OCR
Oxford Cambridge and RSA

F

Friday 19 November 2021 – Morning

GCSE (9–1) Chemistry A (Gateway Science)

J248/01 Paper 1 (Foundation Tier)

Time allowed: 1 hour 45 minutes

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

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

J248801

8991906135

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 **90**.
- 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 **28** pages.

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

DC (LK/JG) 300803/5

SECTION A

Answer **all** the questions.

You should spend a maximum of 30 minutes on this section.

Write your answer to each question in the box provided.

1 Which of these particles has a positive charge?

A Atom

B Electron

C Neutron

D Proton

Your answer ☐ **[1]**

2 Which change of state is described by the term **freezing**?

A Gas to liquid

B Liquid to gas

C Liquid to solid

D Solid to liquid

Your answer ☐ **[1]**

3 A student measures the pH of a solution and finds that the pH is 5.

Which of these statements is correct?

A The solution is a strong acid.

B The solution is a weak acid.

C The solution is alkaline.

D The solution is neutral.

Your answer ☐ **[1]**

4 Which statement describes a **chemical** change?

A Acid being neutralised

B Ice melting

C Salt dissolving in water

D Water boiling

Your answer ☐ **[1]**

5 What is the **mass number** of an atom?

A The total number of neutrons and electrons in an atom.

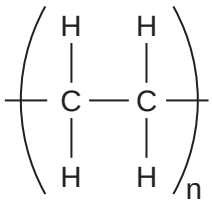
B The total number of protons and electrons in an atom.

C The total number of protons and neutrons in an atom.

D The total number of protons, neutrons and electrons in an atom.

Your answer ☐ **[1]**

6 The structure of poly(ethene) is shown.



Which type of structure does poly(ethene) have?

A Giant covalent

B Ionic

C Metal

D Polymer

Your answer ☐ **[1]**

7 Steel is a mixture of iron and carbon.

What is the name of this type of mixture?

A Alloy

B Ion

C Isotope

D Molecule

Your answer ☐ **[1]**

8 Fractional distillation is used to separate mixtures, such as crude oil.

Which statement about fractional distillation is correct?

A Fractional distillation causes a chemical change.

B Fractional distillation separates mixtures of solids.

C Fractions are separated based on their boiling point.

D The fractional distillation column is hottest at the top.

Your answer ☐ **[1]**

9 Which statement about the melting point of a substance is correct?

A A pure substance has a sharp melting point.

B A pure substance melts over a range of temperatures.

C The melting point of an impure substance is higher than a pure substance.

D The melting point of a pure substance is higher than the boiling point.

Your answer ☐ **[1]**

10 Which statement describes the bonding in **iron**?

A Cross-links between the chains are strong.

B Electrons are shared between atoms.

C Electrons are transferred between atoms, forming ions.

D Positive ions are surrounded by a "sea" of delocalised electrons.

Your answer ☐ **[1]**

11 The melting point of iodine is 114 °C. The boiling point of iodine is 184 °C.

What is the state of iodine at room temperature?

A Aqueous

B Gas

C Liquid

D Solid

Your answer ☐ **[1]**

12 Molten lead bromide, $PbBr_2$, is electrolysed.

Which substance is formed at the **cathode**?

A Bromine

B Hydrogen

C Lead

D Oxygen

Your answer ☐ **[1]**

13 Which substance has **covalent** bonding?

A Aluminium

B Carbon dioxide

C Magnesium

D Sodium chloride

Your answer ☐ **[1]**

14 Quantum dots are a type of nanoparticle. Quantum dots can have a diameter of 6 nm.

What is 6 nm in metres?

A 6×10^{-6} m

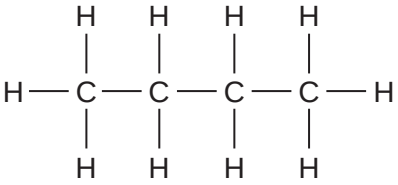
B 6×10^{-8} m

C 6×10^{-9} m

D 6×10^{-10} m

Your answer ☐ **[1]**

15 Butane is a hydrocarbon. The displayed formula of butane is shown.



What is the **empirical formula** of butane?

A CH

B CH_2

C C_2H_5

D C_4H_{10}

Your answer ☐ **[1]**

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

SECTION B

Answer **all** the questions.

16 A student investigates the reaction between acids and metals.

Table 16.1 shows the names and formulae of the acids and metals the student investigates.

Name	Formula
Zinc	Zn
Magnesium	.....
Nitric acid	HNO_3
Hydrochloric acid	.....

Table 16.1

(a) Complete **Table 16.1**. **[2]**

(b) Zinc reacts with nitric acid. Look at the balanced symbol equation for the reaction.

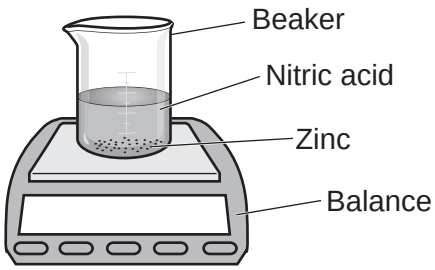
$Zn(s) + 2HNO_3(aq) \longrightarrow Zn(NO_3)_2(aq) + H_2(g)$

What physical state does (aq) represent?

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

(c) The student investigates the reaction between zinc metal and nitric acid.

The diagram shows the apparatus the student uses.



(i) The student uses the balance to record the change in mass during the reaction.

The mass **decreases**. Explain why.

.....

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

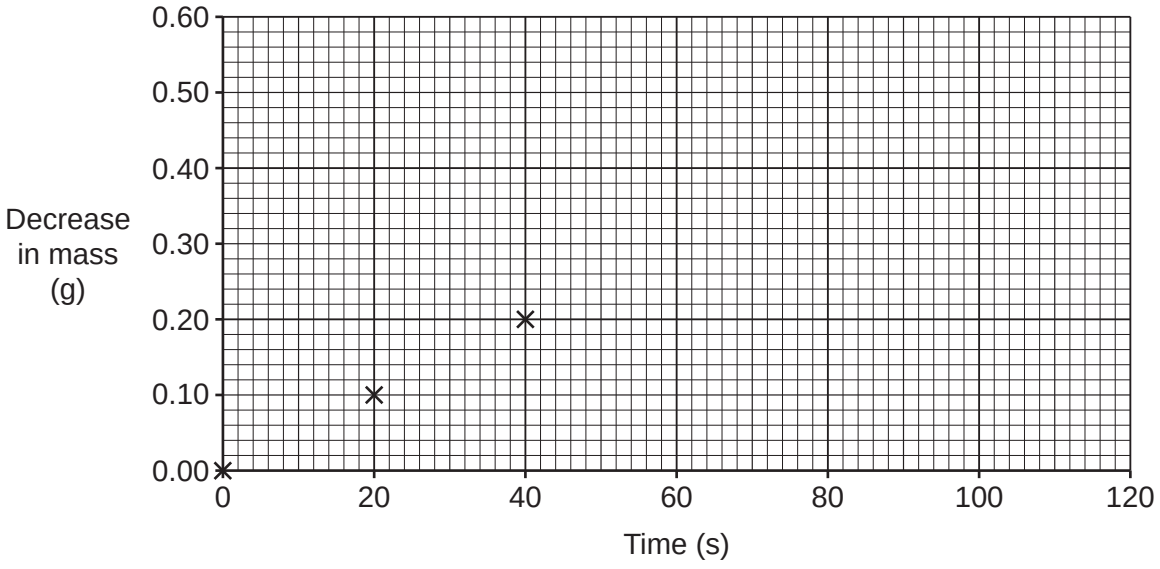
(ii) **Table 16.2** shows the student's results.

Time (s)	Decrease in mass (g)
0	0.00
20	0.10
40	0.20
80	0.40
100	0.50
120	0.60

Table 16.2

Plot the results from **Table 16.2** on the graph and draw a line of best fit.

The first three points have been plotted for you.



[2]

(iii) Use your graph to estimate the **decrease in mass** at 60 seconds.

Decrease in mass = ... g **[1]**

(d) The student does four experiments.

They record the decrease in mass after 120 seconds.

Table 16.3 shows their results.

	Experiment 1	**Experiment 2**	**Experiment 3**	**Experiment 4**
Decrease in mass after 120 seconds (g)	0.60	0.69	0.62	0.59

Table 16.3

(i) The student notices that one of the results is anomalous.

Put a (ring) around the anomalous result in **Table 16.3**. **[1]**

(ii) Calculate the **mean** decrease in mass of the experiments in **Table 16.3**. You should **not** include the anomalous result.

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

Mean decrease in mass = ... g **[3]**

17 Mendeleev developed an early version of the Periodic Table.

Mendeleev arranged the elements in order of increasing **relative atomic mass**.

He thought that some elements were in the wrong order. He swapped the position of these elements so that elements with similar properties were in the same group.

(a) Explain why some elements appeared to be in the wrong order, when arranged by **relative atomic mass**.

.....

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

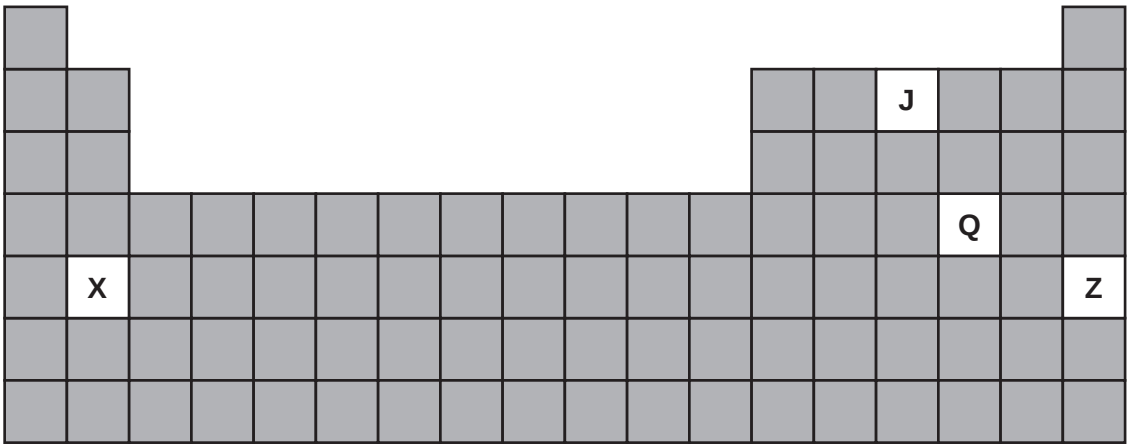
(b) Look at the Periodic Table provided on the data sheet.

Write down the symbols of **two** elements that are **not** arranged in order of increasing **relative atomic mass**.

1 .....

2 ..... **[1]**

(c) The diagram shows a simplified version of the modern Periodic Table. The letters, **J**, **Q**, **X** and **Z** are **not** the symbols for the elements shown.



(i) Which element, **J**, **Q**, **X**, or **Z**, is an unreactive gas with a full outer shell of electrons?

Tick (✓) **one** box.

J ☐

Q ☐

X ☐

Z ☐

Explain your answer.

.....

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

(ii) Which element, **J**, **Q**, **X** or **Z**, is a shiny element that forms positive ions?

Tick (✓) **one** box.

J ☐

Q ☐

X ☐

Z ☐

Explain your answer.

.....

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

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

18 A scientist uses thin layer chromatography to investigate some samples.

The scientist wants to check if the samples contain the same compounds.

(a) **Fig. 18.1** shows the apparatus the scientist uses.

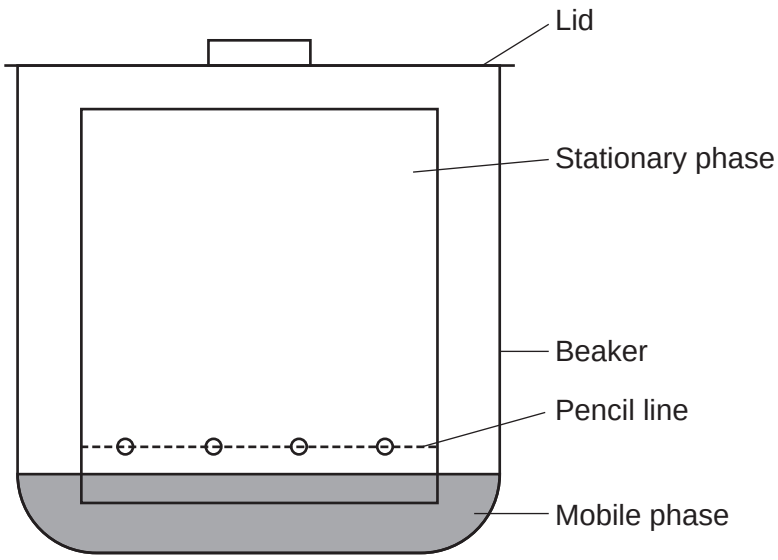


Fig. 18.1

(i) What could be used as the **mobile phase** in the experiment?

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

(ii) Why does the scientist put a lid on top of the beaker?

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

(b) **Fig. 18.2** shows the scientist's chromatogram.

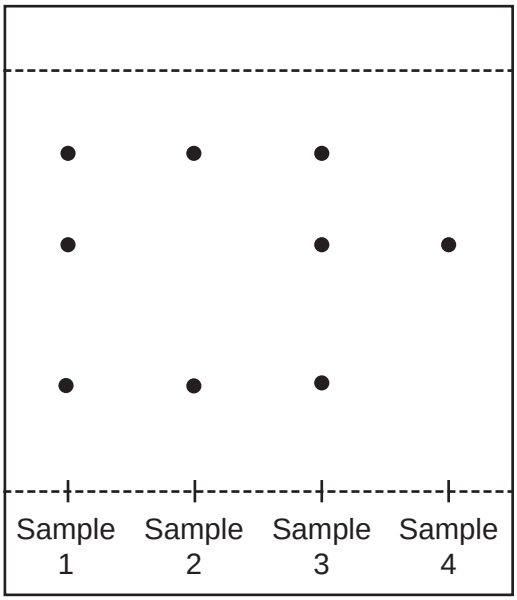


Fig. 18.2

The scientist thinks one of the samples is a **pure substance**.

(i) Is the scientist correct?

Explain your answer.

.....

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

(ii) Explain what is meant by a pure substance.

.....

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

(iii) Which **two** samples contain the same mixture of chemicals?

Tick (✓) **two** boxes.

Sample 1 ☐

Sample 2 ☐

Sample 3 ☐

Sample 4 ☐

[1]

(c) Another scientist is investigating the **formulation** of a medicine.

The scientist uses gas chromatography to calculate the amount of three compounds in the medicine.

The results are shown in the table.

	Active ingredient	**Lactose**	**Starch**
Mass (g)	0.50	0.45	0.16

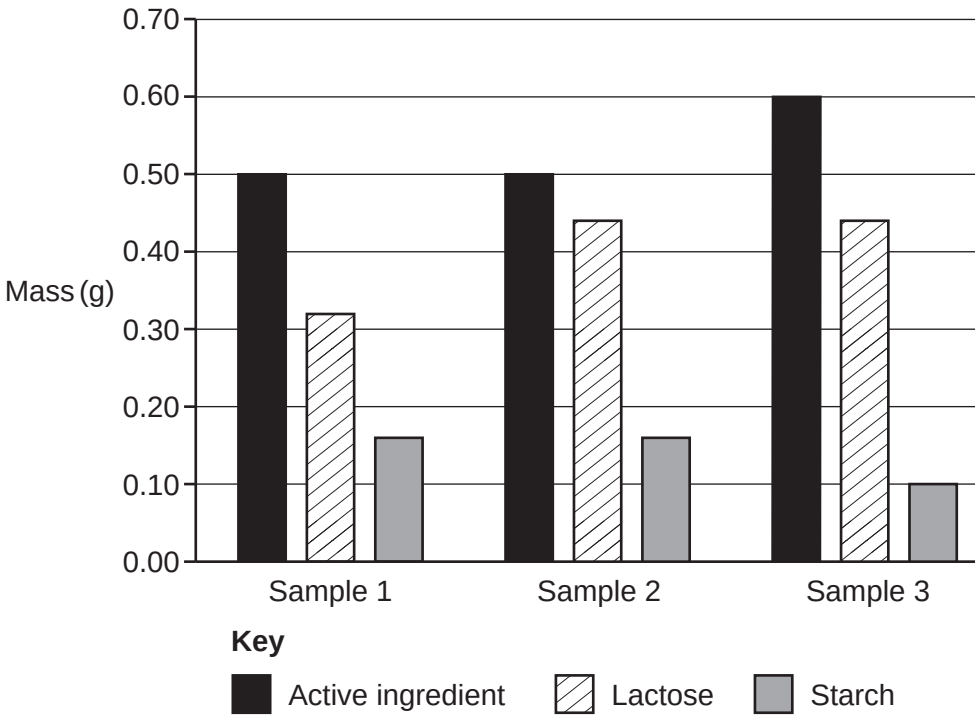
(i) Calculate the percentage of **lactose** in the medicine.

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

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

(ii) The scientist tests some samples to determine whether they have the same formulation as the medicine.

The graph shows their results.



Which sample has the same formulation as the medicine?

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

(iii) Why does the scientist use gas chromatography, instead of thin layer chromatography, in this investigation?

.....

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

19 Sodium hydroxide, NaOH, reacts with sulfuric acid, H_2SO_4, in a neutralisation reaction.

(a) **Table 19.1** shows the cations and anions in solutions of sodium hydroxide and sulfuric acid.

Solution	Cation	Anion
NaOH	Na^+	.....
H_2SO_4	.....	SO_4^-

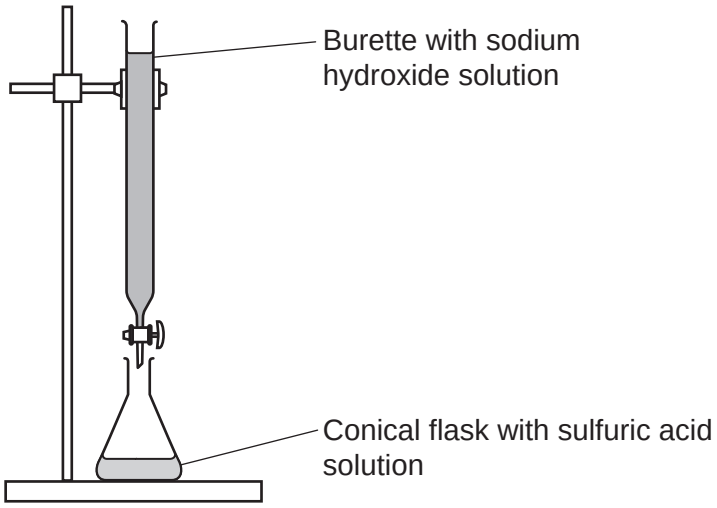
Table 19.1

Complete **Table 19.1** to show the **ions** in solutions of sodium hydroxide and sulfuric acid.

[2]

(b) A student investigates the neutralisation reaction.

The diagram shows the apparatus the student uses.



(i) The student repeats the experiment and stops the reaction at a neutral pH.

The student thinks the solution in the conical flask contains **more** hydrogen ions than hydroxide ions.

Is the student correct?

Explain your answer.

.....

.....

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

(ii) The student repeats the reaction and stops the reaction at a neutral pH.

Write down what you would see when taking the pH of a **neutral** solution, using a pH probe and universal indicator.

pH probe reading .....

Universal indicator ..... **[2]**

(c) When sodium hydroxide, NaOH, reacts with sulfuric acid, H_2SO_4, sodium sulfate, Na_2SO_4, and water are made.

Complete the **balanced symbol** equation for the reaction.

..... NaOH + H_2SO_4 $\rightarrow$ Na_2SO_4 + ...

[2]

(d) The student repeats the experiment using solutions of three different acids. **Table 19.2** shows their results.

The concentration of sodium hydroxide solution used is the same each time.

Solutions of acid	Volume of acid (cm^3)	Volume of sodium hydroxide solution added to get to neutral pH (cm^3)
X	25.0	12.2
Y	25.0	16.5
Z	25.0	24.2

Table 19.2

Which of the acid solutions, **X**, **Y** or **Z**, has the **lowest** pH at the start of the experiment?

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

20 Nanoparticles can be used as catalysts to speed up chemical reactions.

Some information about three nanoparticle catalysts is shown in the table.

Nanoparticle	Surface area to volume ratio	Length (nm)
A	5.0	22
B	0.5	13
C	2.5	48

(a) Which nanoparticle will be the best catalyst? Give a reason for your answer.

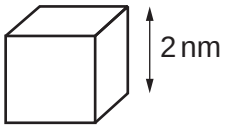
Nanoparticle .....

Reason .....

.....

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

(b) Another nanoparticle **D** is cube shaped. The sides are 2 nm in length.



D

(i) Calculate the **surface area** of nanoparticle **D**.

Surface area = ... nm^2 **[2]**

(ii) The volume of nanoparticle **D** is $8\,nm^3$.

Use your answer to question **(b)(i)** to calculate the surface area to volume ratio of nanoparticle **D**.

Use the equation, **ratio = surface area ÷ volume**.

Surface area to volume ratio of nanoparticle **D** = ... **[2]**

(c) It is possible to use nanoparticles to transport medication inside the body.

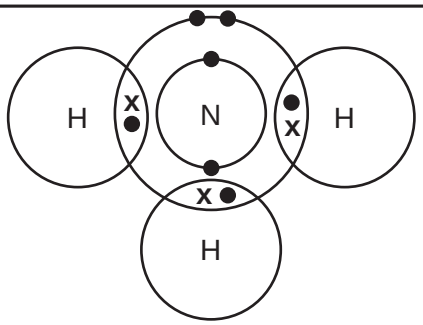
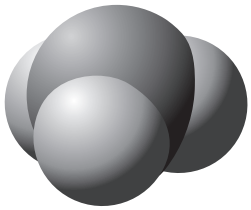
Explain why nanoparticles are not yet widely used for this purpose.

.....

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

21 Molecules can be shown using different diagrams or models.

The table shows a diagram and a model of ammonia, NH_3.

Molecule	Dot and cross diagram	3-D space filling model
Ammonia, NH_3		

(a)* Describe the **advantages** and **limitations** of these two different ways of showing a molecule of ammonia.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

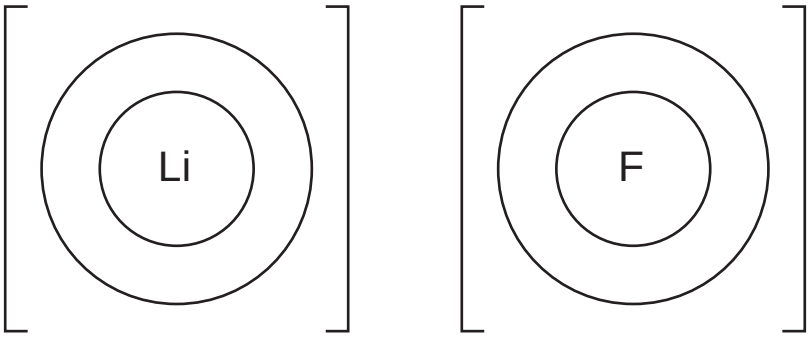
.....

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

(b) Dot and cross diagrams can also be used to show **ionic** compounds.

Lithium fluoride, LiF, is an ionic compound.

- The electronic structure of a lithium atom is 2.1.
- The electronic structure of a fluorine atom is 2.7.



Complete the dot and cross diagram to show the ions in lithium fluoride. **[2]**

(c) Lithium fluoride is a solid at room temperature.

Describe how particles are arranged in a solid.

.....

.....

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

(d) Which statements about lithium fluoride are correct?

Tick (✓) **two** boxes.

Lithium fluoride has weak intermolecular forces. ☐

Lithium fluoride can conduct electricity in the solid state. ☐

Lithium fluoride contains metal and non-metal elements. ☐

Lithium fluoride is a salt formed from lithium hydroxide and hydrofluoric acid. ☐

Lithium fluoride has a low melting point. ☐

[2]

22 The table shows carbon can exist as several different structures called allotropes.

Allotrope	Covalent bonds
Diamond	.....
Graphite	.....
Graphene	3

(a) Complete the table to show how many covalent bonds carbon forms in these allotropes. **[2]**

(b) **(i)** Diamond can be used as a cutting tool because it is so hard.

Explain why diamond is so hard.

Use ideas about structure and bonding in diamond in your answer.

.....

.....

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

(ii) Graphite can be used as a lubricant because it is slippery.

Explain why graphite is slippery.

Use ideas about structure and bonding in graphite in your answer.

.....

.....

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

(c) Explain why carbon forms many other compounds. Use ideas about the bonding in carbon compounds in your answer.

.....

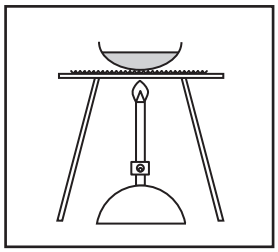
.....

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

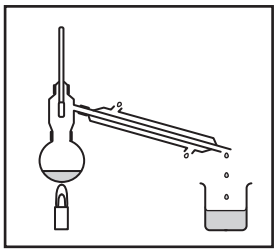
23 The table shows information about some properties of four substances.

Substance	Melting point (°C)	Boiling point (°C)	Solubility in water	Does the substance conduct electricity?
M	−98	65	Soluble	No
N	−114	78	Soluble	No
O	661	1304	Soluble	Only when molten or dissolved
P	1085	2562	Insoluble	Yes

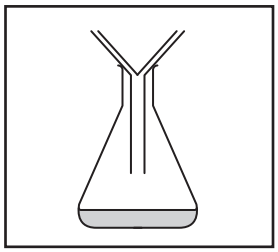
(a) Which diagram shows the apparatus that should be used to separate a mixture of substance **M** and substance **N**? Tick (✓) **one** box.



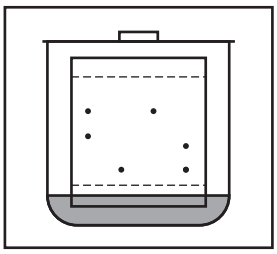
☐



☐



☐



☐

[1]

(b) **(i)** Describe a method that could be used to separate a mixture of substance **O** and substance **P** to obtain pure samples.

.....

.....

.....

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

(ii) A student separates substance **O** from a mixture.

They start with 6.2 g of the mixture and obtain 2.6 g of pure substance **O**.

Calculate the mass of pure substance **O** that could be separated from 10.0 g of the mixture.

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

Mass of pure substance **O** = ... g **[3]**

(c) Draw lines to connect each substance with its correct type of structure and bonding.

Substance M	Giant Covalent
Substance O	Ionic
Substance P	Metallic
	Polymer
	Simple Covalent

[3]

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).