Qualification Accredited

Oxford Cambridge and RSA

GCSE (9-1)

Examiners' report

GATEWAY SCIENCE COMBINED SCIENCE A

J250
For first teaching in 2017

J250/03 Summer 2018 series

Version 1

www.ocr.org.uk/science

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 J250/03 series overview

J250/03 is one of the components in the new revised GCSE (9-1) Combined Science (Chemistry) A (Gateway Science) examination. It covers topics C1-C3 and CS7 (PAGs C1-C5).

In general the paper was accessible to most candidates but also gave higher ability candidates plenty of opportunity to demonstrate their knowledge. Candidates achieved a range of marks although most were in the lower range. The majority of candidates seemed to find this paper challenging. Some candidates were hampered by a lack of ability to express themselves in clear English.

Candidate performance overview

Candidates who did well on this paper generally:

- Knew the names of scientific apparatus and could describe how to use them to determine the melting point of ice to obtain accurate results: Question 11
- Understood how electrolysis worked and could use the correct technical terms: Question 13
- Were able to analyse information to interpret, evaluate and draw conclusions: Questions 16 (b) (ii), (iii) and 16 (c)
- Knew how to calculate Rf values accurately from the data on a chromatogram, interpret the results and express their conclusions coherently: Question 17
- Linked observed properties e.g. conductivity, density and melting points to the structure and bonding in iron and carbon nanotubes, expressing their ideas clearly: Question 18
- Were able to balance equations correctly: Question 19 (c) (i)
- Performed calculations competently, showing clear working e.g. comparing numbers which were not in standard form: 8, calculating a mean: Questions 16 (b)(i), ratios: 17, 18 (c)

Candidates who did less well on this paper generally:

- Struggled to select and name appropriate apparatus and to describe a valid method for determining the melting point of ice: Question 11
- Did not know the difference between an empirical formula and a molecular formula: Questions 14 (a)
- Did not understand what was meant by a limitation: Question 14 (c)
- Struggled to interpret experimental data provided in a table: Questions 16 (b) (ii), (iii),16 (c), 19 (c) (ii)
- Found it difficult to interpret a chromatogram to obtain the correct data in order to calculate Rf values accurately and to explain their results coherently: Question 17
- Struggled to explain the link between the properties of iron and carbon nanotubes and their structure and bonding: Question 18
- Did not know what was meant by a state (of matter): Question 19 (c) (ii)

Most candidates had sufficient space to write their answers, with few using the additional answer space. There was no evidence that candidates did not have time to finish the examination.

Question 1

1 A student wants to make solid ammonium sulfate from the solution of ammonium sulfate.

What should the student do first?

A Distil the solution.

B Evaporate the solution.

C Filter the solution.

D Use chromatography.

Your answer ☐ **[1]**

Some candidates correctly chose evaporation. Distillation and filtration were common wrong choices.

Question 2

2 A metal carbonate reacts with an acid.

What products are made?

A Salt and carbon dioxide

B Salt and water

C Salt, carbon dioxide and water

D Salt, hydrogen and carbon dioxide

Your answer ☐ **[1]**

Some candidates correctly chose C. Many forgot that water was also produced and chose A.

Question 3

3 Ethanoic acid is a **weak** acid.

What is the pH of ethanoic acid?

A 1

B 5

C 7

D 12

Your answer ☐ **[1]**

Many candidates knew the answer was pH 5, but some selected pH 1. A number of candidates wrote the pH number in the box rather than A, B, C or D.

Question 4

4 A student wants to re-crystallise a solute from a solution.

What type of apparatus should she use?

A An evaporating dish, wire gauze, tripod and Bunsen burner

B A filter funnel, filter paper and conical flask

C A round-bottomed flask connected to a condenser

D A separating funnel

Your answer ☐ **[1]**

This question was well answered with most candidates choosing A. The most common wrong answer was B with very few choosing C or D.

Question 5

5 What is the chemical formula for sodium chloride?

A Na_2Cl

B $NaCl$

C $NaCl_2$

D Na_2Cl_3

Your answer ☐ **[1]**

Some candidates correctly chose NaCl, but many selected A.

Question 6

6 In 1808 John Dalton published his theory about matter.

Which of Dalton's ideas is now known to be **incorrect**?

A A chemical reaction is a rearrangement of atoms.

B All matter consists of atoms.

C Atoms cannot be subdivided.

D When elements react, their atoms combine in simple, whole-number ratios.

Your answer ☐ **[1]**

Some candidates correctly selected C, but more candidates chose D.

Question 7

7 An element has a **relative atomic mass** of 19.0.

Find this element on the Periodic Table.

How many protons does this element contain?

A 9

B 10

C 19

D 28

Your answer [ ] **[1]**

Most candidates correctly selected A, but a few thought that the relative atomic mass indicated the number of protons so chose C.

Question 8

8 An atom is the smallest particle of an element.

What is the approximate size of a single atom?

A 0.0001×10^{-6} m

B 0.0001×10^{-10} m

C 0.01×10^{-10} m

D 0.1×10^{-12} m

Your answer [ ] **[1]**

A few candidates chose the correct answer A. B was the most common wrong answer, but C and D were often chosen. Candidates struggled to compare the data as it was not given in standard form.

Question 9

9 Graphite is used in pencils.

Why can graphite make marks on paper?

A All the bonds in graphite are weak.

B Atoms in graphite are in layers.

C Forces between layers in graphite are strong.

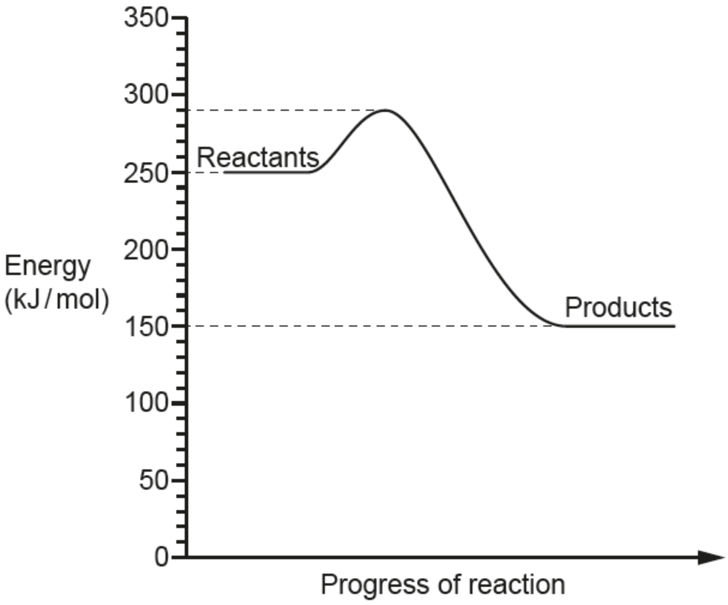
D Every atom in graphite is strongly bonded to four others.

Your answer ☐ **[1]**

Some candidates correctly chose B, with all the other incorrect options being popular.

Question 10

10 The diagram shows a reaction profile.



What is the energy change of the reaction?

A +40 kJ/mol

B –100 kJ/mol

C +140 kJ/mol

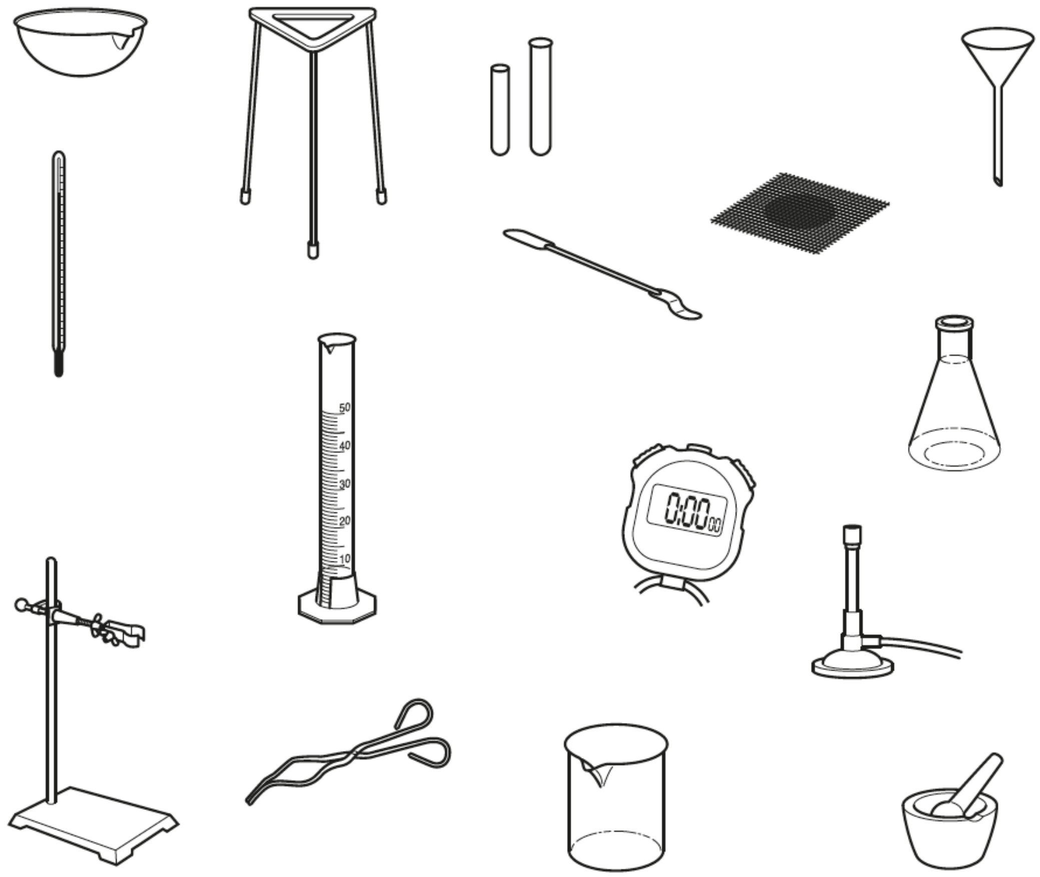
D –140 kJ/mol

Your answer ☐ **[1]**

Some candidates correctly answered B, but C and D were the main wrong choices.

Question 11 (a)

11 Look at the pictures of some common laboratory equipment.



(a) A student wants to **accurately** measure the melting point of ice.

Describe an experiment that she could do.

You may draw a **labelled** diagram to help your answer.

Use some of the equipment from the pictures on page **6**.

....

....

....

.... **[2]**

Candidates that drew a labelled diagram were more likely to get 2 marks than candidates who just tried to describe it. Most candidates attempted to draw a diagram but generally used the pictures from the question rather than the diagrams they have been taught. Unlabelled diagrams were common and gained no credit. Only a few candidates knew the names of common apparatus and most did not realise that a beaker was most appropriate. Many used evaporating basins, often just labelled as a bowl, conical flasks or sometimes measuring cylinders to heat their ice in. Many candidates thought the stop clock was the key instrument, and in many cases missed out the thermometer.

Descriptions were often confused with many candidates timing how long it took for the ice to melt instead of recording the melting point. Few explained that it should be heated, but gained credit for this from drawing a labelled Bunsen burner or for just leaving the ice to melt at room temperature. Crushing the ice, stirring or keeping the thermometer in the ice were rarely mentioned.

Question 11 (b)

(b) Suggest **one** thing the student could do to improve the experiment.

....

.... **[1]**

Most candidates gained the mark by suggesting that the experiment should be repeated, although some incorrectly suggested changing one of the variables. Few candidates mentioned crushing the ice, stirring or using a water bath. However, some of those who left it at room temperature to melt in question 11 (a) got credit for using a Bunsen burner in this question. A few scored the mark for using a more sensitive, digital or electronic thermometer, but computer controlled equipment /data loggers were not seen.

Question 12 (a) (i)

12 **(a)** This question is about atomic structure.

(i) What is meant by **relative atomic mass**?

....

.... **[1]**

Most candidates confused this with mass number and referred to the number of protons and neutrons. Almost no candidates managed to explain correctly or even mentioned carbon 12. Many thought it was the mass of one atom.

Question 12 (a) (ii)

(ii) What **two** things can you work out from the **atomic number** of an element?

1 ....

2 ....

[2]

This question differentiated well with higher ability candidates scoring 2 marks for number of protons and number of electrons. Most candidates scored at least one mark for stating the number of protons. However, many candidates confused atomic number and mass number and referred to the number of neutrons. A few candidates put more than 2 answers which resulted in a loss of credit e.g. 1. Number of protons and neutrons (no mark) 2. Number of electrons (1 mark). Some just wrote 'protons' rather than 'number of protons', but were credited with the mark. Some candidates interpreted the question differently and stated things they could deduce e.g. the number of electrons in the outer shell, number of electron shells, period number. They did gain credit for this, although it was not what the question had intended.

Question 12 (b)

(b) Look at the table about the particles in an atom.

Particle	Relative Charge	Relative Mass
Proton	+1	....
Neutron	....	1
Electron	....	Almost 0

Complete the table.

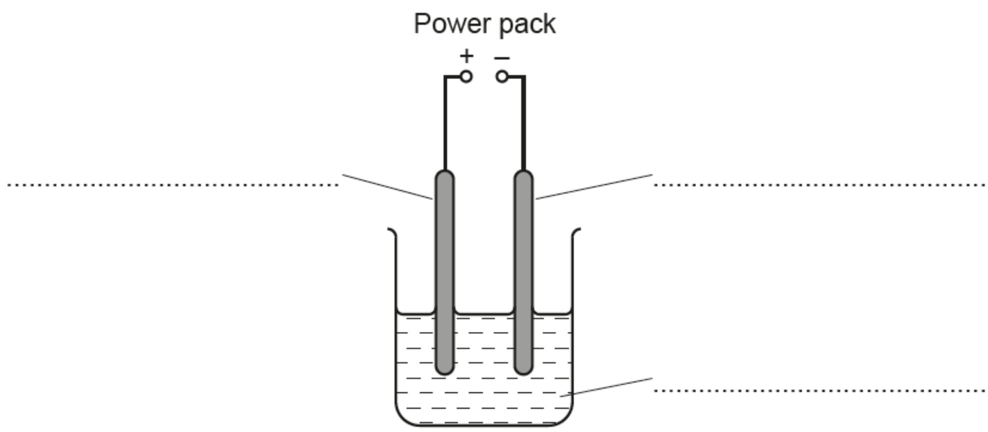
[3]

Higher ability candidates frequently gained 3 marks. Most candidates scored at least one mark, with the relative mass of the proton almost always being correct.

Question 13 (a) (i)

13 (a) Look at the diagram of an electrolysis experiment.

(i) Complete the labels on the diagram.



[2]

This question was a good discriminator. Some higher ability candidates could name the anode and cathode correctly, but fewer could label the electrolyte. However, some gained credit by giving a correct example of an electrolyte instead. Some stated sodium chloride, having presumably seen it in the question that followed. Common incorrect responses were positive or negative terminal/rod for the electrodes and solution or water for the electrolyte. A few thought the dashes in the beaker were electrons.

Question 13 (a) (ii)

(ii) Sodium chloride is an **ionic** compound.

Sodium chloride

- Will **not** conduct electricity when it is solid
- Will conduct electricity when it is dissolved in water.

Explain why.

....

....

.... **[2]**

Some of the highest ability candidates were able to explain that ions are only able to freely in solution. Most answers were irrelevant. Candidates frequently wrote about electricity/electrons having space to move through liquids not solids. They often referred to electrons, sometimes delocalised electrons, instead of ions.

Question 13 (b)

(b) A scientist electrolyses three different compounds.

Complete the table below to show what products will be formed.

Compound	Product formed at negative electrode	Product formed at positive electrode
Molten $PbBr_2$	Lead	....
A solution of KBr	Hydrogen	....
A solution of $CuCl_2$	Copper	....

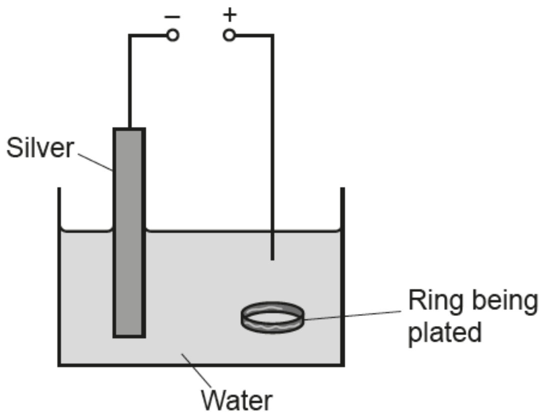
[3]

Higher ability candidates mostly scored at least 2 marks with the answers to $PbBr_2$ and $CuCl_2$ most often being correct. For KBr, potassium and hydrogen were common incorrect answers. Lower ability candidates did not always even name an element and there were a wide range of incorrect responses. A significant number lost marks by writing bromide/chloride instead of bromine/chlorine. Many candidates did not attempt this question.

Question 13 (c)

(c) Electrolysis can also be used to **electroplate** one metal onto another.

Look at the diagram of this experiment.



The experiment shown in this diagram will **not** work.

Suggest **two** things that must be changed to make the experiment work.

....

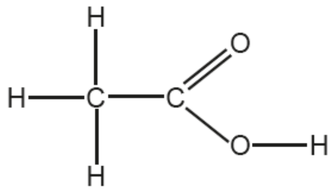
....

.... **[2]**

Where marks were credited it was mostly for the idea of swapping the anode and cathode, and for connecting the ring. Many candidates struggled to articulate their answer clearly enough to gain credit. Candidates were able to gain a mark by stating that water would not work but an alternative was to name a suitable electrolyte. Most could not do this and did not realise that metal ions were required in solution. Some lower ability candidates thought that there was no power source.

Question 14 (a)

14 Look at the molecule below:



(a) Write down the **empirical formula** for this molecule.

.... **[1]**

A few candidates correctly gave CH_2O, but most candidates did not understand what was meant by an empirical formula, so marks were rarely credited. Most tried to write a molecular formula, but some attempted a symbol equation. Some candidates wrote both molecular and empirical formulae so did not gain credit.

Key

Misconception

Question 14 (b)

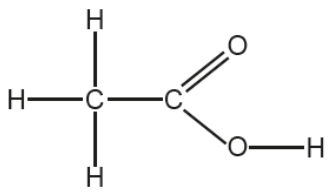
(b) Calculate the **relative formula mass**, M_r, for this molecule.

Answer = ... **[1]**

Some candidates calculated this correctly but working was frequently not shown. A common wrong answer was 30 instead of 60. Many did not attempt an answer.

Question 14 (c)

(c) The displayed formula for the molecule does not show the exact length of the bonds.



Write down **two** other limitations of the displayed formula.

....

....

....

....

.... **[2]**

A few candidates scored marks for the idea of 3D shape and sizes of atoms not being shown in the diagram. Many did not seem to understand what 'limitation' meant. They took it to mean 'what is the mistake with it' and started trying to correct the formula with comments such as there shouldn't be two lines between the C and the O. Others talked about bond lengths/ strengths, sometimes just repeating the stem of the question. Most marks were credited for the idea of size, but there was poor understanding that it was the atoms that were different sizes.

Question 15 (a)

15 This question is about electronic structure and bonding.

(a) The electronic structure of phosphorus is 2.8.5.

Use these **three numbers** to explain the **position** of phosphorus in the Periodic Table.

....

....

....

.... **[2]**

Higher ability candidates scored both marks for explaining clearly how they deduced the group and period numbers. A significant number mentioned columns and rows instead of groups and periods. Many candidates realised it was in Group 5 but could not link this to having 5 electrons in the outer shell. Fewer candidates could link the 3 shells of electrons to it being in period 3. Many worked out that the atomic number was 15. The fact that it had 15 electrons led some candidates to place it in group 15 without the correct reason. Some just looked up Phosphorus on the periodic table and described its position.

Question 15 (b)

(b) Phosphorus bonds with hydrogen to form the toxic gas phosphine, PH_3.

Draw a 'dot and cross' diagram to show the **covalent** bonding in PH_3.

[2]

Many candidates gained one mark for showing a shared pair of electrons, but fewer were able to complete the rest of the diagram successfully. Some attempted an ionic structure or a stick diagram. Many candidates did not attempt this question.

Question 16 (a)

16 Sodium hydroxide reacts with hydrochloric acid.

Sodium chloride and water are made.

(a) Write a **word** equation for this reaction.

.... **[1]**

Most candidates constructed a creditworthy equation but some could not copy the names of the chemicals from the stem of the question accurately. Some candidates used different chemicals to those shown in the questions. Some attempted a symbol equation but this rarely gained credit, even though it did not have to be balanced.

Question 16 (b) (i)

(b) A student adds 5 cm^3 of hydrochloric acid (HC*l*) to 55 cm^3 of sodium hydroxide (NaOH).

He measures the highest temperature reached during the reaction.

He also measures the pH at the end of the reaction.

He repeats this experiment three times and works out the mean temperature.

He then repeats the experiment with different volumes of hydrochloric acid and sodium hydroxide.

Look at his results.

Experiment	**Volume of HC*l* (cm^3)**	**Volume of NaOH (cm^3)**	**Highest temperature reached during reaction (°C)**				**pH at the end of the reaction**
			1	**2**	**3**	**Mean**	
A	10	50	29.3	30.6	30.7	30.2	12.0
B	20	40	34.5	35.3	35.2	35.0	7.8
C	30	30	37.3	37.6	36.7	37.2	7.0
D	40	20	34.3	35.5	34.6		6.3

(i) Calculate the mean temperature for experiment **D**.

Answer = ...°C **[1]**

Most candidates were able to calculate the mean of 34.8 correctly but a few made mathematical errors. A small number appeared to have just guessed.

Question 16 (b) (ii)

(ii) Describe the pattern of the highest temperature reached for experiments **A** to **C**.

....

.... **[1]**

Candidates gained the mark by stating that the temperature increased. However, the more they wrote the more likely they were to lose the mark for qualifying their answer incorrectly e.g. the temperature increased as the volume of hydrochloric acid ***and*** sodium hydroxide increased. Others just gave an observation from the table rather than a pattern e.g. A had the highest temperature. Some candidates were confused because there were three repeats in the table. A few misread the question and described the pattern from A to D rather than A to C.

Question 16 (b) (iii)

(iii) Describe the pattern of pH at the end of the reaction for experiments **A** to **D**.

....

....

.... **[1]**

Most candidates gained the mark by stating that pH decreased, but others who tried instead to describe the change from alkalinity to acidity got confused. A few did not gain the mark because they qualified their answer incorrectly in a similar way to question 16(b)(ii). More candidates gained credit in this question than the previous one as there was only one set of pH data, unlike temperature.

Question 16 (b) (iv)

(iv) How could the student measure the pH?

....

.... **[1]**

A few candidates gained the mark for knowing that pH was measured using universal indicator, but some used a pH probe or meter. Some lost credit by including litmus as well as universal indicator. The most common incorrect answer was to use a pH scale. Other incorrect answers included litmus, using a ruler, adding acid or merely looking at the colour of the solution.

Question 16 (c)

(c) What conclusion can you draw from the student's experiments?

....

.... **[1]**

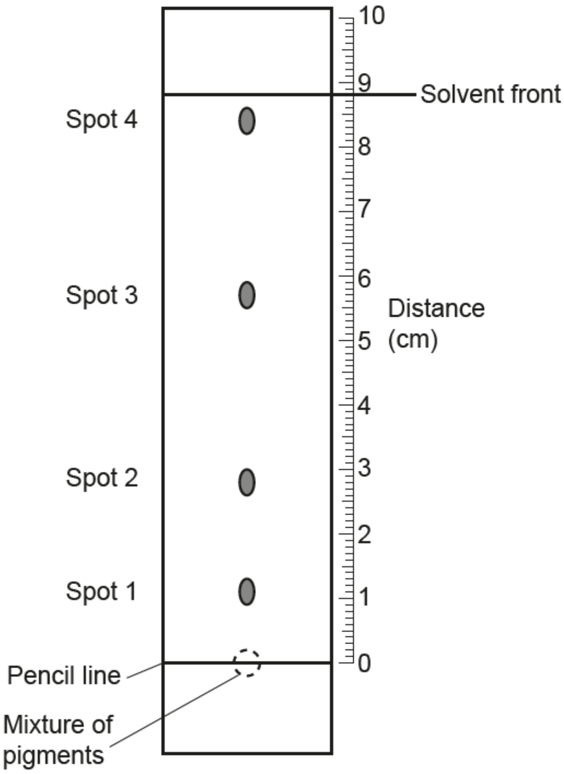
Candidates could score the mark for a wide variety of valid conclusions drawn from the table of data. However, a lot of candidates did not seem to understand what a conclusion was, so just gave an observation or quoted data from the table. Many gained credit by just repeating the answer they had given in questions 16(b)(ii) or (iii). A common wrong answer was that as temperature increased pH decreased, as candidates had not spotted that temperature had dropped at D. Some candidates thought that a conclusion meant that a graph or diagram should be drawn.

Question 17

17* A student wants to find out which pigments are in a plant.

She does a chromatography experiment on a sample from the plant.

Look at her results.



Distance to **spot 1**	= 1.1 cm
Distance to **spot 2**	= 2.8 cm
Distance to **spot 3**	= 5.7 cm
Distance to **spot 4**	= 8.4 cm

The R_f values for some pigments are shown in the table.

Pigment	**R_f value**
A	0.95
B	0.45
C	0.32
D	0.25
E	0.15

Calculate the R_f value for each spot.

Describe and explain which pigments are in the sample from the plant and suggest why further analysis of the plant pigments is needed.

....

....

....

....

....

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....

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....

....

.... **[6]**

Some candidates knew how to calculate Rf values and made a reasonable attempt to state the Rf formula and to calculate some or all of the Rf values correctly. Rounding errors stopped some candidates accessing higher levels. Not all identified pigments A and C, although some knew they were present but did not link them to spots in the chromatogram. A few higher ability candidates accessed Level 3 by explaining that spot 3 did not relate to any of the known pigments that had been tested, but most did not realise that the identity of spot 1 is ambiguous as its Rf value did not match any pigments exactly. Most simply restated the stem of the question to say that further analysis is needed, but did not clearly suggest why or what should be done. Virtually no one suggested looking up the Rf values of other pigments.

Many candidates did not attempt this question, and some just wrote irrelevant facts about plant pigments used for photosynthesis. Some candidates gained little credit as they were unable to present their answers in a coherent and logical way.

Exemplar 1

Rf of Spot 1 = $\frac{1.1}{8.8}$ = ~~0.125~~ 0.13

Rf of Spot 2 = $\frac{2.8}{8.8}$ = ~~0.318~~ 0.32

Rf of Spot 3 = $\frac{5.7}{8.8}$ = ~~0.65~~ 0.65

Rf of Spot 4 = $\frac{8.4}{8.8}$ = 0.95

~~Rf of Spo~~

Pigmant A ~~AA~~ and C are in the sample from the plant, further analysis of the plant pigments are needed because they may not be in the plant ~~have exp~~ the student is experimenting with. **[6]**

L2

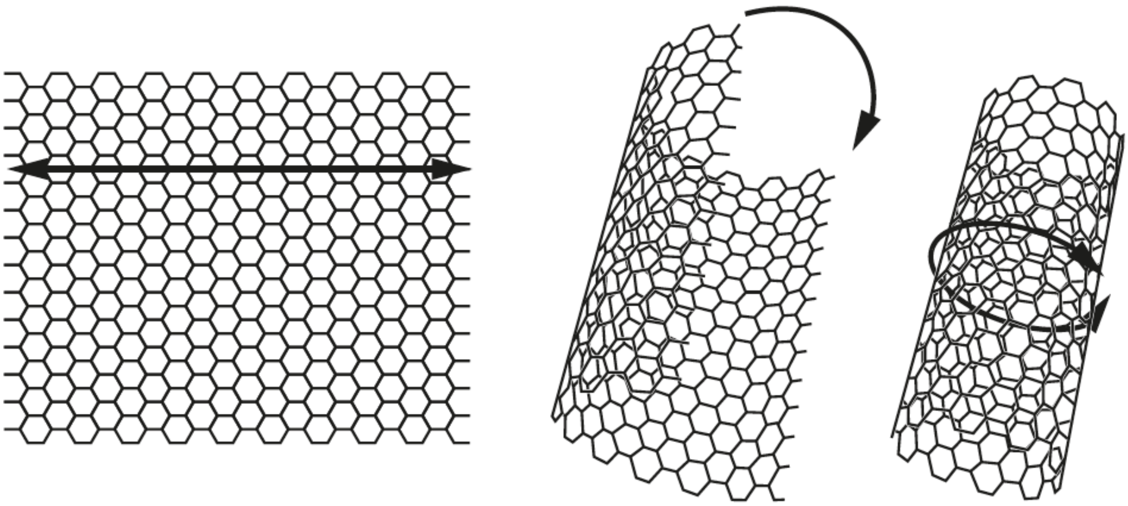
^

This candidate has measured the solvent front accurately and used the Rf formula to calculate all four Rf values correctly. They have analysed the information to conclude that pigments A and C were in the sample. However, they have not explained which spots they relate to on the chromatogram. They state that further analysis is needed (as given in the stem of the question), but have not made any relevant suggestions as to why this is necessary. This response was credited Level 2 with 3 marks. With improved communication to link spot 4 to pigment A, and spot 2 to pigment C the candidate would have been credited Level 2 with 4 marks.

Question 18 (a)

18 Carbon nanotubes are a new material.

The diagrams show how a graphene sheet can form a nanotube.



(a) Nanotubes are more than 100 times stronger than iron.

Explain why nanotubes are so strong. Use ideas about bonding.

....

....

....

....

.... **[2]**

Mostly candidates scored 1 mark for the idea of strong bonds, although this often not expressed clearly. Few identified covalent bonds. Many candidates mentioned intermolecular forces which invalidated any otherwise correct answers.

Question 18 (b)

(b) Carbon is a non-metal.

Carbon nanotubes conduct electricity.

Explain why carbon nanotubes conduct electricity.

....

....

.... **[2]**

Candidates mostly gained 1 mark for the idea that electrons could move. Explanations involving delocalised electrons were rarely seen, with many writing about space for electricity to flow in nanotubes rather than about the electrons. Those who wrote about free or delocalised electrons often did not say that they moved. Many stated that carbon nanotubes conduct because carbon is a metal. Some thought they conduct because it's a non-metal and non-metals are good conductors. A significant minority of incorrect responses mentioned inclusion of metals in the nanotubes as the reason for conductivity, or said that nanotubes had been designed so they conduct.

Question 18 (c)

(c) Carbon nanotubes and iron have very similar electrical conductivities.

Look at some other properties of carbon nanotubes and iron.

Material	**Density (g/cm^3)**	**Melting point (°C)**
Carbon nanotubes	1.6	3500
Iron	7.9	1538

(i) Calculate how many times more dense iron is than carbon nanotubes.

Answer = ... **[2]**

Many candidates were able to calculate this correctly. Some did not show their working so when they made an error, typically in rounding, they did not gain any credit. The most common error was to subtract the densities to give 6.3. A few candidates used the melting point data by mistake.

Question 18 (c) (ii)

(ii) Explain why iron is more dense than carbon nanotubes.

....

....

.... **[1]**

Some candidates could explain about the iron atoms being tightly packed. However, they often did not give comparative answers so gained no credit e.g. iron atoms are close together. Some candidates said 'they' are hollow but did not make it clear that they meant carbon nanotubes. Some just stated that iron was heavier or had more mass but few mentioned relative atomic mass. A variety of irrelevant answers were given including relating density to melting point and conductivity.

Question 18 (c) (iii)

(iii) Suggest a reason why carbon nanotubes have a higher melting point than iron.

....

.... **[1]**

Many candidates knew that carbon nanotubes had strong bonds but did not always make their answer comparative so did not score the mark. Many incorrect answers linked high melting point to high density, or just to the nanotubes being stronger.

Question 19 (a)

19 The table shows some common ions.

Negative ions		**Positive ions**	
Nitrate	NO_3^-	Aluminium	Al^{3+}
Oxide	O^{2-}	Magnesium	Mg^{2+}

(a) Write the formula for **aluminium oxide**.

.... **[1]**

A few candidates deduced that the correct formula for aluminium oxide was Al_2O_3, but a few wrote Al_3O_2. Most included charges on the ions and some attempted to write a word or symbol equation.

Question 19 (b)

(b) A teacher wrote the formula for magnesium nitrate as:

$MgNO_3$

A student says that the formula is incorrect.

Who is right? Explain your answer.

....

.... **[1]**

Most candidates did not understand how to answer this question. Some realised the charges had to be balanced but couldn't do this to write the correct formula. A lot of candidates said it was incorrect as nitrate doesn't contain oxygen.

Question 19 (c) (i)

(c) Aluminium sulfide reacts with dilute hydrochloric acid.

(i) Balance the equation for this reaction.

Al_2S_3 + ... HCl → .... $AlCl_3$ + ... H_2S **[1]**

Only higher ability candidates seemed to understand how to balance an equation, and few could do this correctly. A significant number of candidates had written new formulae or names of chemicals on the dotted lines. A large number of candidates did not attempt to answer.

Question 19 (c) (ii)

(ii) The table shows the melting point and boiling point of H_2S.

Melting point	–85.5 °C
Boiling point	–60.7 °C

What state does H_2S exist in at room temperature?

.... **[1]**

Some candidates did not understand what was meant by state. A significant number of candidates who didn't get the marks here had written something that wasn't a state of matter. Incorrect answers included numbers, formulae and 'boiling point'.

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