

Answer **all** the questions.

1 The answer to each part of this question is a number.

(a) (i) How many neutrons are there in an atom of chlorine-37?

..... [1]

(ii) How many electrons are needed to fill one orbital?

..... [1]

(iii) How many electrons are there in the 3p sub-shell of a chlorine atom?

..... [1]

(b) (i) Calculate the relative atomic mass of a sample of gallium containing 60% ^{69}Ga and 40% ^{71}Ga . Give your answer to **three** significant figures.

[1]

(ii) Calculate the relative formula mass of $(\text{NH}_4)_2\text{CO}_3$.

[1]

(iii) Calculate the number of grams of NaNO_3 in 200 cm^3 of a 0.250 mol dm^{-3} solution.

[2]

(iv) Calculate the number of molecules in 100 cm^3 of SO_2 gas at room temperature and pressure.

1.00 mol of SO_2 molecules occupies 24.0 dm^3 at room temperature and pressure.
 $L = 6.02 \times 10^{23}\text{ mol}^{-1}$.

[1]

(c) Determine the oxidation number of chlorine in NaClO_4 .

..... [1]

[Total: 9]

2 Element **A** is in **Period 3**, Na–Ar, of the Periodic Table.

Some of the successive ionisation energies of element **A** are shown below.

ionisation energy/kJ mol ⁻¹						
1st	2nd	3rd	4th	5th	6th	7th
789	1577	3232	4356	16 091	19 785	23 787

(a) Define the term *first ionisation energy*.

.....

 [3]

(b) Identify element **A** from the elements in Period 3, Na–Ar.

Explain how you decided on your answer.

element **A**:
 explanation:

 [3]

(c) Elements in the same **group** in the Periodic Table have different ionisation energies.

Explain why there is a trend in first ionisation energies for elements in the same group.

.....

 [3]

[Total: 9]

- 3 Calcium chloride, CaCl_2 , is used for dust control on roads and in car parks.

Calcium chloride is made up of Ca^{2+} and Cl^- ions.

- (a) Complete the table below.

species	protons	electrons
Ca^{2+}		
Cl^-		

[2]

- (b) Draw a 'dot-and-cross' diagram of CaCl_2 . Show outer electron shells only.

[2]

- (c) Solid calcium chloride does **not** conduct electricity. An aqueous solution of calcium chloride does conduct.

Explain the different conductivities of solid and aqueous calcium chloride.

.....

.....

.....

..... [2]

- (d) Calcium chloride can be made by reacting limestone with hydrochloric acid.



In the laboratory, a student carries out this reaction using 4.85 g CaCO_3 and 1.50 mol dm^{-3} HCl . She then evaporates water from the solution to obtain solid CaCl_2 .

- (i) How many moles of CaCO_3 were reacted?

answer =mol [2]

- (ii) What mass of CaCl_2 is formed by the reaction of 4.85 g of CaCO_3 ?

answer = g [1]

- (iii) Calculate the volume, in cm^3 , of 1.50 mol dm^{-3} HCl that reacts with 4.85 g of CaCO_3 .

answer = cm^3 [2]

- (e) Choose another chemical that could be reacted with hydrochloric acid to make calcium chloride.

Write a balanced equation for the reaction.

..... [2]

- (f) Compound **B** is a calcium compound used in making paper. Compound **B** is manufactured by passing SO_2 gas through a solution of calcium hydroxide.

Compound **B** has the following percentage composition by mass:

Ca, 19.82%; H, 0.99%; S, 31.74%; O, 47.45%.

- (i) Determine the empirical formula for compound **B**.

[2]

- (ii) Construct a balanced equation for the manufacture of compound **B** from calcium hydroxide by this method.

..... [1]

[Total: 16]

- 4 The boiling points of the halogens chlorine, bromine and iodine are shown below.

halogen	boiling point/°C
chlorine	–35
bromine	59
iodine	184

- (a) Explain this trend in the boiling points of the halogens.

.....

.....

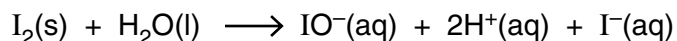
.....

.....

.....

..... [3]

- (b) Iodine reacts with water as shown below.



Determine the changes in oxidation number of iodine in this reaction and comment on your answers.

.....

.....

.....

.....

..... [3]

(c) A student carries out the following investigation.

- **Step 1:** The student adds an excess of chlorine gas to an aqueous solution of potassium bromide.
- **Step 2:** The student adds aqueous silver nitrate to the resulting solution.

(i) In **step 1**, what would the student observe?

Write an ionic equation for the reaction that takes place.

observation:

ionic equation: [2]

(ii) For **step 2**, write an ionic equation, including state symbols, for the reaction that takes place.

..... [2]

(d) Many covalent compounds of the halogens, such as CCl_4 , have polar bonds. Polarity can be explained in terms of electronegativity.

(i) Explain what is meant by the term *electronegativity*.

.....

 [2]

(ii) Molecules of the covalent compound CCl_4 have polar bonds.

Draw a diagram to show the shape of a molecule of CCl_4 .

On your diagram, show the polarity of the bonds.

[2]

(iii) A molecule of CCl_4 is non-polar. Explain why.

.....
 [1]

[Total: 15]

substance	magnesium	diamond	ice
electrical conductivity of solid	good	poor	poor
melting point	649 °C	3550 °C	0 °C

[illegible]

..... [10]

Quality of Written Communication [1]

[Total: 11]

END OF QUESTION PAPER