OCR
Oxford Cambridge and RSA

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Friday 27 May 2022 – Morning

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

J248/03 Paper 3 (Higher 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

J248603

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 the 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 **24** pages.

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

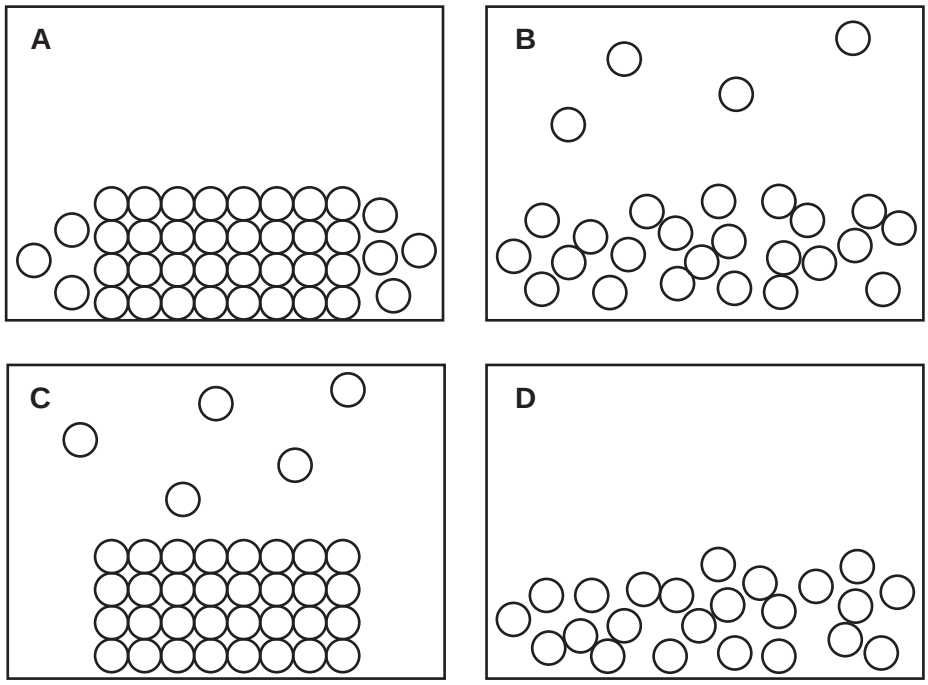
SECTION A

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 particle model diagram shows evaporation?



Your answer ☐ **[1]**

2 The radius of a helium atom is 0.14 nm.

What is the radius of a helium atom in metres?

A 0.14×10^{-10} m

B 1.4×10^{-10} m

C 1.4×10^{-9} m

D 14×10^{-9} m

Your answer ☐ **[1]**

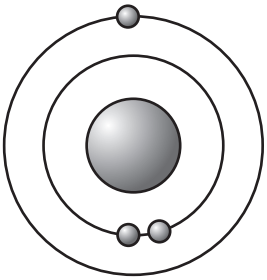
3 A Group 1 element reacts with a Group 7 element, so that both elements have a full outer shell of electrons. The table shows what happens to both elements during the reaction.

	Group 1 element	Group 7 element
A	gains 1 electron	loses 1 electron
B	gains 2 electrons	loses 2 electrons
C	loses 1 electron	gains 1 electron
D	loses 2 electrons	gains 2 electrons

Which row is correct?

Your answer ☐ **[1]**

4 The diagram of an atom shows that electrons occupy shells around the nucleus.



Which scientist proposed this atomic model?

A Bohr

B Dalton

C J. J. Thomson

D Mendeleev

Your answer ☐ **[1]**

5 What is an oxidising agent?

A A species that causes oxidation but does not get oxidised or reduced itself.

B A species that is oxidised and reduced.

C A species that is oxidised, while another species in the reaction is reduced.

D A species that is reduced, while another species in the reaction is oxidised.

Your answer ☐ **[1]**

6 Which statement about carbon allotropes is correct?

A Buckminsterfullerene is a type of carbon nanotube.

B Carbon atoms in diamond and graphite form 4 covalent bonds.

C Graphene and graphite both have carbon atoms arranged in layers.

D Strong covalent bonds cause diamond to have a high melting point.

Your answer ☐ **[1]**

7 A student wants to separate substances by filtration.

They write a method for the experiment but **not** in the correct order as shown.

1. Pour the mixture through the funnel into the conical flask.
2. Fold the filter paper.
3. Collect the filtrate in the conical flask.
4. Put the filter paper into the funnel.
5. Collect any insoluble substances on the filter paper.

What is the correct method order for this experiment?

A 1, 2, 4, 5, 3

B 2, 1, 4, 5, 3

C 2, 4, 1, 5, 3

D 4, 2, 5, 3, 1

Your answer ☐ **[1]**

8 Molten sodium chloride can be electrolysed.

What is the correct half equation for the reaction at the negative electrode (cathode)?

A $2Cl^- - 2e^- \longrightarrow Cl_2$

B $2H^+ + 2e^- \longrightarrow H_2$

C $Na^+ + e^- \longrightarrow Na$

D $4OH^- - e^- \longrightarrow O_2 + 2H_2O$

Your answer ☐ **[1]**

9 One mole of hydrogen gas, H_2, fills a volume of 24 dm^3.

How much volume does 2.0 g of hydrogen gas fill?

A 12 dm^3

B 24 dm^3

C 36 dm^3

D 48 dm^3

Your answer ☐ **[1]**

10 Why do some polymers have different flexibilities?

A They are more flexible because they contain covalent bonds.

B They are more flexible as they do not have strong cross-links.

C They are more rigid because they contain ionic bonds.

D They are more rigid because they have weak intermolecular forces.

Your answer ☐ **[1]**

11 A student investigates an endothermic reaction. Their results are shown in the table.

	Temperature	Bond energies
A	increases	less energy is needed to break bonds in reactants than is needed to make bonds in products
B	increases	more energy is needed to break bonds in reactants than is needed to make bonds in products
C	decreases	less energy is needed to break bonds in reactants than is needed to make bonds in products
D	decreases	more energy is needed to break bonds in reactants than is needed to make bonds in products

Which statement is correct for an endothermic reaction?

Your answer ☐ **[1]**

12 A scientist investigates the melting point of some substances that may contain paracetamol as shown in the table.

The melting point of pure paracetamol is 169 °C.

Substance	Melting point (°C)
1	169
2	156
3	166 – 169
4	170 – 174

Which statement about the results is correct?

A All of the substances contain paracetamol.

B Substance 2 does not contain paracetamol.

C Substance 3 is pure paracetamol.

D Substance 4 is impure paracetamol.

Your answer ☐ **[1]**

13 A sample of propanoic acid, $C_3H_6O_2$, is made using an isotope of hydrogen, called deuterium.

The relative atomic mass of deuterium is 2.0.

What is the relative molecular mass, M_r, of propanoic acid when deuterium atoms replace all the hydrogen atoms?

A 68.0

B 74.0

C 80.0

D 86.0

Your answer ☐ **[1]**

14 Which statement about the bonding in magnesium oxide is correct?

A There are strong covalent bonds between atoms.

B There are strong covalent bonds between ions.

C There are strong electrostatic forces between atoms.

D There are strong electrostatic forces between ions.

Your answer ☐ **[1]**

15 An alloy that contains silver, copper and tin has 96% tin and 2.5% copper. The rest is silver.

What is the mass of silver in 12.0 g of the alloy?

A 0.18 g

B 0.3 g

C 1.8 g

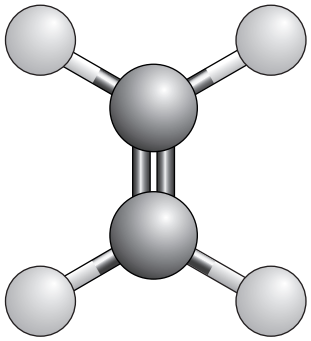
D 3.0 g

Your answer ☐ **[1]**

SECTION B

Answer **all** the questions.

16 The diagram shows a ball and stick model for ethene, C_2H_4.



(a) Which statements about this ball and stick model of ethene are correct?

Tick (✓) **two** boxes.

The model shows how many electrons the carbon atoms have. ☐

The model shows how many electrons the hydrogen atoms have. ☐

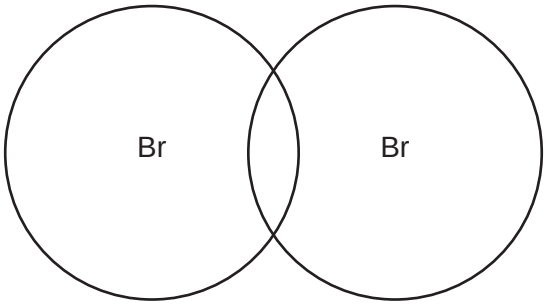
The model shows how much space each atom fills. ☐

The model shows that the carbon atoms are bigger than the hydrogen atoms. ☐

The model shows the difference between double bonds and single bonds. ☐

[2]

(b) Molecules can be drawn using dot and cross diagrams.



Complete the dot and cross diagram for bromine, Br_2.

Show the electrons in the outer shells only.

[2]

(c) At room temperature, ethene is a gas and bromine is a liquid.

Use the particle model to describe **two** differences between the movement or arrangement of the particles in ethene and the particles in bromine.

1 .....

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2 .....

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[2]

(d) Ethene reacts with bromine to make a product.

The relative formula mass of the product is 187.8.

There are **2** carbon atoms and **4** hydrogen atoms in the product.

Calculate how many bromine atoms are in the product.

Number of bromine atoms = ... **[3]**

17 A student has a sample of a **liquid**.

(a) (i) State a method the student uses to find out if the sample is **pure**.

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

(ii) The student finds out that the sample is **impure**.

The sample contains hexane, C_6H_{14}, and cyclohexane, C_6H_{12}.

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

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

(iii) The boiling point of hexane is lower than the boiling point of cyclohexane.

Describe a method the student could use to obtain a sample of **pure** hexane from the mixture of cyclohexane and hexane.

You can include a labelled diagram in your answer.

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..... **[4]**

(b) (i) The student obtains 12.0 g of hexane from 15.2 g of the mixture of hexane and cyclohexane.

Calculate the percentage of hexane obtained.

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

Percentage of hexane = ... % **[2]**

(ii) Hexane reacts with oxygen in a combustion reaction.

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

2 C_6H_{14} + ...O_2 → .....CO_2 + ...H_2O

[1]

18 A scientist investigates three solutions, **A**, **B** and **C**. They want to find out if the solutions are acids or alkalis. They don't have any universal indicator or a pH probe.

- In test 1, they try to neutralise the solutions by adding 25 cm^3 of dilute hydrochloric acid to 25 cm^3 of each solution.
- In test 2, they add 1.0 g of magnesium carbonate to 25 cm^3 of each solution.

The table shows the scientist's observations.

	Observation after test 1	**Observation after test 2**
solution **A**	salt formed	no change
solution **B**	no salt formed	vigorous bubbling
solution **C**	no salt formed	bubbling

(a)* Use the observations from both test 1 and test 2 to state which solutions are acids and which solutions are alkalis.

Explain your answer.

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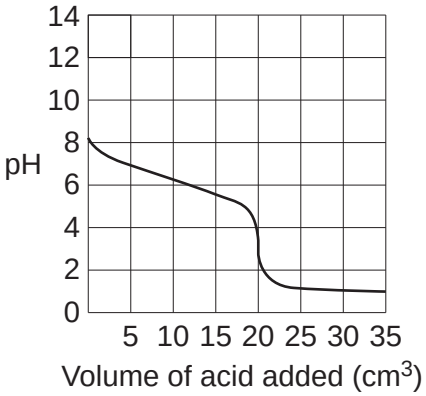
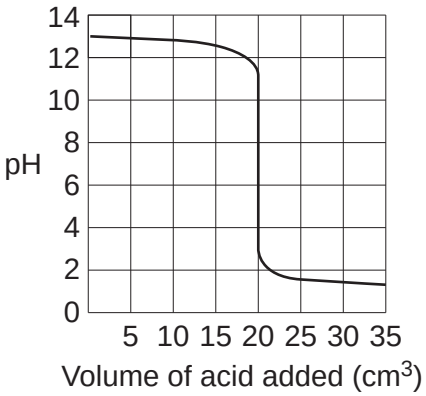
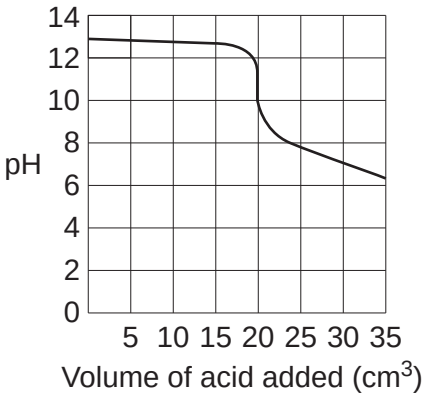
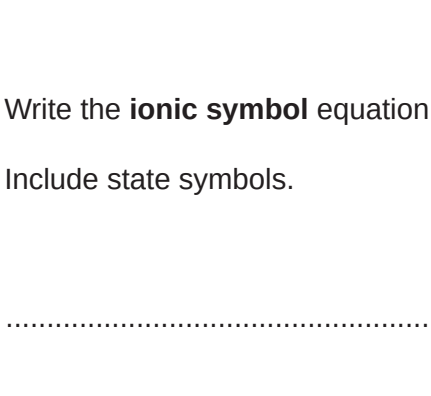
..... **[6]**

(b) The graphs show the titration curves for three different experiments.

Draw **three** lines to connect each **titration curve** with its correct **description**.

Titration curve	Description
	Strong acid added to strong alkali
	Weak acid added to strong alkali
	Strong acid added to weak alkali
	Weak acid added to weak alkali

[3]

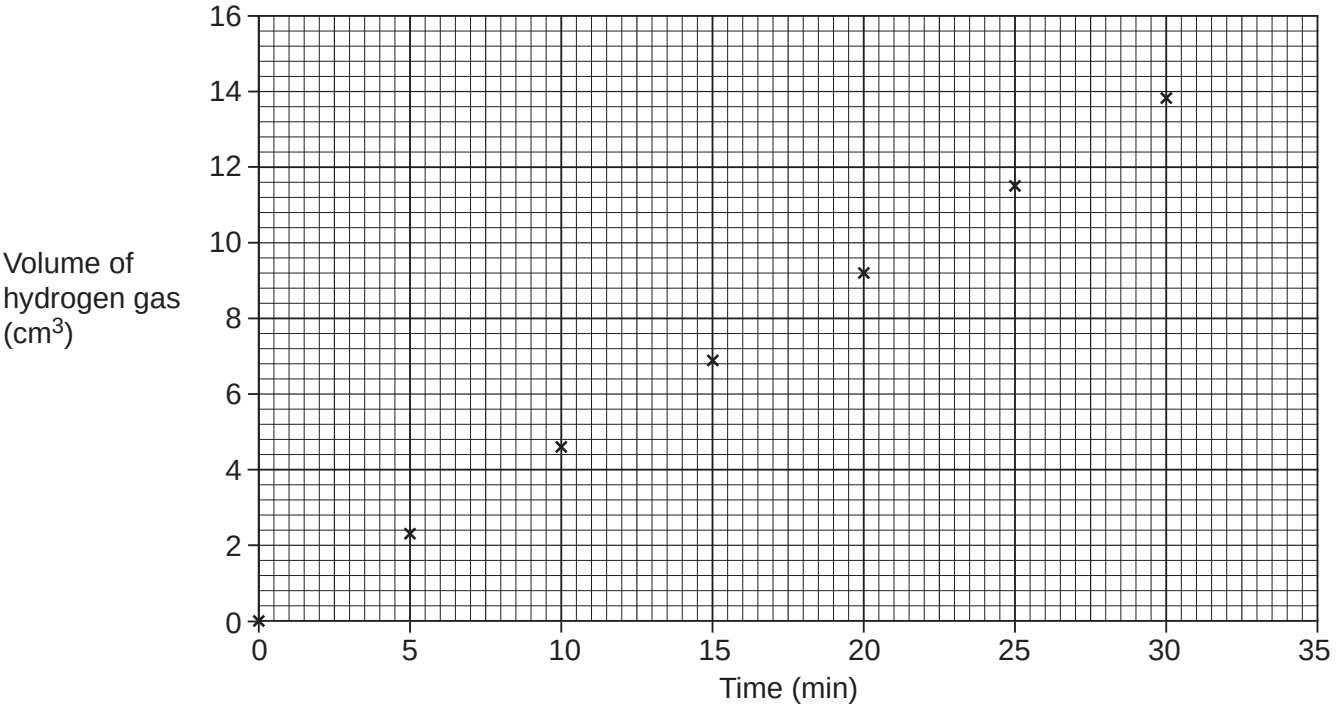
(c) Write the **ionic symbol** equation for a neutralisation reaction.

Include state symbols.

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

19 A teacher sets up an experiment to investigate the electrolysis of aqueous sodium chloride, NaC*l*.
The teacher measures the volume of hydrogen gas given off.

The teacher plots the results on a graph.



(a) (i) Draw a line of best fit on the graph. **[1]**

(ii) What is the volume of hydrogen gas given off after 23 minutes?

Volume of hydrogen gas = ... cm^3 **[1]**

(iii) Which electrode is hydrogen gas given off at?

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

(iv) State the name of the product made at the other electrode.

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

(b) A student repeats the teacher's experiment with aqueous copper sulfate, $CuSO_4$.
The student finds that **no** hydrogen gas is given off.

Explain why hydrogen gas is given off in the electrolysis of aqueous NaC*l*, but **not** in the electrolysis of aqueous $CuSO_4$.

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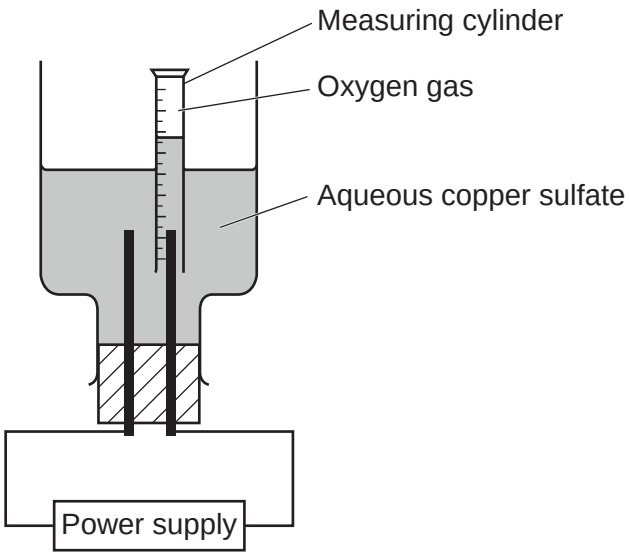
..... **[3]**

(c) In the electrolysis of aqueous copper sulfate, copper is also made.

The teacher sets up an experiment to measure the volume of oxygen gas made.



Explain how the student could change the experiment to measure the amount of copper formed.

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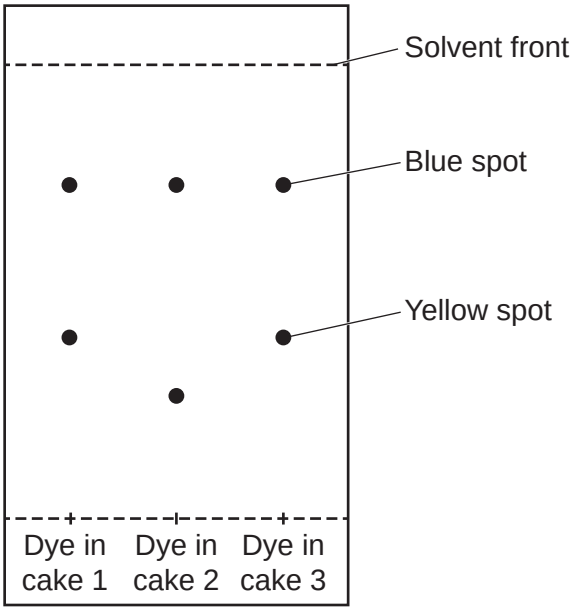
..... **[3]**

20 Three cakes each contain a different brand of food colouring dye.

- The colour is the same in each cake, but the taste in one is different.
- The cakes' baker thinks it is because of the food colouring dye.

(a) The baker compares the food colouring dyes that were used in the three different cakes using thin layer chromatography. The chromatogram is shown in **Fig. 20.1**.

Fig. 20.1



(i) Calculate the R_f value of the blue spot in the dye in cake 3.

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

R_f value of blue spot in the dye in cake 3 = ... **[3]**

(ii) Which of the cakes would you expect to taste the same?

Explain your answer using data from **Fig. 20.1**.

.....

.....

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

(b) The baker thinks the dyes are mixtures where the substances are combined in exact amounts.

(i) What is the name given to this type of mixture?

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

(ii) Brass is also a mixture of different substances combined in exact amounts.

What type of substance is brass?

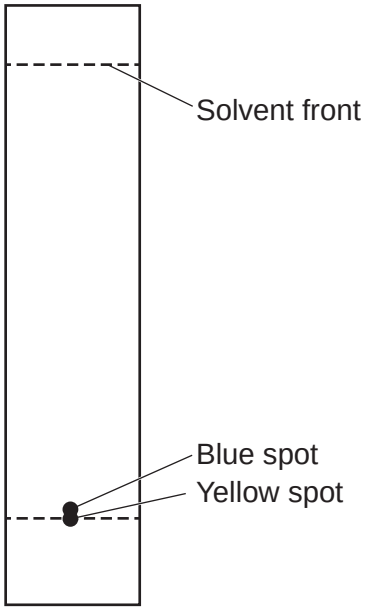
Tick (✓) **one** box.

Allotrope	☐
Alloy	☐
Fullerene	☐
Isotope	☐
Polymer	☐

[1]

(c) The student tests another dye. The chromatogram is shown in **Fig. 20.2**.

Fig. 20.2



What should the student change in their experiment to separate the blue and yellow spots?

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

21 Phosphorus can exist as P_4 molecules.

Phosphorus trichloride, PCl_3, is made in the reaction of phosphorus, P_4, and chlorine as shown in the equation.

$$P_4 + 6Cl_2 \rightarrow 4PCl_3$$

(a) (i) A scientist starts the reaction with 2.0 mol of phosphorus, P_4.

Calculate the mass of 2.0 mol of phosphorus.

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

(ii) Calculate the maximum mass of phosphorus trichloride, PCl_3, that could be made from 2.0 mol of phosphorus, P_4.

Maximum mass of phosphorus trichloride = ... g **[3]**

(iii) The scientist reacts the 2.0 mol of phosphorus, P_4, with 866.2 g of chlorine, Cl_2.

Which is the **limiting reactant**? Explain your answer.

Limiting reactant .....

Explanation .....

.....

.....

.....

[4]

(b) Some information about phosphorus compounds is shown in the table.

Name	Formula	Melting point (°C)	Boiling point (°C)	State at room temperature
Phosphorus trichloride	PCl_3	–94	76	.....
Phosphorus pentachloride	PCl_5	161	167	.....
Phosphorus trifluoride	PF_3	–152	–102	.....

(i) Complete the table. **[2]**

(ii) Put a (ring) around the compound with the weakest intermolecular forces.

Phosphorus trichloride

Phosphorus pentachloride

Phosphorus trifluoride

Explain your answer using information from the table.

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.....

.....

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

(iii) The scientist thinks phosphorus trichloride is a **giant covalent** compound.

Explain why the scientist is incorrect.

.....

.....

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

22 Compounds that contain the element zinc, Zn, have many uses.

(a) Calculate the mass of one atom of zinc.

The Avogadro constant is 6.02×10^{-23}.

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

Mass of one atom of zinc = ... g **[3]**

(b) Zinc bromide is an ionic compound made from zinc ions, Zn^{2+}, and bromide ions, Br^{-}.

(i) Construct a **balanced ionic** equation for the formation of zinc bromide.

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

(ii) Zinc bromide can conduct electricity when aqueous or molten, but not when solid.

Zinc metal can conduct electricity when solid.

Explain why.

Zinc bromide .....

.....

Zinc metal .....

.....

[3]

(c) Zinc oxide, ZnO, is another compound containing zinc.

The table shows some information about four different zinc oxide particles.

Particle	Size of zinc oxide particles (m)	Cost per gram (£/g)	Purity (%)
A	1.85×10^{-7}	0.05	95.00
B	6.54×10^{-9}	0.31	99.99
C	8.52×10^{-7}	0.87	99.99
D	4.02×10^{-8}	1.84	99.99

(i) Which particles are nanoparticles?

Tick (✓) **two** boxes.

A ☐

B ☐

C ☐

D ☐

[1]

(ii) A scientist wants to buy some zinc oxide particles to use in suncream. A large surface area to volume ratio is important.

Which particle, **A**, **B**, **C** or **D**, would be the most suitable for use in suncream?

Explain your answer.

Particle .....

Explanation .....

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.....

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[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).