point as to melt **[6]** it the energy has to overcome bonds rather than just intermolecular atraction and it does not conduct as there are no electrons or ions free to moove.

This is a level 3 response, which has analysed the information to identify the type of bonding present in all three substances. The candidate has provided a correct explanation for the type of bonding in substances A and B, linking their answer to the data. The candidate has only been credited with 5 marks, rather than 6, as they have only given a partial explanation for their choice of ionic bonding for substance C. They have not explained why C does not conduct electricity when solid. The statement that C has 'strong intermolecular attraction' is incorrect.

Question 26 (a)

26 The value of the Avogadro constant is 6.02×10^{23}.

(a) What is meant by the Avogadro constant?

....

.... **[1]**

Higher ability candidates were able to recall that the Avogadro constant is the 'number of entities in one mole'. When candidates did not gain credit they usually described the number of atoms or number of molecules in one mole of a substance. Examiners only gave credit if the candidate's answer was linked to a correct substance. For example, 'the number of molecules in one mole of oxygen' was credited but not 'the number of atoms in one mole of oxygen'.

Question 26 (b)

(b) Calculate the number of water molecules in 72 g of water, H_2O.

Give your answer to **3** significant figures.

Answer = ... **[3]**

Higher ability candidates scored 3 marks on this question. Lower ability candidates often gained the first mark for calculating the moles of water in 72g of water. A common misconception was that the number of water molecules was 72 x 6.02 x 10^{23}. It is worth centres stressing to candidates that if they are asked to give their answer to a specific number of significant figures, they can only score full marks by doing so.

Question 26 (c)

(c) A student is reacting magnesium oxide with nitric acid.

Look at the equation for the reaction.

$$MgO + 2HNO_3 \longrightarrow Mg(NO_3)_2 + H_2O$$

The student wants to make 14.8 g of magnesium nitrate, $Mg(NO_3)_2$.

Calculate the masses of magnesium oxide and nitric acid that he needs.

Mass of magnesium oxide needed = ... g

Mass of nitric acid needed = ... g **[4]**

Common errors in this question were:

- the relative formula mass of HNO_3 calculated as 64, i.e. 2 + 14 + (3x16) = 64.
- the relative formula mass of HNO_3 multiplied by 2, but then the number of moles also multiplied up, i.e. 126 x 0.4 = 50.4g.
- 126 used as the relative formula mass of HNO_3, i.e. 0.2 x 126 = 25.2g.

Examiners gave credit for 'error carried forward' at each stage of this multi-stage calculation.

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