Qualification Accredited

GCSE (9-1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE CHEMISTRY B

J258

For first teaching in 2016

J258/01 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 question paper can be downloaded from OCR.

Paper 1 series overview

Candidates performed very well on this examination and appeared to have sufficient time to answer the whole paper, and the overall standard was good. Examiners were impressed at the increasing number of candidates who were prepared to show their working in calculations. When the answer is correct the working is ignored, but when the answer is incorrect then the working is all that is available to decide what credit can be given.

Bearing in mind that the standard was good, it is important to flag up areas where the candidates could have done even better.

As usual, the stress of sitting an examination meant that the instructions in each question were not always read carefully. Several of the objective style questions involved giving **two** responses, and candidates who only gave one response automatically limited themselves to half marks. This was most marked near the start of the paper. Candidates should remember that it is worth glancing at the mark allocation given on the right-hand side of the answer line.

Candidates should realise that examiners are only allowed to mark what the candidate has written, not what they suspect the candidate intended to say. The examination is an exercise in communication as well as in science, and while every effort is made to allow for poor communication skills, candidates must use terms correctly. Examiners could not give credit to candidates who suggested that, in Question 5a, the gallium teaspoon melted because its **boiling** point was exceeded, nor who miscopied the name 'propanone' as 'propane' in Question 12, nor who used the term 'intermolecular force' instead of 'covalent bond' at several points in the paper.

Sometimes candidates seemed to lose the thread of their own explanations, and so wrote answers such as 'protons are bigger than protons' in Question 7e.

Question 1 (a)

1 Chemists add chlorine to water. This makes the water suitable to drink.

(a) Choose the test for chlorine.

Tick (✓) **one** box.

Makes a 'pop' with a lighted splint. ☐

Relights a glowing splint. ☐

Turns blue litmus red and then white. ☐

Turns limewater milky or cloudy. ☐

[1]

Over half the candidates realised that the test for chlorine involved litmus. The most common alternative responses were 'popping' with a lighted splint and turning limewater cloudy

Question 1 (b)

(b) Choose words from the list below to complete the sentences.

You may use each word once, more than once, or not at all.

animals **diseases** **microorganisms** **smelly** **toxic**

Chlorine is used to kill .... in water.

This stops the untreated water from causing ....

Chlorine can be hazardous because it is ....

[3]

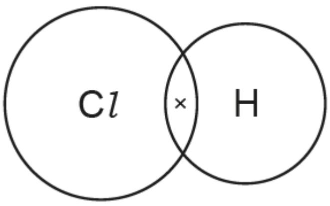
Most candidates successfully identified the correct words. The most common alternative was 'disease, disease, toxic'

Question 1 (c)

(c) A chlorine atom has seven electrons in its outer shell.

Complete the 'dot and cross' diagram for an HC*l* molecule.

You only need to show outer-shell electrons.



[2]

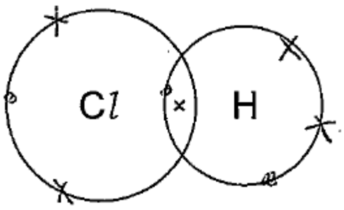
This question acted as a good indicator of a candidate's overall ability. Candidates were able to score partial credit as examiners were looking for two aspects, a pair of shared electrons, as in exemplar 1, and six unshared electrons around the chlorine with none around the hydrogen, as in exemplar 2

Exemplar 1

A chlorine atom has seven electrons in its outer shell.

Complete the 'dot and cross' diagram for an HC*l* molecule.

You only need to show outer-shell electrons.

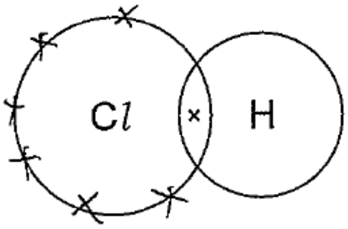


Exemplar 2

A chlorine atom has seven electrons in its outer shell.

Complete the 'dot and cross' diagram for an HC*l* molecule.

You only need to show outer-shell electrons.



Question 2 (a) (i)

2 'Camping gas' contains butane.

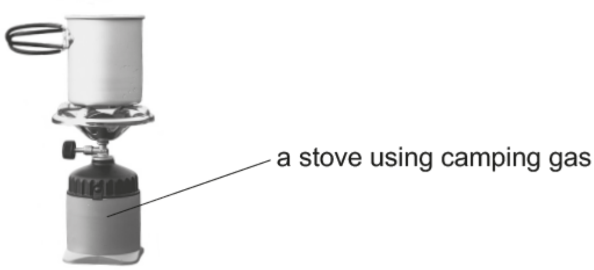


Fig. 2.1 shows a model of butane. The model helps us to imagine what butane looks like.

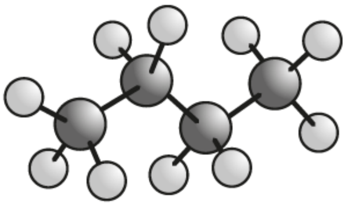


Fig. 2.1

(a) **Fig. 2.1** is called a 'ball and stick' model.

(i) What do the 'sticks' show?

Put a (ring) around the **two** correct answers.

covalent bonds

intermolecular forces

ionic bonds

shared electrons

[2]

Most candidates realised that the 'sticks' showed covalent bonds, although often went on to ring either 'ionic bonds' or 'intermolecular forces'. This misunderstanding also showed up later in the paper, and many candidates appeared to use the term as a generic description of any bonding rather than specifically that between separate molecules.

The majority of candidates circled only one response rather than the two that were asked for.

Question 2 (a) (ii)

(ii) Which statement is correct about the model of butane shown in **Fig. 2.1**?

Tick (✓) **one** box.

It shows how the electrons are arranged. ☐

It shows the shape of the molecule. ☐

It shows the exact sizes of the atoms. ☐

[1]

Higher ability candidates realising that the model showed the shape of the molecule. The most common response was that it shows the electron arrangement.

Question 2 (b)

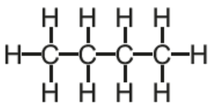
(b) Butane is a hydrocarbon.

Which two statements about butane are correct?

Tick (✓) **two** boxes.

The molecular formula of butane is C_4H_{10}. ☐

The empirical formula of butane is CH_2. ☐

Butane can be shown as  . ☐

Butane is an alkene. ☐

[2]

Most candidates identified the two correct statements with ease.

Question 2 (c)

(c) 58 g of butane contain 48 g of carbon.

What is the percentage of carbon in butane?

Give your answer to **2** significant figures.

Percentage of carbon = ... % **[3]**

The question discriminated well. Examiners gave the first two marks if the answer was given to the wrong number of significant figures. Exemplar 3 shows such a candidate, whereas exemplar 4 shows the complete process. Even those who made basic mistakes in their calculation were often able to gain some credit for their working.

Exemplar 3

58 g of butane contain 48 g of carbon.

What is the percentage of carbon in butane?

Give your answer to **2** significant figures.

48g ÷ 58g = 0.8275 x100 =
82.76

Percentage of carbon = ...82.76........ % **[3]**

Exemplar 4

58 g of butane contain 48 g of carbon.

What is the percentage of carbon in butane?

Give your answer to **2** significant figures.

$\frac{48}{58} \times 100 = 82.75\ldots$
$\doteq 83$ (2 s.f.)

Percentage of carbon = ...83........ % **[3]**

Question 3 (a) (i)

3 This question is about the efficiency of LED light-bulbs in 2015 compared to 2011.

The table shows part of a life-cycle assessment for the two light-bulbs. The numbers in the table compare the energy used to give the same amount of light in a certain time.

Stage in life cycle	2011 light (MJ)	2015 light (MJ)
Manufacture	343	132
Transport	3	2
Use of the light-bulb	3540	1630
Total energy used		

(a) (i) Which **stage** uses the most energy?

.... **[1]**

Most candidates identified the usage stage as using the most energy. A few did not notice that the word 'stage' was emboldened, and so suggested the year rather than the stage.

Question 3 (a) (ii)

(ii) In total, the 2011 light-bulb uses more energy than the 2015 light-bulb.

Calculate the difference in the **total** energy used.

Difference in total energy = ... MJ **[2]**

Most candidates correctly calculating the difference.

Question 3 (b)

(b) The **last** stage in the life-cycle assessment is missing.

Name the **last** stage.

.... **[1]**

The question was an excellent indicator of a candidate's ability. Examiners accepted a variety of responses so long as they indicated the need for disposal or recycling, as in exemplar 5 below.

Exemplar 5

The **last** stage in the life-cycle assessment is missing.

Name the **last** stage.

being destroyed / recycled

light-bulb ~~breaking are / not working~~ **[1]**

Question 3 (c)

(c) The percentage decrease in energy use at 'manufacture' stage from 2011 to 2015 is given by:

$$\frac{343 - 132}{343} \times 100 = 62\%$$

Calculate the percentage decrease in energy use at 'use of the light-bulb' stage from 2011 to 2015.

Give your answer to **2** significant figures.

Percentage decrease = ... % **[2]**

Most candidates were able to gain partial credit for their working, and many were able to score both marks.

Question 4 (a)

4 Some cars use hydrogen fuel cells.

This is the reaction that happens in the fuel cell:

$$2H_2 + O_2 \rightarrow 2H_2O$$

(a) Name the product of this reaction.

.... **[1]**

While this question appears to be straightforward, a significant minority could not name the product. 'Hydrogen oxide', which was often seen, was given credit but answers such as 'hydroxide' were not.

Question 4 (b)

(b) Most cars still use petrol as a fuel.

Give two **advantages** of using hydrogen as a fuel for cars.

1 ....

....

2 ....

....
[2]

Almost all candidates were aware that the advantage of hydrogen as a fuel lay in its environmental credentials. It was a much more difficult task to take this further and detail specific advantages, and so gain credit. General references to 'harm to the environment', while commendable, did not show enough specific understanding of the problem to be given credit. Similarly, references to expense are not specific enough unless justified by extra detail. Both these responses can be seen in exemplar 6.

Exemplar 6

Most cars still use petrol as a fuel.

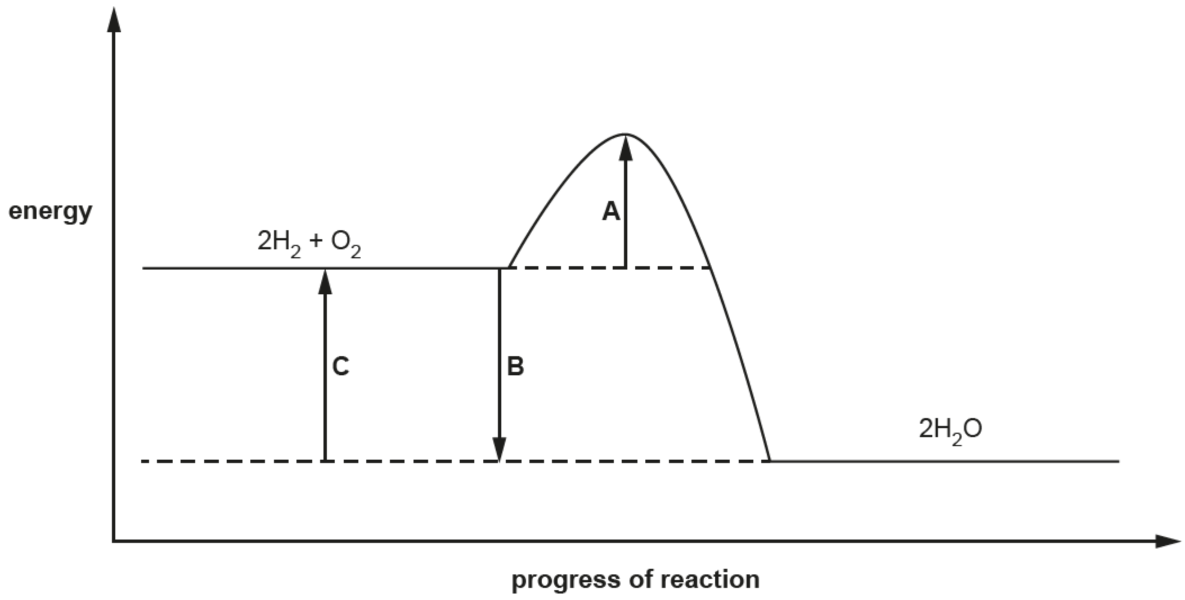
Give two **advantages** of using hydrogen as a fuel for cars.

1 ~~It is beneficial to our environment.~~
It is less harmful to our environment.

2 It isn't as expensive as petrol.
(hydrogen as fuel is cheaper)
[2]

Question 4 (c) (i)

(c) The reaction profile below shows the energy changes when hydrogen and oxygen react together.



You may use each letter once, more than once, or not at all.

(i) Which arrow, **A**, **B**, or **C**, shows the activation energy for the reaction? .... **[1]**

While most candidates realised that line A represented the activation energy, a significant minority had problems with this task. An incorrect response did not seem to indicate the ability level of the candidate, and there were almost as many incorrect responses from able candidates as there were from those with exceedingly modest ability.

Question 4 (c) (ii)

(ii) Which arrow, **A**, **B**, or **C**, shows that the reaction is exothermic? .... **[1]**

Whereas this question was more searching.

Question 4 (d) (i)

(d) **(i)** Calculate the relative formula mass of H_2O.

Relative formula mass of H_2O = ... **[1]**

This question was an excellent indicator of a candidate's overall ability. At the one extreme, higher ability candidates had no difficulty in calculating the relative formula mass. Those who were struggling did not seem to know how to approach the task. Those of more average ability often gave answers such as 16+16+1=33 or 8+1+1 = 10, both of which suggest that the main problem lay less with the concept of relative molar mass and more with interpreting formula and knowing which was the mass number.

Question 4 (d) (ii)

(ii) 4 g of hydrogen burns giving out 240 kJ of energy.

How much energy is given out when 20 g of hydrogen burns?

Energy = ... kJ **[2]**

Candidates of even moderate ability were able to successfully calculate the energy given out.

Question 5 (a)

5 A chemist makes a teaspoon out of gallium metal.

Gallium looks like aluminium. Gallium melts at 30 °C and aluminium melts at 660 °C.

(a) Tea is made with boiling water.

What would happen if a gallium spoon is used to stir hot tea?

Explain your answer.

....

....

.... **[2]**

Most candidates stated that the teaspoon would melt, and higher ability candidates explained why, as in exemplar 7. Candidates were not expected to give the boiling point of water, but if they did so they had to do so correctly and unambiguously – see exemplar 8.

A significant minority experienced problems in expressing themselves clearly. References to the boiling point of gallium rather than its melting point, or suggestions that the gallium dissolved rather than melted, could not be given credit.

Exemplar 7

A chemist makes a teaspoon out of gallium metal.

Gallium looks like aluminium. Gallium melts at 30 °C and aluminium melts at 660 °C.

(a) Tea is made with boiling water.

What would happen if a gallium spoon is used to stir hot tea?

Explain your answer.

The boiling point of water is 100°c , so if the water used is at 100°c and Gallium melts at 30°c , the teaspoon would melt because 100°c is much more than 30°c **[2]**

Exemplar 8

A chemist makes a teaspoon out of gallium metal.

Gallium looks like aluminium. Gallium melts at 30 °C and aluminium melts at 660 °C.

(a) Tea is made with boiling water.

What would happen if a gallium spoon is used to stir hot tea?

Explain your answer.

The gallium spoon would melt because water boils at 60°c and above, and as gallium ~~has~~ melts at 30°c then the spoon would start melting **[2]**

Question 5 (b)

(b) When Mendeleev made his Periodic Table, he left a gap below aluminium.

Later gallium was discovered and put into this gap.

Give one reason why gallium fitted into this gap.

Tick (✓) **one** box.

It has a similar melting point to aluminium. ☐

It looks the same as aluminium. ☐

It has similar reactions to aluminium. ☐

There was nowhere else in the table to put it. ☐

[1]

The most common incorrect response was to choose the similar melting point to aluminium, which showed that, even when candidates missed the significance of the chemical properties, they still went for a very sensible alternative.

Question 5 (c)

(c) When gallium reacts it loses three electrons.

Which ion is formed?

Put a (ring) around the correct answer.

Ga Ga^{+} Ga^{2+} Ga^{3+} Ga^{-} Ga^{2-} Ga^{3-}

[1]

The question discriminated well, with more able candidates tending to suggest Ga^{3+} and those of average ability suggesting a wide range of other alternatives. The most common incorrect choices tended to be Ga^{3-} and Ga^{+}.

Question 5 (d)

(d) Ionic compounds have high melting points.

Which two statements explain this?

Tick (✓) **two** boxes.

There are strong attractions between the ions. ☐

Shared electron bonds are broken. ☐

A lot of energy is needed to separate the ions. ☐

Positive ions attract other positive ions. ☐

Ionic compounds conduct electricity. ☐

[2]

This question discriminated well, allowing candidates of average ability to show their understanding

Question 5 (e)

(e) Mendeleev put potassium and sodium in the same group because they both react with water.

Ali's teacher puts a piece of sodium into water. The teacher then puts a piece of potassium into water.

Give **two** ways Ali could tell potassium is more reactive than sodium.

1 ....

....

2 ....

....

[2]

Candidates had great difficulty in putting their ideas into words for this question. The stem tells candidates that potassium is more reactive, so examiners wanted answers that went beyond 'it reacts quicker' and stated what would actually be seen, as in exemplar 9. Some candidates stated what to look for, but unfortunately did not show how the result would confirm that potassium is more reactive. Others gave explanations rather than descriptions of what would be seen, discussing the positions of the elements in the periodic table, as in exemplar 10

Exemplar 9

Mendeleev put potassium and sodium in the same group because they both react with water.

Ali's teacher puts a piece of sodium into water. The teacher then puts a piece of potassium into water.

Give **two** ways Ali could tell potassium is more reactive than sodium.

1 If the potassium react faster then the Sodium.

2 How long it took to react with the water.

[2]

Exemplar 10

Mendeleev put potassium and sodium in the same group because they both react with water.

Ali's teacher puts a piece of sodium into water. The teacher then puts a piece of potassium into water.

Give **two** ways Ali could tell potassium is more reactive than sodium.

1 Looking at a periodic tabel because group 1 metals get more reactive going down the group

2 See which one has a more vigerous reaction

[2]

Question 6 (a) (i)

6 Mia has three metals, **A**, **B** and **C**, that she reacts with water.

This is what she sees:

Metal **A** Fizzes and reacts quickly.

Metal **B** A few bubbles appear after some time.

Metal **C** Slow fizzing.

(a) (i) Put the metals in order of reactivity, with the **most** reactive first.

.... > .... > .... **[1]**

This question was well attempted. Some candidates did not order metals A, B and C but quoted a known reactivity pattern. While such answers could not be given credit, the patterns quoted were usually the correct way around.

Question 6 (a) (ii)

(ii) Which metal forms positive ions most easily?

.... **[1]**

Most candidates realised that metal A was the most reactive.

Question 6 (b)

(b) Metal **A** is placed in copper sulfate solution. A brown metal is made.

Name the brown metal. .... **[1]**

Many candidates were able to give copper as the metal, with the most common mistakes being bromine and iron. Bronze was also suggested.

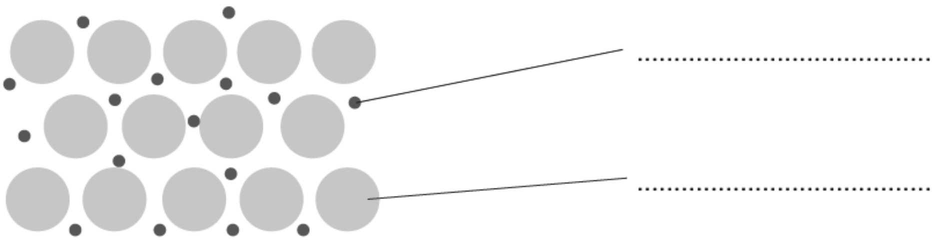
Question 6 (c)

(c) The diagram below shows the bonding in metals.

Label the diagram by writing on the dotted lines.

Use words from the list below.

atom **electron** **metal ion** **proton**



[2]

Labelling the diagram caused difficulties for many, but the mistakes showed that candidates were thinking intelligently about the task. Electrons were identified by almost half the candidates, with the large circles frequently labelled as protons or atoms as in exemplar 11.

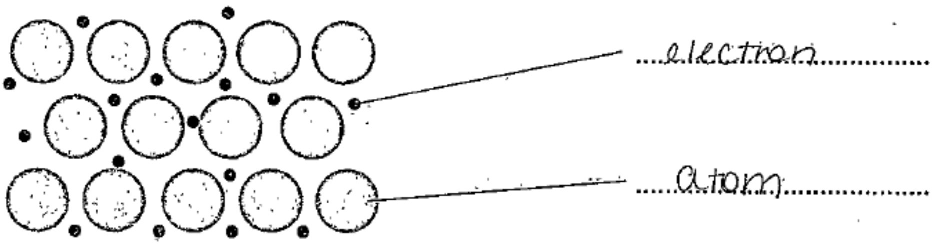
Exemplar 11

The diagram below shows the bonding in metals.

Label the diagram by writing on the dotted lines.

Use words from the list below.

atom **electron** **metal ion** **proton**



[2]

Question 6 (d)

(d) Metals conduct electricity and are malleable (shapeable).

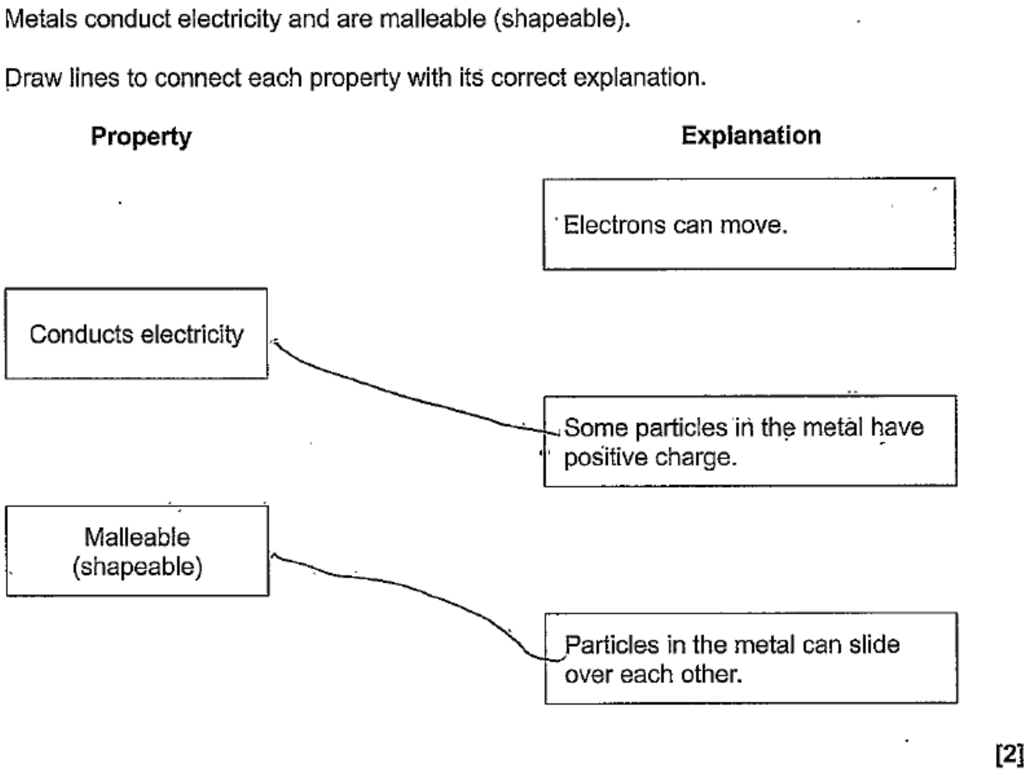
Draw lines to connect each property with its correct explanation.

Property	**Explanation**
Conducts electricity	Electrons can move.
Malleable (shapeable)	Some particles in the metal have positive charge.
	Particles in the metal can slide over each other.

[2]

Malleability was well understood but choosing the best explanation for conductivity proved much more problematic. Again, the most common source of misunderstanding, to connect conductivity to the ions box as in exemplar 12, or even to both electrons and ions, still showed a basic appreciation of the problem.

Exemplar 12

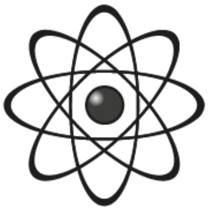

Metals conduct electricity and are malleable (shapeable).

Draw lines to connect each property with its correct explanation.

Question 7 (a)

7 Dalton was one of the first scientists to model the atom.

Rutherford later developed an improved model of the atom from experiments.



Rutherford's model describes:

- a small positive nucleus
- the nucleus surrounded by empty space
- negatively charged particles orbiting in this empty space.

(a) Describe how Dalton's model of the atom was different to Rutherford's.

....

....

.... **[1]**

This was a challenging task as candidates concentrated on absence rather than a simpler presence, and examiners made allowance for this, as in exemplar 13. Most candidates were clearly familiar with the history of the development of models for the atom but, as in exemplar 14, discussed the plum pudding model instead of Dalton's model.

Exemplar 13

Describe how Dalton's model of the atom was different to Rutherford's.

Daltons model did not show empty Space or the shells of electrons, that determine the reactivity of an element **[1]**

Exemplar 14

Describe how Dalton's model of the atom was different to Rutherford's.

Dalton used the plum pudding model which included electrons.

.... **[1]**

Question 7 (b)

(b) Name the 'negatively charged particles' in Rutherford's model.

.... **[1]**

This question discriminated well, with higher ability candidates stating that the negatively charged particles are electrons. Many other candidates suggested neutrons.

Question 7 (c)

(c) We currently know that the nucleus of an atom contains protons and neutrons.

Complete the table by filling in the blank spaces.

	Relative Charge	Relative Mass
Proton	+1	1
Neutron		

[2]

Able candidates had little difficulty stating the charge and mass of a neutron, but others found the task much more difficult. Answers of -1&0, -1&1 were common combinations, and a mass of '-1' was also frequently seen, suggesting that some had trouble linking the concept of relative mass to a concrete model in their own heads.

Question 7 (d)

(d) The table shows the number of protons and neutrons in a sodium atom.

Complete the table by filling in the blank spaces.

	Atomic number	Protons	Mass number	Neutrons
Sodium	11	11	23	12
Fluorine	9		19	

[2]

Most candidates gave the correct values for the number of protons and neutrons, with protons being marginally better answered than neutrons.

Question 7 (e)

(e) Kai finds some information on the internet.

	Approximate size (m)
Hydrogen atom	5.3×10^{-11}
Hydrogen molecule	2.9×10^{-10}
Oxygen molecule	3.5×10^{-10}
Proton	8.7×10^{-16}
Xenon atom	1.1×10^{-10}

Table 7.1

Kai writes some notes:
1 Atoms are smaller than molecules.
2 Atoms are smaller than protons.

Is Kai correct?

Use the information in **Table 7.1** to explain your answer.

....

....

....

....

....

.... **[2]**

Higher ability candidates showed a confident understanding of powers of ten and of negative indices, and were able to communicate that understanding effectively, as in exemplar 15. For many others the question proved taxing, although they were often able to gain partial credit for their analysis of the data.

The relative sizes of atoms, molecules and protons was generally well recognised, although many candidates answered from their general understanding rather than using the information in the table, giving responses such as 'an atom is made of protons, neutrons, electrons, so atom must be bigger than proton'. As this was an exercise in data analysis, such answers could not be given credit. Another example is shown in exemplar 16.

Powers of ten caused great problems, with many candidates ignoring them altogether and comparing the significands only. Others noted the power but did not realise the significance of the negative sign and stated that 10^{-16} was greater than 10^{-11}. Finally, some worked hard to match the data to their prior knowledge and wrote 'the larger the power, the smaller the molecule'

The need for a discursive response meant some candidates lost track of their argument and wrote statements such as 'protons are smaller than protons', or 'Kai's first statement is correct ...... both are smaller than the hydrogen atom'.

Exemplar 15

Kai finds some information on the internet.

	Approximate size (m)
Hydrogen atom	5.3×10^{-11}
Hydrogen molecule	2.9×10^{-10}
Oxygen molecule	3.5×10^{-10}
Proton	8.7×10^{-16}
Xenon atom	1.1×10^{-10}

Table 7.1

Kai writes some notes:

1 Atoms are smaller than molecules.

2 Atoms are smaller than protons.

Is Kai correct?

Use the information in **Table 7.1** to explain your answer.

The table shows that an atom is 5.3 ×10⁻¹¹ (0.000000000053) and an ~~hydrogen~~ molecule is 2.9 × 10⁻¹⁰ (0.00000000029) meaning he is correct, however, he then says atoms are smaller than protons **[2]** but ~~they are~~ their size is 8.7×10⁻¹⁶ (0.00000000000000087) which means his second statement is incorrect.

Exemplar 16

(e) Kai finds some information on the internet.

	Approximate size (m)
Hydrogen atom	5.3×10^{-11} 42
Hydrogen molecule	2.9×10^{-10} 19
Oxygen molecule	3.5×10^{-10}
Proton	8.7×10^{-16} 71
Xenon atom	1.1×10^{-10}

Table 7.1

Kai writes some notes:
1 Atoms are smaller than molecules.
2 Atoms are smaller than protons.

Is Kai correct?

Use the information in **Table 7.1** to explain your answer.

~~No, Atoms are larger than molecules and protons. This is because the Atoms are~~
~~(atom) 5.3x10^-11 = 42, (proton) 8.7x~~
No, Atoms are larger than molecules but they are smaller than proton. This is because proten has a larger size than an Atom. [2]

Question 8 (a) (i)

8 'Tumsoothe' is a medicine that cures indigestion. It is a solution of 'sodium bicarbonate', $NaHCO_3$.

(a) Layla puts some Tumsoothe in a beaker and places it on a balance.

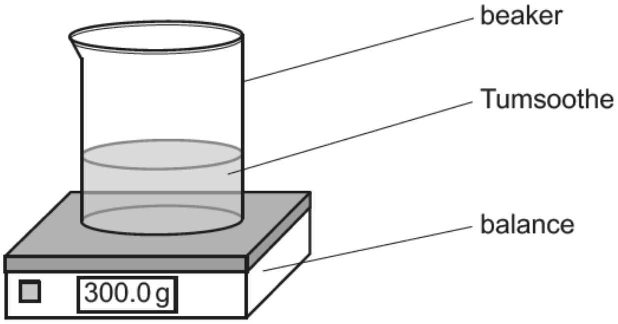


Fig. 8.1

She adds hydrochloric acid to the contents of the beaker and this reaction happens:

$NaHCO_3(aq) + HCl(aq) \rightarrow CO_2(g) + NaCl(aq) + H_2O(l)$

Layla writes down the mass every 10 seconds, as shown in **Table 8.1**.

Time (s)	Mass (g)
0	300.0
10	298.0
20	296.0
30	294.5
40	293.5
50	292.5
60	292.0

Table 8.1

The graph was used to differentiate between the lower ability candidates and those of moderate ability, so it was marked very leniently. So, most scored very well. Candidates were not asked to extrapolate their graph lines to 100 seconds, although most candidates did so successfully. As this was not an essential requirement, those who allowed their extrapolated line to curve upwards were not penalised. There was the usual smattering of candidates who drew straight line graphs.

Question 8 (a) (ii)

(ii) Estimate the mass of the beaker at 100 seconds. Use the graph to help you.

Mass at 100 seconds = ... g **[1]**

Those candidates who extended their graph line often estimated the mass at 100s by eye, ignoring their own line. In such cases, their estimate was often far more accurate than that suggested by the intercept, suggesting that they were treating the two tasks as unrelated activities.

Question 8 (a) (iii)

(iii) Draw an **F** on your graph where the rate of reaction is the **fastest**. **[1]**

This question was well attempted by most candidates, even though there was a significant 'No Response' rate. Examiners wondered if this was because candidates had missed the question accidentally.

Question 8 (b) (i)

(b) (i) Describe the rate of change of mass during the reaction.

.... **[1]**

It is important to read the question carefully. Many candidates did not notice that this question is about **rate** of change of mass, and so gave answers such as 'the mass decreases'.

Question 8 (b) (ii)

(ii) Explain how you worked this out from the graph.

.... **[1]**

Most candidates showed an intuitive understanding, but found it very difficult to put into words, so responses such as 'I looked at the mass at the beginning and the end' were common.

Question 8 (b) (iii)

(iii) The law of conservation of mass says:

'The mass at the start and end of a reaction must be the same.'

Explain why the law is true for the reaction between $NaHCO_3$ and HCl, even though the reading on the balance changes.

....

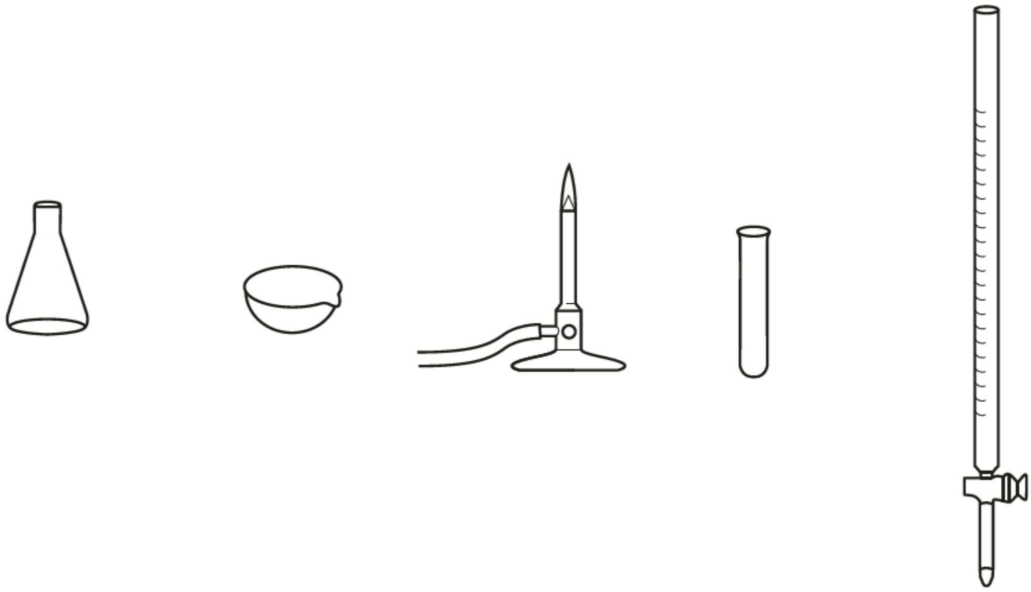
.... **[1]**

Many candidates appeared to have forgotten that this reaction gives off a gas and tried to answer the question in more general terms. Often this exposed significant misunderstandings, such as 'the mass will be restored after the reaction'.

Question 8 (c)

(c) Layla now does a titration because she wants to measure the concentration of $NaHCO_3$ in Tumsoothe.

Put a (ring) around the **two** pieces of apparatus that she needs to carry out the titration.



[2]

This was very well answered. While the burette was almost always chosen there was, however, some variation over the second piece of equipment. The test tube and the Bunsen burner made regular appearances.

Question 8 (d) (i)

(d) Layla repeats her titration three times. Her results are shown.

Repeat	**1**	**2**	**3**
Volume of acid added to neutralise $NaHCO_3$ (cm^3)	20.10	20.15	20.05

(i) Layla says, 'This is good quality data.'

Do you agree?

Explain your answer.

....

....

.... **[1]**

Many candidates could state why this is good quality data. Even those who did not made comments such as 'because she repeated the experiment three times.' While such answers did not gain credit, they still showed intelligent interaction with the question.

Question 8 (d) (ii)

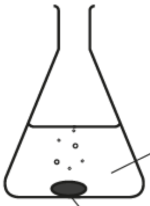
(ii) Calculate the mean value for the volume of acid added in the titration.

Mean value = ... cm^3 **[1]**

Many candidates were able to calculate the mean correctly.

Question 9 (a)

9 Sundip reacts zinc with dilute sulfuric acid.



(a) Complete the symbol equation for the reaction.

$Zn + H_2SO_4 \rightarrow$ .... $+ H_2$ **[1]**

The question discriminated well, with both able and more able candidates able to work out the product for the reaction. SO_4Zn was a not uncommon response and was in this case allowed.

Question 9 (b)

(b) Sundip drops a **piece** of zinc into some dilute sulfuric acid.

The zinc fizzes.

What is the name of the gas given off?

.... **[1]**

Many candidates either knew, or realised from the equation, that hydrogen gas was formed. However, not all realised that parts (a) and (b) related to the same question and gave other answers. Carbon dioxide was the most common incorrect choice, followed by 'zinc sulfate' and, sometimes, 'sulfur' or 'zinc oxide'.

Question 9 (c)

(c) Sundip then drops some zinc **powder** into some dilute sulfuric acid.

Explain why the fizzing is faster with zinc powder.

....

.... **[1]**

Some candidates demonstrated a clear understanding of the effect of surface area, as in exemplar 17. The majority of responses, while not demonstrating such clarity, still showed an intuitive appreciation even though the underlying scientific reasoning could not be given. 'The powder is already broken down', 'the powder is more reactive' and 'because zinc powder is a catalyst' were often seen, see exemplar 18.

Some candidates realised that it was a surface area effect, even if they were less sure of the rationale behind it and wrote 'because the surface area is smaller'.

Exemplar 17

Sundip then drops some zinc **powder** into some dilute sulfuric acid.

Explain why the fizzing is faster with zinc powder.

Because there is a greater Surface area and more Successful frequent Collisions. **[1]**

Exemplar 18

Sundip then drops some zinc **powder** into some dilute sulfuric acid.

Explain why the fizzing is faster with zinc powder.

Because the powder is more broken-up.

.... **[1]**

Question 9 (d)

(d) Sundip adds some blue copper sulfate solution and zinc to the acid.

Sundip **thinks** that the copper sulfate is a catalyst in the reaction.

If Sundip is right, which statements are correct?

Tick (✓) **two** boxes.

The fizzing stays the same.	☐
The copper sulfate is left at the end.	☐
The activation energy is lower with the catalyst present.	☐
All the copper sulfate is used up.	☐

[2]

Many candidates knew that the catalyst lowers the activation energy, far fewer that the copper sulfate is left at the end. A large number suggested that the copper sulfate was used up.

Question 10 (a)

10 An industrial firm makes nitrogen oxide, NO, by the following reaction:

$N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$

(a) The $\rightleftharpoons$ sign shows that the reaction is 'in equilibrium'.

Which two statements are correct at equilibrium?

Tick (✓) **two** boxes.

The reaction $N_2(g) + O_2(g) \rightarrow 2NO(g)$ has stopped. ☐

There is a mixture of N_2, O_2 and NO. ☐

The reaction $N_2(g) + O_2(g) \rightarrow 2NO(g)$ goes in both directions. ☐

The reaction $2NO(g) \rightarrow N_2(g) + O_2(g)$ does not happen. ☐

[2]

Most candidates answered this question well, with the most common incorrect choice being the fourth option.

Question 10 (b)

(b) The NO then reacts with air and water to form nitric acid. Nitric acid is an ingredient used to make fertilisers.

Why is nitric acid not used as a fertiliser on its own?

Tick (✓) **one** box.

It contains nitrogen. ☐

It is not an ammonium compound. ☐

It is too acidic. ☐

[1]

'It contains nitrogen' was a common answer to this question.

Question 10 (c)

(c) In theory, 28 g of nitrogen makes a maximum of 60 g of NO.

However, in a reaction, 28 g of nitrogen makes 9.0 g of NO.

Calculate the percentage yield of the reaction.

Percentage yield = ... % **[2]**

Higher ability candidates calculated the percentage yield without problem, but others experienced difficulty in choosing which numbers to work with, and 28/60 or 9/28 were frequent starting points.

Question 11 (a) (i)

11 Diamond and graphite are two forms of carbon.

(a) **(i)** **Fig. 11.1** shows the structure of diamond:

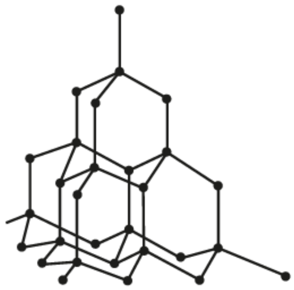


Fig. 11.1

Explain why diamond has a high melting point.

....

.... **[1]**

The whole of Question 11 is common with the Higher Tier paper.

Many candidates gained credit for discussing such concepts as strong bonds or giant structure, as in exemplar 19. Many others showed a fundamental misunderstanding of bonding, treating the terms 'intermolecular force' and 'covalent bond' as being the same, even though they were aware that diamond has a giant structure – see exemplar 20

Exemplar 19

Diamond and graphite are two forms of carbon.

(a) (i) Fig. 11.1 shows the structure of diamond:

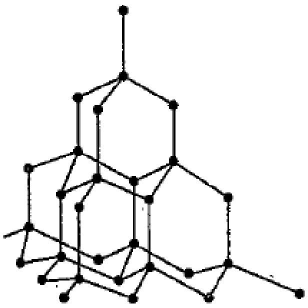


Fig. 11.1

Explain why diamond has a high melting point.

Because it has a giant covalent Structure.

.... **[1]**

Exemplar 20

Diamond and graphite are two forms of carbon.

(a) (i) Fig. 11.1 shows the structure of diamond:

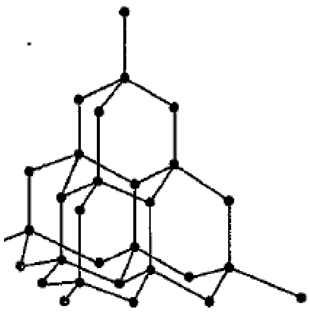


Fig. 11.1

Explain why diamond has a high melting point.

It has very strong intermolecular forces between the atoms. Giant ionic structure. **[1]**

Question 11 (a) (ii)

(ii) **Fig. 11.2** shows the structure of graphite.

Graphite also has a high melting point.

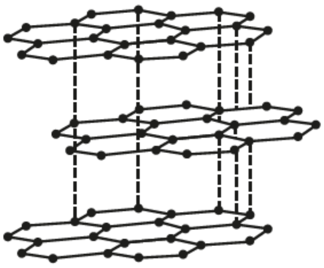


Fig. 11.2

Describe and explain **two** other properties of graphite.

Use the structure shown in **Fig. 11.2** to help explain your answers.

Property 1 ....

Explanation ....

....

Property 2 ....

Explanation ....

.... **[2]**

Many candidates experienced some difficulty in describing properties of graphite, and malleability was a common suggestion. This was not given credit. Melting point was often discussed despite the instruction not to use it.

Question 11 (b)

(b) Diamond has a high density.

1.0 g of diamond has a volume of 0.29 cm^3.

Calculate the mass of 1.0 cm^3 of diamond.

Give your answer to **2** significant figures.

Mass = ... g **[2]**

This question discriminated well, and able candidates showed clear understanding of how to carry out the calculation. Others showed confusion in surprising places, such as the meaning of '$0.29cm^3$'. A significant minority of calculations divided 1 by 0.29^3, and so ended up with a value of 41.

Examiners are noticing an increasing number of candidates using iterative techniques. Where these produce the correct answer, such candidates are given full marks, and where the answer is incorrect examiners were still able to give credit for the working so long as it was laid out clearly enough.

Question 11 (c) (i)

(c) 12 g of diamond produces 44 g of CO_2 when it is burned completely.

(i) Calculate the mass of CO_2 produced when 1.0×10^{-3} g of diamond is burned completely.

Give your answer to **2** significant figures.

Mass of CO_2 = ... g **[2]**

Higher ability candidates successfully calculated the mass of CO_2, but others often used 12/44 rather than 44/12.

Question 11 (c) (ii)

(ii) Jane makes some statements about graphite and diamond:

1 'Complete combustion of 12 g of graphite produces less than 44 g of CO_2.'

2 'This is because atoms in graphite are further apart than in diamond.'

Do you agree with Jane's statements?

Explain your answer.

....

....

....

.... **[2]**

A few candidates were able to explain why the Jane's first statement was incorrect, and that the atomic spacing was independent of the mass of carbon dioxide produced. The majority of candidates either agreed, giving responses such as 'less CO_2 is given off as the particles are further apart', as in exemplar 21 or disagreed for other erroneous reasons, as in exemplar 22

Exemplar 21

Jane makes some statements about graphite and diamond:

1 'Complete combustion of 12 g of graphite produces less than 44 g of CO_2.'

2 'This is because atoms in graphite are further apart than in diamond.'

Do you agree with Jane's statements?

Explain your answer.

I agree with her statement as the structure of graphite is further apart and the structure of a diamond is closer together. **[2]**

Exemplar 22

Jane makes some statements about graphite and diamond:

1 'Complete combustion of 12 g of graphite produces less than 44 g of CO_2.'

2 'This is because atoms in graphite are further apart than in diamond.'

Do you agree with Jane's statements?

Explain your answer.

I disagree, because graphite has layers which means it takes longer to burn

[2]

Question 12 (a) (i)

12 Ben uses chromatography to investigate a solid black food dye.

(a) Ben tests the solubility of the dye in three solvents.

Here are his results:

Solvent	Result
water	insoluble
ethanol	insoluble
propanone	soluble

(i) Which of the three solvents are **non-aqueous**?

.... **[1]**

The whole of this question was common with the Higher Tier paper.

While some candidates realised that both ethanol and propanol are non-aqueous, the most common response was to give ethanol only. 'Water' was frequently suggested as being 'non-aqueous'.

In the pressure of the examination, some candidates wrote 'propane' instead of 'propanol'. As propane is a completely different substance, these candidates gained no credit.

Question 12 (a) (ii)

(ii) Ben uses paper chromatography to investigate the dye.

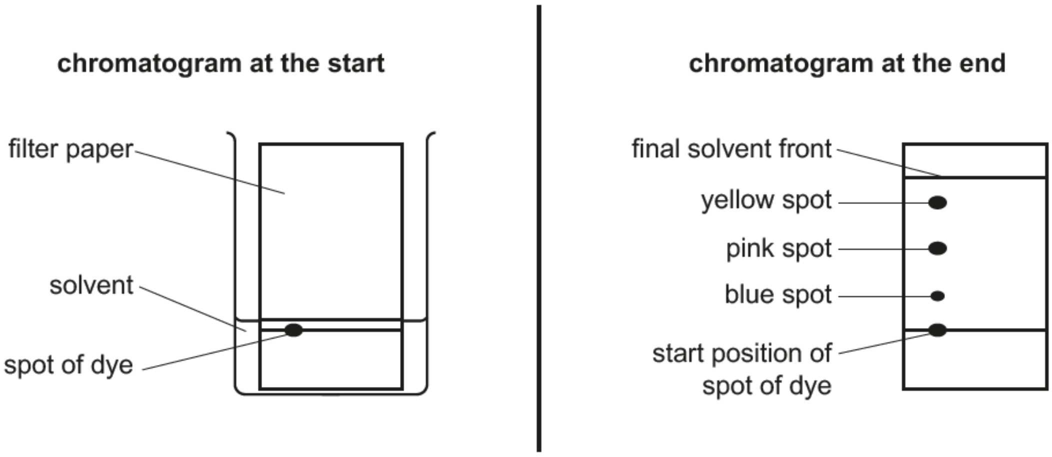
Which of the three solvents should Ben use in his investigation?

.... **[1]**

Water was the most common response. Few candidates realised that the information in the table would indicate the most appropriate solvent,

Question 12 (b) (i)

(b) Here is some information about the experiment:



(i) Name the stationary phase.

.... **[1]**

The term 'stationary phase' was unfamiliar to most candidates. The main suggestions were 'the start position of the dye'. Some candidates suggested 'the mobile phase', which suggests that they found the terms familiar even if they did not know what they meant.

Question 12 (b) (ii)

(ii) What is wrong with the way Ben set up his experiment?

Explain your answer.

....

....

.... **[2]**

Many candidates realised that the solvent should not be covering the spot, and so gained the first mark. Explaining why this was so was much more difficult. A large minority missed the spot placement and suggested that 'there was nothing holding the paper up'.

Question 12 (b) (iii)

(iii) Which spot has the greatest R_f value in the chromatogram at the end?

Explain your answer.

....

....

.... **[2]**

This part was better answered than the others, and many candidates clearly understood how R_f values are calculated, as in exemplar 23. Other candidates made suggested that it was the size of the spot that was relevant, as in exemplar 24.

Exemplar 23

Which spot has the greatest R_f value in the chromatogram at the end?

Explain your answer.

yellow spot because you measure the line from the Start position to the Spot and then from the Start position to the final Solvent front, yellow dot has travelled the furtest distance. **[2]**

Exemplar 24

Which spot has the greatest R_f value in the chromatogram at the end?

Explain your answer.

pink Spot, it look large than other Spot.

.... **[2]**

Question 12 (c)

(c) Ben thinks the dye is a pure substance. Kareem, another student, disagrees.

Who do you agree with?

Explain your answer.

....

.... **[1]**

Many candidates could explain why the dye must be made up of several colours, with others not quite understanding what had happened and suggesting that 'colouring has been added to the dye' and 'the dye is mixed with other substances'.

Question 12 (d)

(d) Ben measures the melting point of the dye.

Describe what Ben would see if the dye is pure.

....

.... **[1]**

A very small minority realised that a pure dye would have a sharp melting point.

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