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F321 Style Questions from Old Specification

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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 $(NH_4)_2CO_3$.

[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.
$L = 6.02 \times 10^{23}$ 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*.

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

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

Explain how you decided on your answer.

element **A**: .....

explanation: .....

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..... **[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.

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..... **[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.

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

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

$$CaCO_3(s) + 2HCl(aq) \longrightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

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.

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

(b) Iodine reacts with water as shown below.

$$I_2(s) + H_2O(l) \longrightarrow IO^-(aq) + 2H^+(aq) + I^-(aq)$$

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

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..... **[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*.

.....

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..... **[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.

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

[Total: 15]

5 In this question, one mark is available for the quality of spelling, punctuation and grammar.

Many physical properties can be explained in terms of bonding and structure. The table below shows some properties of magnesium, diamond and ice.

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

Explain these properties in terms of bonding and structure.

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[10]

Quality of Written Communication **[1]**

[Total: 11]

END OF QUESTION PAPER