OCR
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F

Friday 19 November 2021 – Morning

GCSE (9–1) Combined Science B (Twenty First Century Science)

J260/02 Chemistry (Foundation Tier)

Time allowed: 1 hour 45 minutes

8347921226

You must have:
- a ruler (cm/mm)
- the Data Sheet for GCSE (9–1) Combined Science (Chemistry) B (inside this document)

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

J260002

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 can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **95**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*****).
- This document has **32** pages.

ADVICE
- Read each question carefully before you start your answer.

Answer **all** the questions.

1 Mendeleev organised elements into the first Periodic Table.

(a) (i) What information did Mendeleev use to help him decide the order of the elements?

Tick (✓) **one** box.

Alphabetical order	☐
Colour	☐
Date discovered	☐
Relative atomic mass	☐

[1]

(ii) Mendeleev left gaps in the table.

Give **one** reason why he needed to leave gaps.

.....

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

(b) (i) **Fig. 1.1** shows the electron arrangement in a lithium atom.

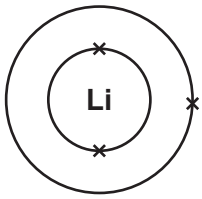


Fig. 1.1

Draw lines to connect each statement about the number and arrangement of electrons in a lithium atom with the correct information in the Periodic Table.

Number and arrangement of electrons in a lithium atom	**Information in the Periodic Table**
Number of electrons in the outer shell	Atomic number
Number of electron shells	Group number
Total number of electrons	Period number

[2]

(ii) The properties of an element depend on the arrangement of electrons in its atoms.

Lithium and fluorine have different arrangements of electrons, and different properties.

Fig. 1.2 shows the electron arrangement of fluorine.

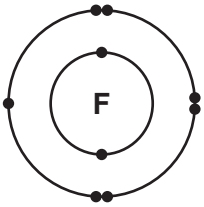


Fig. 1.2

Complete the table about the properties of lithium and fluorine.

Put a (ring) around the correct answers.

Lithium – Group 1	Fluorine – Group 7
Metal / non-metal	**Metal / non-metal**
Loses / gains electrons to form ions	**Loses / gains** electrons to form ions
Forms **positive / negative** ions	Forms **positive / negative** ions

[2]

2 Ideas about the structure of the atom have developed over time.

(a) **(i)** Draw lines to connect each scientist with their idea about the structure of the atom.

Scientist	Idea
Bohr	Atoms contain a nucleus.
Rutherford	Electrons are arranged in shells.
Thomson	An atom is like a 'plum pudding'.

[2]

(ii) Give **one** reason why scientists needed to develop new ideas about the structure of the atom over time.

.....

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

(b) Scientists now know that the atom contains electrons, protons and neutrons.

(i) Complete the table by giving the charge of each of these particles.

Particle	Charge
Electron	.....
Proton	.....
Neutron	.....

[1]

(ii) Electrons are arranged in shells around the outside of the atom.

Give the location of the other particles in the atom.

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

(iii) How many electrons, protons and neutrons are there in an atom of phosphorus?

Use the Data Sheet.

Electrons .....

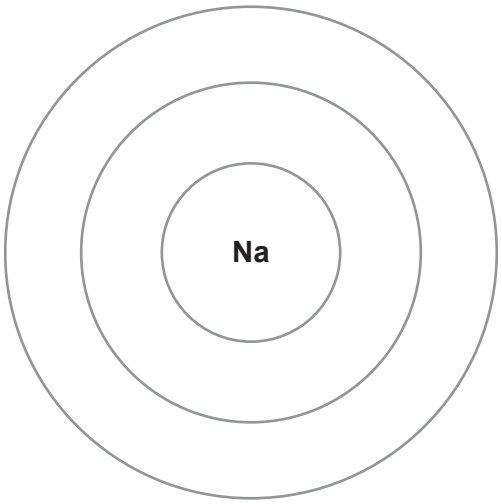
Protons .....

Neutrons .....

[2]

(c) Sodium is in Group 1 of the Periodic Table.

Complete the diagram to show the arrangement of electrons in a sodium atom.
Use the Data Sheet.



[2]

3 Crude oil is a mixture of hydrocarbons.

(a) How is crude oil separated into fractions?

Put a (ring) around the correct answer.

Cracking **Crystallisation** **Filtration** **Fractional distillation** **Titration**

[1]

(b) The fractions in crude oil are needed for fuels and other uses.

Some fractions are needed in larger amounts than other fractions.

The table gives information about the percentage of each fraction in crude oil and the percentage of each fraction needed. It also shows the number of carbon atoms in each fraction.

Fraction	Percentage in crude oil (%)	Percentage of fraction needed (%)	Number of carbon atoms in the fraction
Gas	2	4	1–4
Petrol	6	22	5–10
Naphtha	10	5	8–12
Paraffin	13	8	9–16
Diesel	19	23	15–25
Fuel oil	50	38	20–30

(i) Name **two** fractions where the percentage of fraction needed is greater than the percentage in crude oil.

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

(ii) Which **three** fractions in the table contain $C_{10}H_{22}$?

Put a (ring) around the correct answers.

Diesel **Fuel oil** **Gas** **Naphtha** **Paraffin** **Petrol**

[1]

(iii) A process is used to break down larger molecules into smaller molecules.

What is the name of this process?

Put a (ring) around the correct answer.

Cracking **Crystallisation** **Filtration** **Fractional distillation** **Titration**

[1]

(iv) The process in **(b)(iii)** is used to break down naphtha to make petrol.

Give **two** reasons why naphtha is broken down to make petrol.

Use data from the table to support your answer.

1 .....

.....

2 .....

.....

[2]

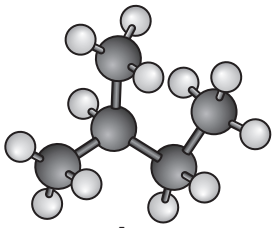
(v) A molecule with ten carbon atoms can be broken down into a molecule with eight carbon atoms and one other molecule.

Complete the symbol equation to show the formula of the other molecule formed.

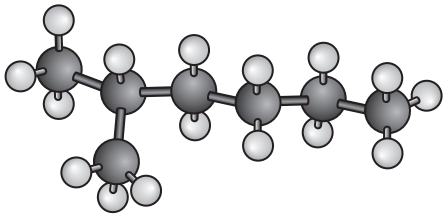
$C_{10}H_{22} \rightarrow C_8H_{18} +$ .....

[2]

(c) The diagrams show 3D models of the structures of five hydrocarbons in crude oil.



A



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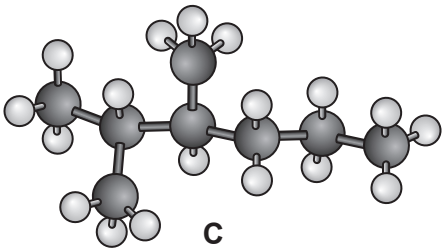

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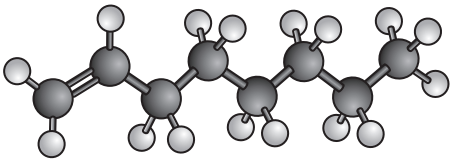
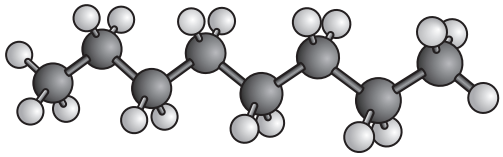


D



E

(i) Which **two** structures have the formula C_8H_{18}?

Tick (✓) **two** boxes.

A ☐

B ☐

C ☐

D ☐

E ☐

[2]

(ii) Which structure is an alkene?

Give **one** reason for your answer.

Structure .....

Reason .....

.....

[2]

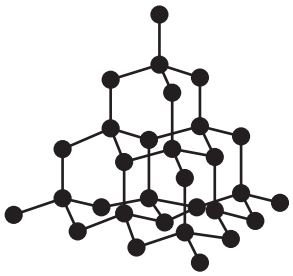
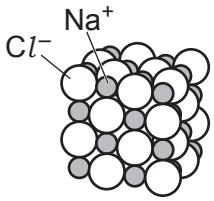
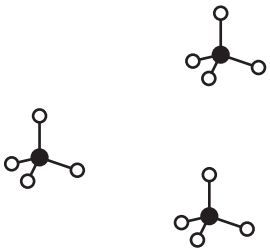
(d) Crude oil is a finite source of hydrocarbons.

Define **finite**.

.....

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

4 The table shows some information about diamond, sodium chloride and methane.

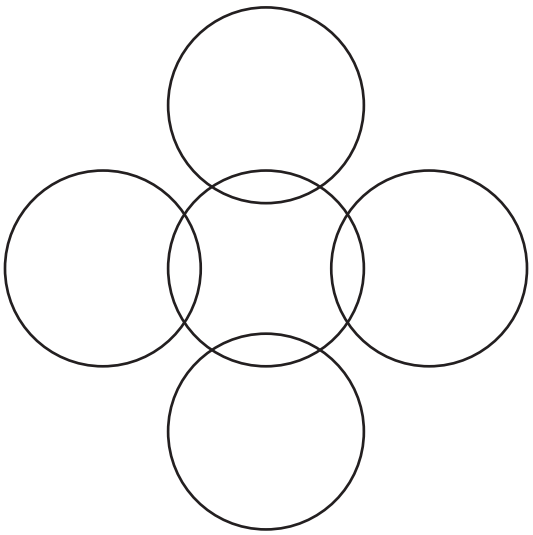
	Diamond	**Sodium chloride**	**Methane**
3D Structure			
Element or compound?	.....	.....	Compound
Type of bonding	.....	.....	Covalent
High or low boiling point?	High	.....	Low

(a) Complete the table. **[4]**

(b) Structures can also be shown by dot and cross diagrams.

(i) Complete the dot and cross diagram for methane.

Show outer electrons only, and label each atom.



[2]

(ii) Which features of a **methane** molecule are shown by a 3D structure and a dot and cross structure?

Tick (✓) **one** box in each row.

Feature	Shown only by 3D structure	Shown only by dot and cross structure	Shown by 3D structure and by dot and cross structure
Shape of molecule			
Number of bonds			
Number of electrons in bonds			

[3]

(c) Why does diamond have a much higher boiling point than methane?

Tick (✓) **two** boxes.

All bonds in diamond are strong. ☐

Bonds between atoms in methane are weak. ☐

Bonds in methane are ionic. ☐

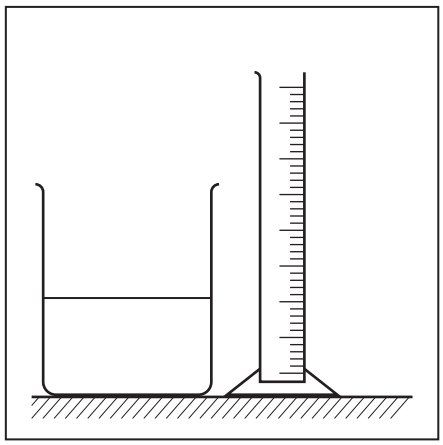
Covalent bonds are weak. ☐

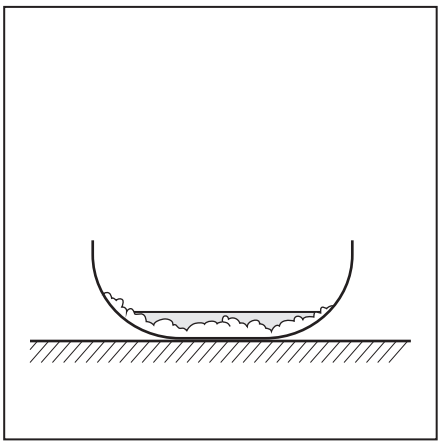
Forces between methane molecules are weak. ☐

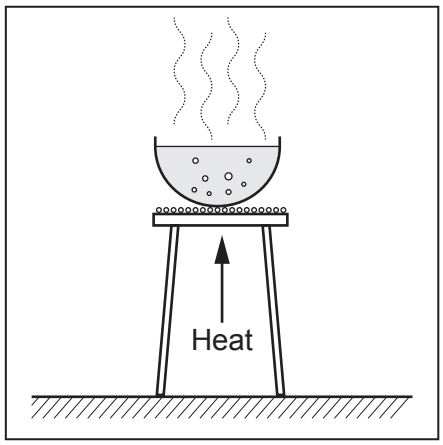
[2]

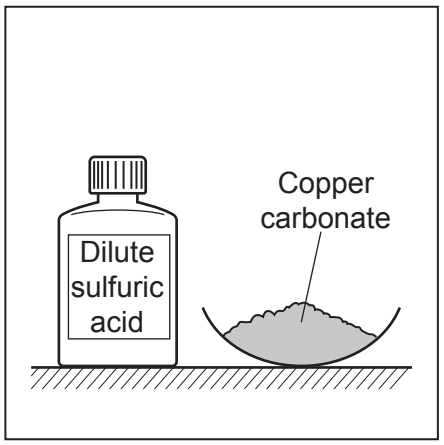
5* Kai makes some copper sulfate crystals. He uses solid copper carbonate and 20 cm^3 of dilute sulfuric acid.

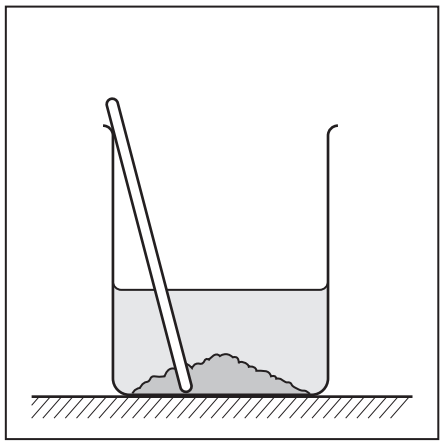
The pictures show some of the apparatus he uses. They are **not** in the correct order.

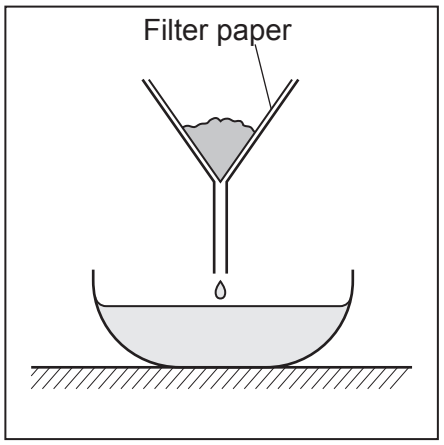












Describe how Kai produces a sample of dry copper sulfate crystals from solid copper carbonate and dilute sulfuric acid.

Use the apparatus in the pictures to support your answer.

.....

.....

.....

.....

.....

.....

.....

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.....

.....

..... **[6]**

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6 Sarah does an experiment. She adds small pieces of zinc to 50 cm^3 of 0.1 mol/dm^3 sulfuric acid.

She measures the volume of hydrogen gas collected every 30 seconds.

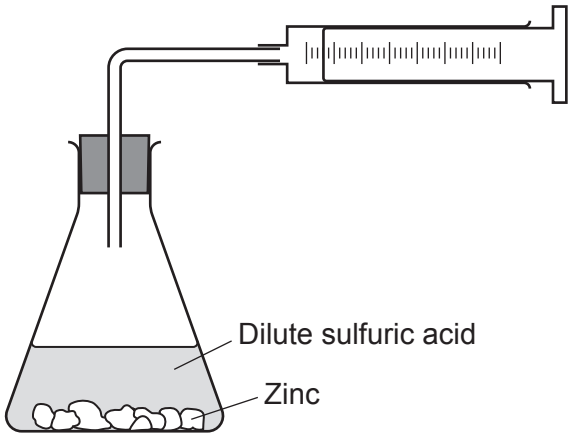


Fig. 6.1

(a) Sarah finds that the reaction is very slow.

Describe **two** ways in which Sarah could change her experiment to make the rate of reaction faster.

1 .....

2 .....

[2]

(b) Sarah plots a graph from her results, as shown in **Fig. 6.2**.

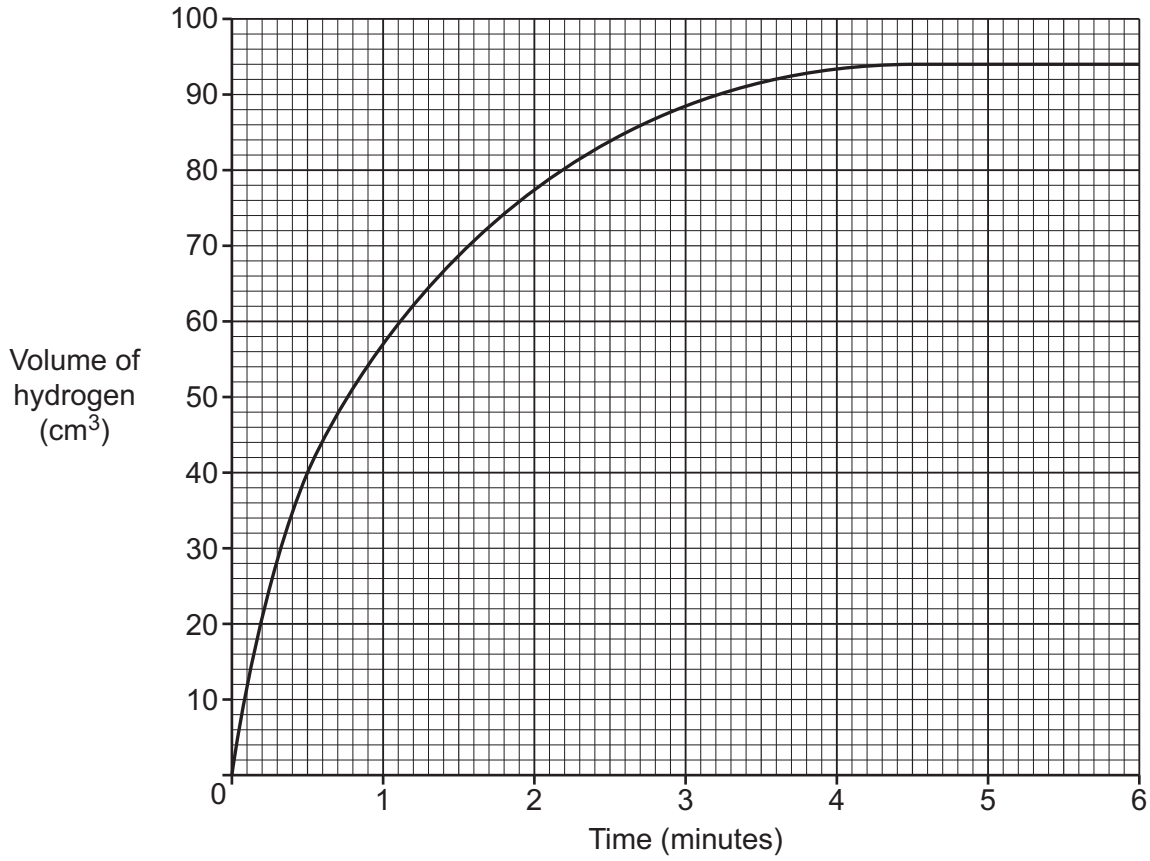


Fig. 6.2

(i) How many **seconds** does it take for 40 cm^3 of hydrogen to be collected?

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

(ii) What happens to the rate of the reaction during the first 4 minutes?

Tick (✓) **one** box.

It slows down ☐

It speeds up ☐

It stays constant ☐

[1]

(iii) What is the total volume of hydrogen collected after 4.5 minutes?

..... cm^3 **[1]**

(iv) Why does the graph level out after 4.5 minutes?

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

(c) Sarah repeats the experiment using 50 cm^3 of **0.05** mol / dm^3 sulfuric acid instead of 50 cm^3 of **0.1** mol / dm^3 sulfuric acid.

The table shows her results:

Time (minutes)	1	2	3	4	5	6
Volume of hydrogen (cm^3)	24	40	46	48	48	48

(i) Plot the results in the table on **Fig. 6.2 and** draw a line of best fit. **[2]**

(ii) What happens when she uses 50 cm^3 of 0.05 mol / dm^3 sulfuric acid instead of 50 cm^3 of 0.1 mol / dm^3 sulfuric acid?

Put a (ring) around the correct answers.

The rate of the reaction at the start is **faster** / **slower** / **the same**.

The total volume of hydrogen produced is **less** / **more** / **the same**.

[2]

7 Magnesium and sodium are reactive metals.

(a) Magnesium reacts very slowly with cold water.

(i) Write the balanced symbol equation for this reaction.

magnesium	+	water	→	magnesium oxide	+	hydrogen
.....	+	.....	→	.....	+	.....

[3]

(ii) How does the equation show that magnesium is **oxidised** in this reaction?

.....

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

(b) Sodium reacts quickly with cold water to form hydrogen gas and sodium hydroxide solution.

Sodium hydroxide solution is an alkali.

(i) What tests can be used to show that an alkali and hydrogen gas are formed?

Draw lines to connect each **product** with its correct **test**.

Product	**Test**
	Pops a lighted splint
Hydrogen gas	
	Relights a glowing splint
	Turns universal indicator blue
Alkali	
	Turns universal indicator red

[1]

(ii) Why does sodium react **more** quickly with cold water than magnesium?

.....

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

(c) Magnesium and sodium are extracted from their compounds by electrolysis.

Electrolysis does not work if ionic solids are used. The ionic solids must be melted before electrolysis.

(i) Explain why solid ionic compounds must be melted before electrolysis.

.....

.....

.....

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

(ii) Give the name of the product formed at each electrode when molten sodium chloride is electrolysed.

Positive electrode .....

Negative electrode .....

[1]

8 A medicine company makes tablets which contain magnesium hydroxide.

Jamal uses dilute hydrochloric acid in a titration to check the mass of magnesium hydroxide in one tablet.

(a) Magnesium hydroxide reacts with dilute hydrochloric acid to form a salt and water.

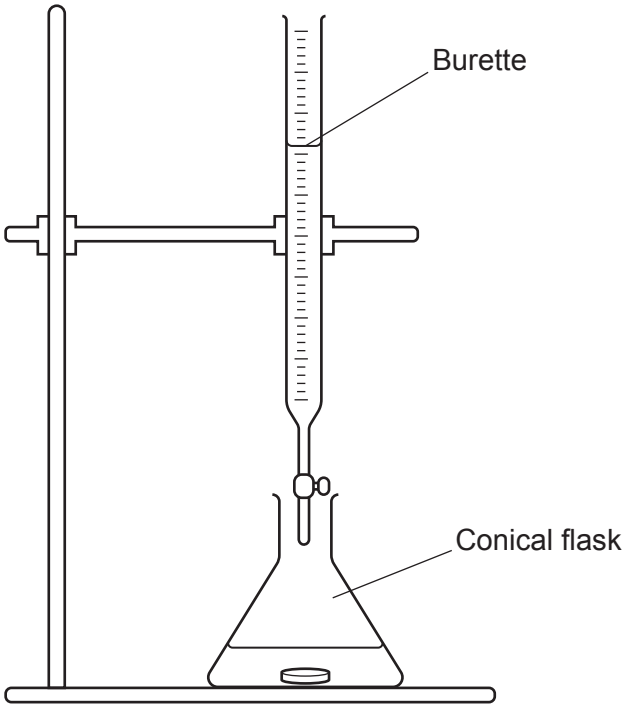
Complete the word equation for the reaction.

magnesium hydroxide + hydrochloric acid → ..... + water

.....

[1]

(b) Jamal adds water and indicator to one tablet in a conical flask. He then adds the acid to the conical flask from a burette until all of the magnesium hydroxide has reacted.



He uses the burette to find the volume of acid that reacts with the magnesium hydroxide in the tablet.

Describe **two** things that he needs to do to get an accurate value for this volume.

1 .....

.....

2 .....

.....

[2]

(c) Jamal uses his results to work out the mass of magnesium hydroxide in one tablet.

(i) Calculate the **relative formula mass** of magnesium hydroxide, $Mg(OH)_2$.

Use the Data Sheet.

Relative formula mass = ... **[2]**

(ii) Jamal finds that 10.2 cm^3 of acid reacts with one tablet.

He uses this formula to find the mass of magnesium hydroxide in one tablet:

Mass of magnesium hydroxide (mg) = volume of acid (cm^3) × relative formula mass of $Mg(OH)_2$

Calculate the mass of magnesium hydroxide in one tablet.

Use your answer to **(c)(i)**.

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

Mass of magnesium hydroxide = ... mg **[2]**

(d) The tablets are sold in packs of 100 tablets.

Jamal tests five tablets from three packs of tablets, **Pack A**, **Pack B** and **Pack C**.

Table 8.1 shows his results.

	Mass of magnesium hydroxide (mg)				
Tablet number	**1st**	**2nd**	**3rd**	**4th**	**5th**
Pack A	595	601	591	598	602
Pack B	601	609	603	611	607
Pack C	592	597	591	593	597

Table 8.1

Each tablet should contain a mass of 600 mg of magnesium hydroxide.

The required standard is that each tablet must be within 10 mg of this mass.

Complete **Table 8.2** by deciding if each pack meets the required standard.

Tick (✓) **one** box in each row.

	Meets standard	Does not meet standard
Pack A		
Pack B		
Pack C		

Table 8.2

[2]

(e) **(i)** Tablets are an example of a type of substance called a formulation.

Complete the sentences to describe a formulation.

Put a (ring) around the correct answers.

A formulation is a **mixture / single substance**.

Its composition is **fixed / variable**.

[1]

(ii) Which method can be used to show if a substance is pure or impure?

Tick (✓) **one** box.

Chromatography ☐

Combustion ☐

Measurement of pH ☐

Neutralisation ☐

[1]

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9 The table shows data about the composition of the Earth's atmosphere 4 billion years ago and today.

	Composition of gases in Earth's atmosphere (%)	
	4 billion years ago	**Today**
Carbon dioxide	20	0.04
Water	50	small
Nitrogen	3	78
Oxygen	0	21
Other gases	.....	small

(a) (i) Complete the table to show the approximate percentage of other gases in the atmosphere 4 billion years ago. **[1]**

(ii) Four billion years ago the Earth was extremely hot.

When the temperature of the Earth cooled to below 100 °C there was a large decrease in the amount of water vapour in the atmosphere.

Describe what happens when hot water vapour cools to below 100 °C.

Use ideas about arrangement and speed of particles in your answer.

.....

.....

.....

..... **[3]**

(b) How and why have the percentages of **carbon dioxide** and **oxygen** in the atmosphere changed over time?

Use data from the table to support your answer.

.....

.....

.....

.....

.....

..... **[3]**

(c) Some rocks are red because they contain iron oxide.

Iron oxide was formed when iron in the rocks reacted with oxygen in the atmosphere.

(i) Complete the **balanced symbol** equation for the reaction which produces iron oxide.

..... Fe + ... O_2 $\rightarrow$ $2Fe_2O_3$

[1]

(ii) Scientists think these red rocks formed 2.3 million years ago.

Suggest why these rocks could **not** form 4 billion years ago.

Use data from the table to support your answer.

.....

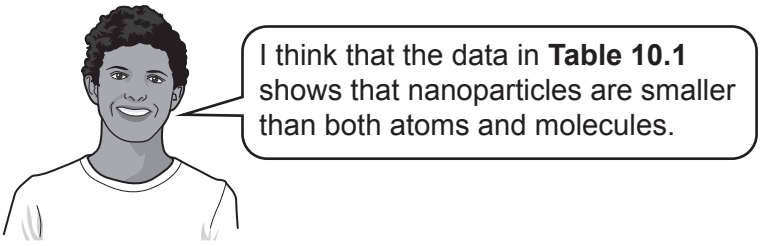
..... **[1]**

10 **Table 10.1** shows data about the sizes of some particles.

Particle	Approximate size (m)
Nanoparticles	between 1×10^{-9} and 1×10^{-7}
Hydrogen atom	1.06×10^{-10}
Oxygen atom	1.56×10^{-10}
Water molecule	2.75×10^{-10}
Carbon atom	1.54×10^{-10}
Polymer molecules	1.00×10^{-6}

Table 10.1

James comments on the data in **Table 10.1**.



(a) Discuss James' comment.

Use **Table 10.1** to support your answer.

.....

.....

.....

.....

.....

..... **[3]**

(b) **Table 10.2** shows information about the particles in some silver powders.

Type of powder	Size of particles (nm)	Surface area to volume ratio
Nanoparticles	50	0.12
Fine powder	5000	0.0012
Coarse powder	10 000	0.0006

Table 10.2

(i) Which type of powder in **Table 10.2** provides the biggest surface area for a given volume of silver?

Give **one** reason for your answer.

Type of powder .....

Reason .....

.....

[1]

(ii) James thinks that the data in **Table 10.2** gives this relationship.

surface area to volume ratio ∝ **size of particle**

Is James correct?

Yes ☐

No ☐

Explain your answer.

.....

.....

.....

.....

[2]

(c) The different ways that nanoparticles are used depends on their properties.

Draw lines to connect each **property** of nanoparticles with the **use** that depends on it.

Property	Use
Atoms arranged in balls	Carry medicines into the body
Atoms arranged in tubes	Catalysts
High surface area to volume ratio	Molecular sieves

[2]

(d) Nanoparticles are used as catalysts.

Which **two** statements explain how a catalyst increases the rate of a reaction?

Tick (✓) **two** boxes.

Catalysts decrease the activation energy of the reaction. ☐

Catalysts increase the energy change of the reaction. ☐

Catalysts increase the kinetic energy of the particles. ☐

Catalysts increase the temperature. ☐

Catalysts reduce the energy needed to break the bonds in the reactants. ☐

[2]

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).