OCR
Oxford Cambridge and RSA

F

Thursday 16 May 2019 – Morning

GCSE (9−1) Chemistry B (Twenty First Century Science)

J258/01 Breadth in Chemistry (Foundation Tier)

Time allowed: 1 hour 45 minutes

7712197351

You must have:
- the Data Sheet (for GCSE Chemistry B (inserted))
- a ruler (cm/mm)

You may use:
- a scientific or graphical calculator
- an HB pencil

J 2 5 8 0 1

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Answer **all** the questions.
- Where appropriate, your answers should be supported with working. Marks may be given for a correct method even if the answer is incorrect.
- Write your answer to each question in the space provided. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.

INFORMATION
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- This document consists of **28** pages.

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PLEASE DO NOT WRITE ON THIS PAGE

Answer **all** the questions.

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]

(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 ..... .

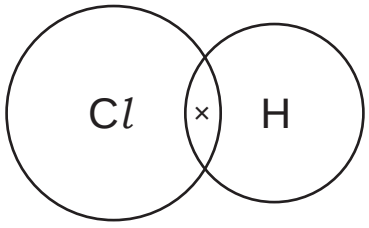
Chlorine can be hazardous because it is ..... .

[3]

(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]

2 ‘Camping gas’ contains butane.

a stove using camping gas

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

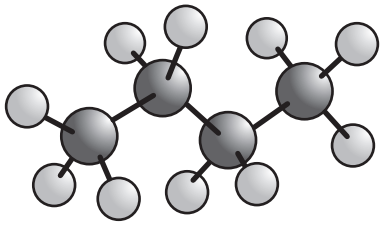


Fig. 2.1

(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]

(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]

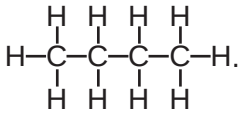
(b) Butane is a hydrocarbon.

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]

(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]**

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]**

(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]**

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

Name the **last** stage.

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

(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]**

4 Some cars use hydrogen fuel cells.

This is the reaction that happens in the fuel cell:

$2H_2 + O_2 \longrightarrow 2H_2O$

(a) Name the product of this reaction.

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

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

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

1 .....

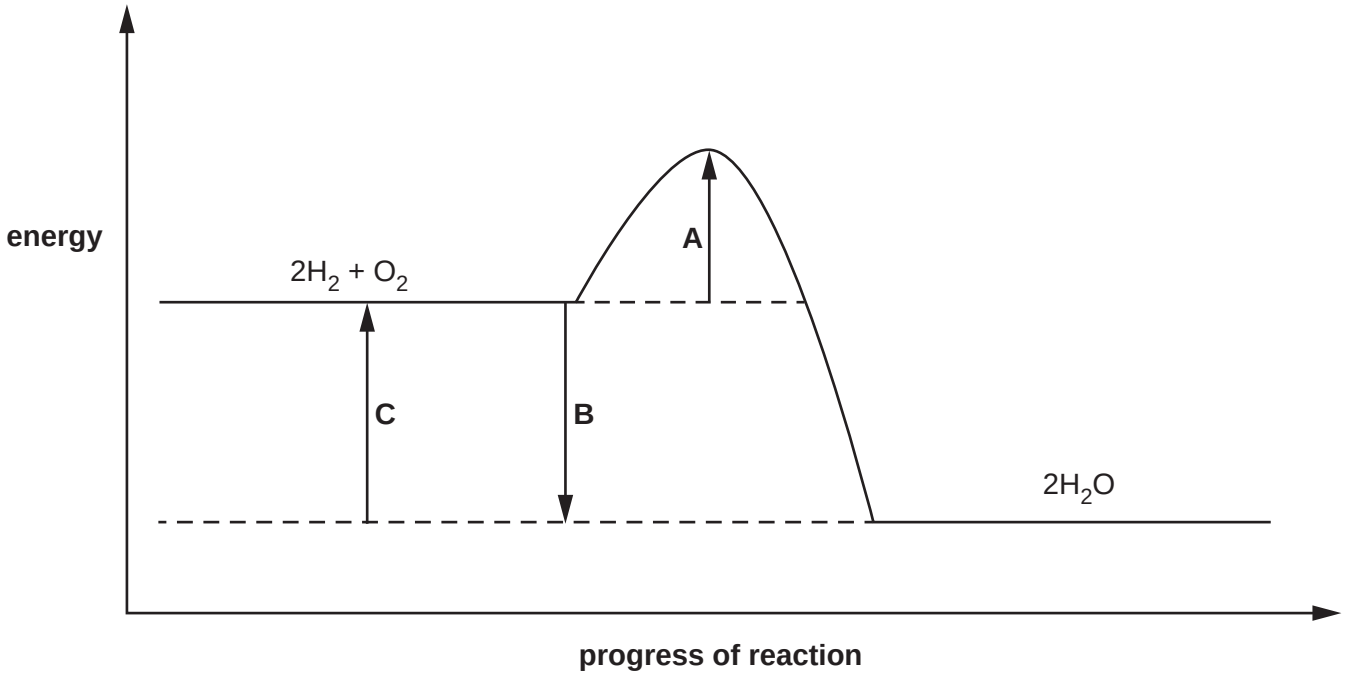
.....

2 .....

.....

[2]

(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]

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

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

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

(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]**

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]**

(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]

(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]

(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]

(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]

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]**

(ii) Which metal forms positive ions most easily?

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

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

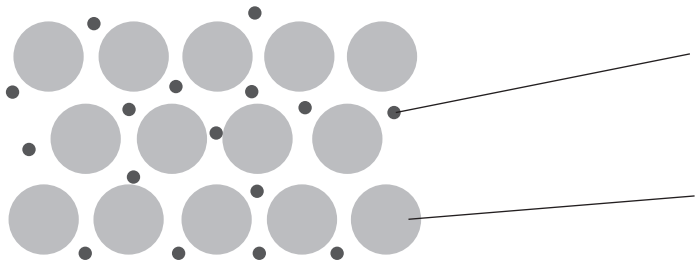
Name the brown metal. ..... **[1]**

(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]

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

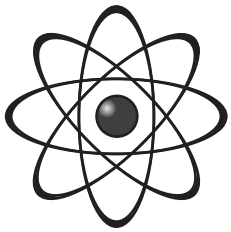
Draw lines to connect each property with its correct explanation.

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]

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]**

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

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

(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]

(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]

(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]**

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.

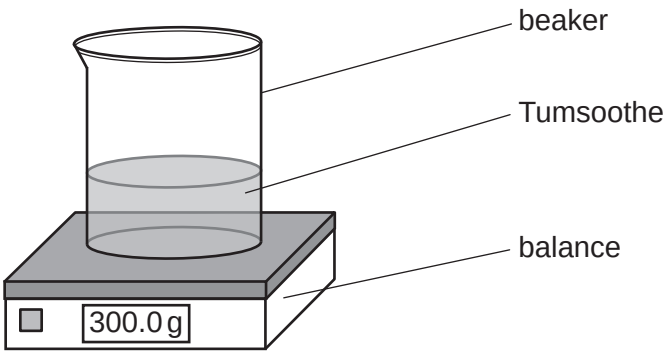


Fig. 8.1

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

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

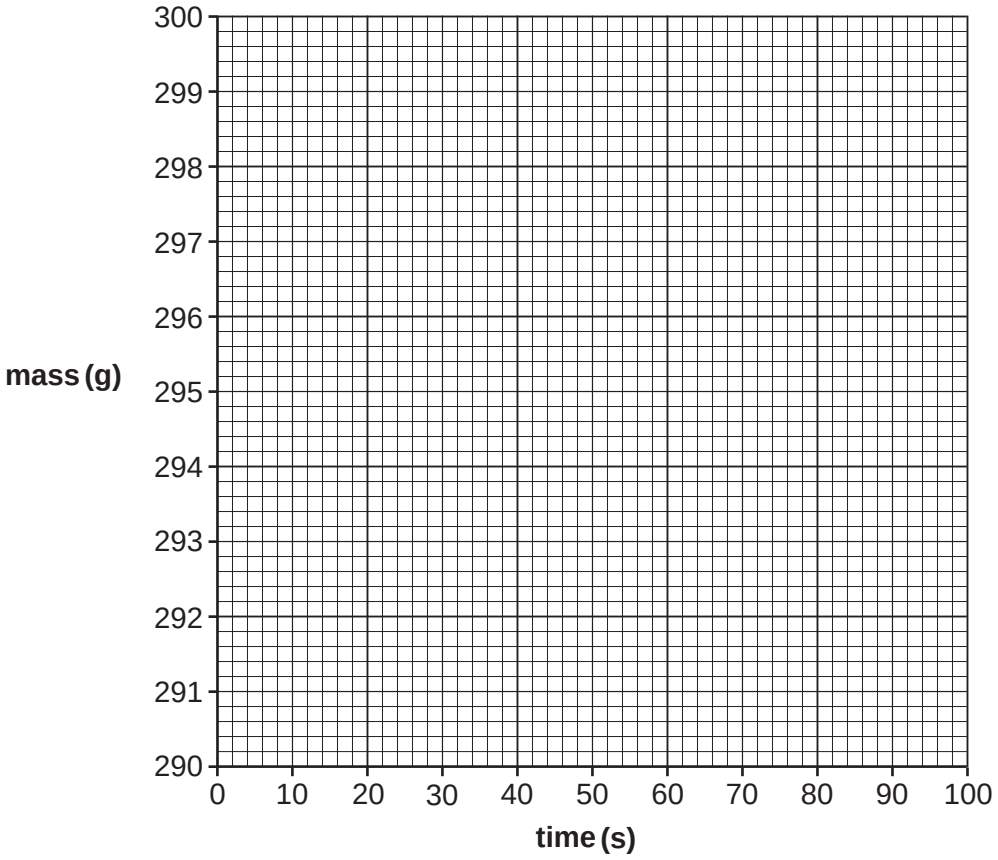
Layla writes down the mass every 10 seconds, as shown in **Table 8.1**.

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

(i) Plot a graph of mass against time on the axes below, using **Table 8.1**.

Add a curve of best fit to the graph. **[2]**



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

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

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

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

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

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

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

(iii) The law of conservation of mass says:

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

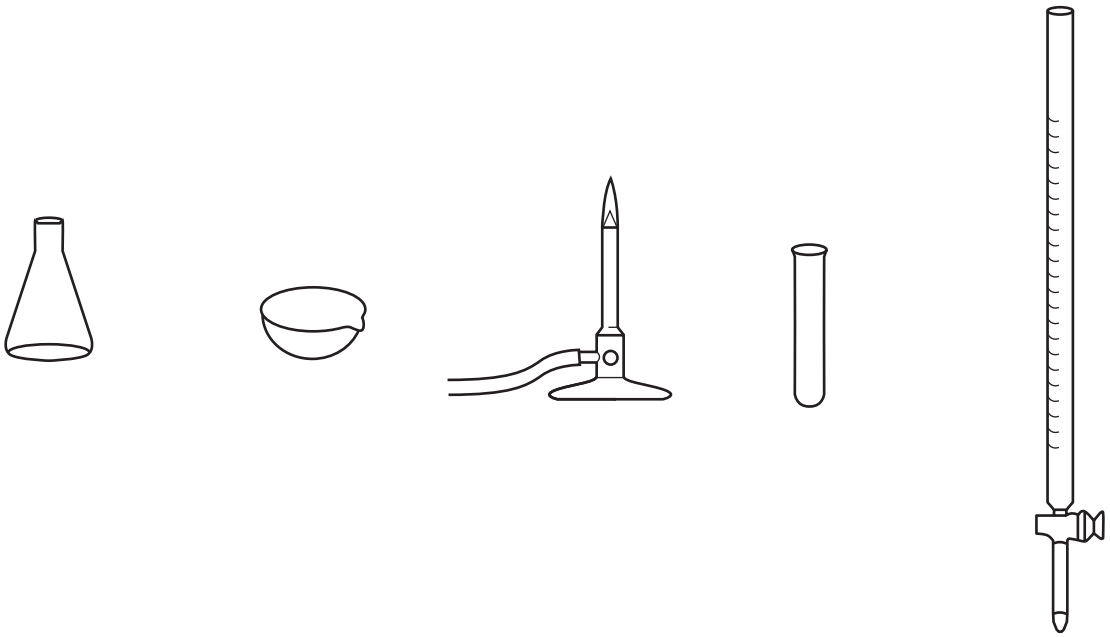
Explain why the law is true for the reaction between $NaHCO_3$ and HCl, even though the reading on the balance changes.

.....

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

(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]

(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.

.....

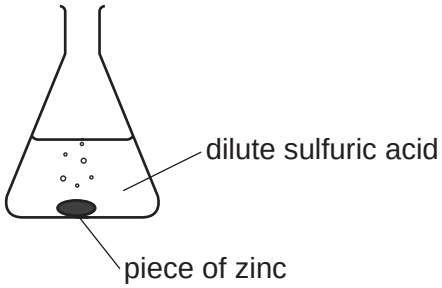
.....

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

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

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

9 Sundip reacts zinc with dilute sulfuric acid.



(a) Complete the symbol equation for the reaction.

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

(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]**

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

Explain why the fizzing is faster with zinc powder.

.....

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

(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]

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]

(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]

(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]**

11 Diamond and graphite are two forms of carbon.

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

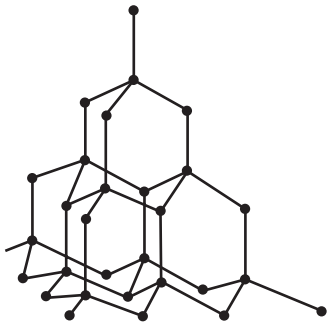


Fig. 11.1

Explain why diamond has a high melting point.

.....

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

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

Graphite also has a high melting point.

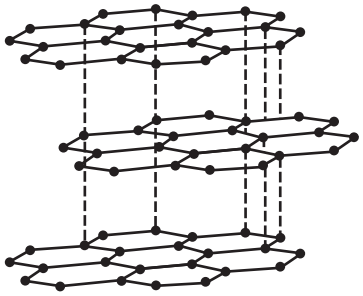


Fig. 11.2

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]

(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]**

(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]**

(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]**

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]**

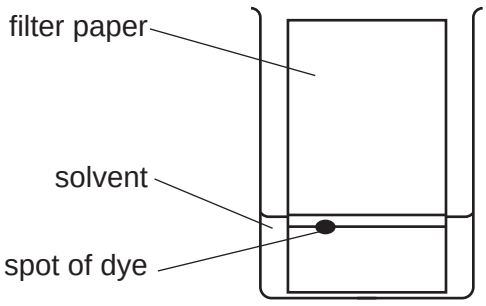
(ii) Ben uses paper chromatography to investigate the dye.

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

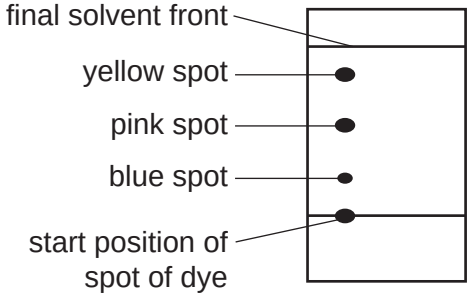
..... **[1]**

(b) Here is some information about the experiment:

chromatogram at the start



chromatogram at the end



(i) Name the stationary phase.

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

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

Explain your answer.

.....

.....

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

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

Explain your answer.

.....

.....

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

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

Who do you agree with?

Explain your answer.

.....

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

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

Describe what Ben would see if the dye is pure.

.....

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

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).