Atoms, Amount, Equations & Reactions
AS & A Level

Question Paper 6

Level	A Level
Subject	Chemistry
Exam Board	OCR
Module	Foundations in Chemistry
Topic	Atoms, Amount, Equations & Reactions
Paper	AS & A Level
Booklet	Question Paper 6

Time allowed: **74 minutes**

Score: **/55**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E
>85%	73%	60%	47%	34%	21%

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Nitrogen is the most common gas in the atmosphere.

(a) Atoms of nitrogen consist of protons, neutrons and electrons.

Complete the table below. [2]

Particle	Relative mass	Relative charge	Position within the atom
Proton			
Neutron			
Electron			shell

(b) The electrons in the second shell of a nitrogen atom are found in an s-orbital and three p-orbitals.

(i) State, in words, the 3D shape of an s-orbital and a p-orbital.

s-orbital

p-orbital

[1]

(ii) Describe the relative energies of the 2s orbital and **each** of the three 2p orbitals in a nitrogen atom. [2]

(c) Draw a '*dot-and-cross*' diagram to show the bonding in a nitrogen molecule.

Show **outer** electrons only. [1]

(d) Calculate the amount, in mol, of nitrogen **atoms** in 5.117×10^{20} nitrogen **molecules**.

Give your answer in standard form. [2]

(e) N_2O_3 is an unstable oxide of nitrogen that decomposes in a redox reaction.

$$N_2O_3(g) \rightarrow NO(g) + NO_2(g)$$

(i) State the oxidation number of nitrogen in each oxide in the table below. [1]

Oxide	Oxidation number of nitrogen
N_2O_3	
NO	
NO_2	

(ii) Name this type of redox reaction.

In your answer you should use appropriate technical terms spelled correctly. [1]

(f) N_2O_3 reacts with water to form an acid as the only product. This reaction is **not** a redox reaction. The empirical formula of the acid formed is the same as the molecular formula.

(i) State what is meant by the term *molecular formula*. [1]

(ii) Suggest the empirical formula of the acid formed. [1]

[Total: 12 Marks]

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This question is about the chemistry of the metals zinc, magnesium, aluminium and calcium.

(a) Complete the electron configuration of a zinc atom. [1]

(b) A sample of zinc was found to contain four isotopes with the abundances shown in the table.

Isotope	Abundance (%)
^{64}Zn	49.0
^{66}Zn	27.9
^{67}Zn	4.3
^{68}Zn	18.8

(i) Define the term *relative atomic mass*. [3]

(ii) Calculate the relative atomic mass of zinc in this sample.

Give your answer to **two** decimal places. [2]

(c) Zinc carbonate, $ZnCO_3$, reacts with dilute hydrochloric acid.

A student reacts a sample of $ZnCO_3$ with an excess of dilute hydrochloric acid in a test-tube.

(i) Describe what the student would see during this reaction. [1]

(ii) Write the equation for the reaction between $ZnCO_3$ and dilute hydrochloric acid. [1]

(d) Magnesium will undergo redox reactions with aqueous salts of less reactive metals.

(i) A student reacts magnesium with aqueous copper(II) sulfate.

$$Mg(s) + CuSO_4(aq) \longrightarrow Cu(s) + MgSO_4(aq)$$

Explain, in terms of **numbers** of electron transferred, the redox processes taking place in this reaction. [2]

(ii) The student also noticed that the magnesium started fizzing.

The student thought the fizzing was due to the magnesium reacting with water in the mixture.

Write the equation for the reaction of magnesium with water. [2]

Include state symbols.

(e) A student reacts 35.0 cm^3 of 3.00×10^{-2} $moldm^{-3}$ $H_2SO_4(aq)$ with an excess of Al.

An equation for this reaction is shown.

$$2Al(s) + 3H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 3H_2(g)$$

Calculate the mass, in g, of $Al_2(SO_4)_3$ formed in solution.

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

Show your working. [4]

(f) Compounds of calcium have many uses.

(i) Identify a compound of calcium that could be used to convert a soil pH from 5.8 to 7.5 [1]

(ii) Calcium phosphide, Ca_3P_2, is an ionic compound used in rat poison.

Calcium phosphide can be prepared by reacting calcium metal with phosphorus, P_4.

Write the equation for the reaction of calcium with phosphorus to form calcium phosphide. [1]

(iii) Draw a '*dot-and-cross*' diagram to show the bonding in calcium phosphide, Ca_3P_2.

Show **outer** electrons only. [2]

[Total: 20 Marks]

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Tungsten metal is used in the manufacture of some types of steel.

Tungsten has an atomic number of 74.

(a) Tungsten has many isotopes.

(i) Explain what is meant by *isotopes*. [1]

(ii) The mass number of one isotope of tungsten is 184.

Complete the table below to show the atomic structure of this tungsten isotope. [1]

Protons	Neutrons	Electrons

(iii) What is used as the standard measurement of relative isotopic mass? [1]

(b) In the manufacture of tungsten metal, an oxide of tungsten, WO_3, is reacted with hydrogen gas.

$$WO_3(s) + 3H_2(g) \rightarrow W(s) + 3H_2O(g)$$

(i) Using **oxidation numbers**, show what has been oxidised and what has been reduced in this reaction.

oxidised

reduced [2]

(ii) A chemist reacts 11.59 g of WO_3 with hydrogen gas.

Calculate the volume of hydrogen gas, in dm^3, required to completely react with this mass of WO_3 at room temperature and pressure.

[3]

[Total 8 Marks]

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A student carries out an experiment to identify an unknown carbonate.

- The student weighs a sample of the solid carbonate in a weighing bottle.
- The student tips the carbonate into a beaker and weighs the empty weighing bottle.
- The student prepares a 250.0 cm^3 solution of the carbonate.
- The student carries out a titration using 25.0 cm^3 of this solution measured using a pipette with 0.100 mol dm^{-3} hydrochloric acid in the burette.

(a) The sample of carbonate is dissolved in approximately 100 cm^3 of distilled water in a beaker and the solution transferred to a volumetric flask. The volume of the solution is made up to 250.0 cm^3 with distilled water.

Another student suggests two possible sources of error:

- A small amount of solid remained in the weighing bottle.
- A small amount of solution remained in the beaker.

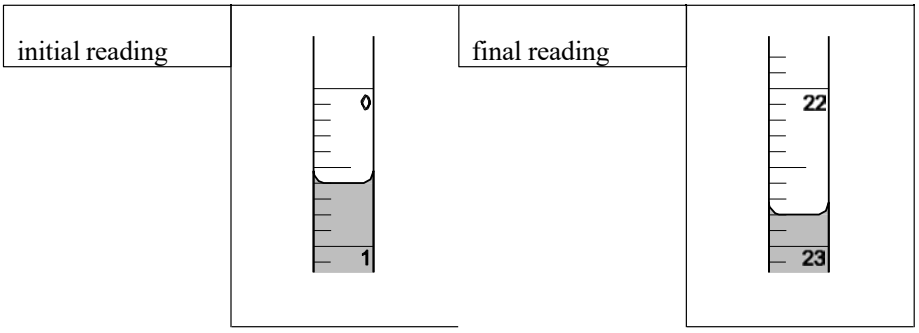
State whether the other student's statements are correct.

How could the procedure be improved? **[2]**

(b) The student carries out the final part of the experiment by adding 0.100 mol dm^{-3} hydrochloric acid to a burette and performing a titration using a 25.0 cm^3 sample of the aqueous carbonate.

The student reads the burette to the nearest 0.05 cm^3.

The diagrams below show the initial burette reading and the final burette reading.



(i) Record the student's readings and the titre. **[1]**

(ii) Describe what the student should do next to obtain reliable results for the titration. **[1]**

(c) The equation below represents the reaction between the carbonate and hydrochloric acid.

$$M_2CO_3(aq) + 2HCl(aq) \rightarrow 2MCl(aq) + CO_2(g) + H_2O(l)$$

(i) Calculate the amount, in mol, of M_2CO_3 used in the titration. **[2]**

(ii) The student's mass readings are recorded below.

Mass of weighing bottle + carbonate / g	14.92
Mass of weighing bottle / g	13.34

Use the student's results to identify the carbonate, M_2CO_3. **[4]**

[Total 10 Marks]

Question 5

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An alcohol **A** contains carbon, hydrogen and oxygen only. The alcohol is a liquid at room temperature and pressure but can easily be vaporised.

1.15 g of **A** produces 761 cm^3 of gas when vaporised, measured at 100 kPa and 366 K.

Determine the molar mass of compound **A** and draw a possible structure for **A**. **[5]**

Structure of **A**

[Total 5 Marks]