

AS LEVEL CHEMISTRY

PAPER 1

PRACTICE PAPER 25

(structured questions only)

Answer all questions

Max 80 marks

Name		
Mark/80%	Grade

Note – this paper only contains structured questions

1. Mass spectrometry is a technique that can be used to separate isotopes of an element in order to determine relative atomic mass.

(a) Give the meaning of the term relative atomic mass.

[2 marks]

(b) In a spectrometer, isotopes are converted into ions that are then detected. Describe how the ions are detected.

[2 marks]

(c) **Table 1** gives the relative abundance of each isotope in the mass spectrum of a sample of silicon, recorded using a high-resolution mass spectrometer.

Table 1

<i>m/z</i>	Relative abundance / %
27.976	92.23
28.976	4.67
29.973	3.10

Use the data to calculate a value for the relative atomic mass of this sample of silicon. Give your answer to 3 decimal places.

[2 marks]

- (d) A second mass spectrum was recorded for the same sample of silicon.
The voltage supply was of a higher voltage for this second spectrum.

State and explain **one** similarity and **one** difference between the two spectra.

[4 marks]

Similarity _____

Explanation _____

Difference _____

Explanation _____

[Total 10 marks]

2. Compounds containing Cu^{2+} , OH^- and CO_3^{2-} ions are sometimes described as basic copper carbonates.

- (a) Solid $\text{Cu}_2(\text{OH})_2\text{CO}_3$ is added to an excess of dilute hydrochloric acid.
A solution of copper(II) chloride is formed, together with two other products.

- (a) (i) Write an equation for the reaction.

[2 marks]

- (a) (ii) Suggest **one** observation that could be made during the reaction.

[1 mark]

(b) A 5.000 g sample of a different basic copper carbonate contains 0.348 g of carbon, 0.029 g of hydrogen and 1.858 g of oxygen.

(b) (i) State what is meant by the term empirical formula.

[1 mark]

(b) (ii) Calculate the empirical formula of this basic copper carbonate. Show your working.

[3 marks]

[Total 7 marks]

3. This question is about the periodicity of the Period 3 elements.

(a) State and explain the general trend in first ionisation energy across Period 3. **[4 marks]**

(b) Give one example of an element which deviates from the general trend in first ionisation energy across Period 3.

Explain why this deviation occurs. **[3 marks]**

(c) Table 3 shows successive ionisation energies of an element Y in Period 3.

Table 3

Ionisation number	1	2	3	4	5	6	7	8
Ionisation energy / kJ mol ⁻¹	1000	2260	3390	4540	6990	8490	27 100	31 700

Identify element Y.

Explain your answer using data from Table 3.

[2 marks]

(d) Identify the Period 3 element that has the highest melting point.

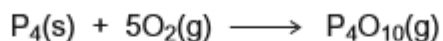
Explain your answer by reference to structure and bonding.

[4 marks]

[Total 13 marks]

4. Phosphoric(V) acid (H_3PO_4) is an important chemical. It can be made by two methods. The first method is a two-step process.

(a) In the first step of the first method, phosphorus is burned in air at $500\text{ }^\circ\text{C}$ to produce gaseous phosphorus(V) oxide.



220 g of phosphorus were reacted with an excess of air.

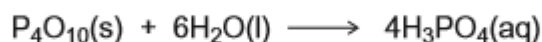
Calculate the volume, in m^3 , of gaseous phosphorus(V) oxide produced at a pressure of 101 kPa and a temperature of $500\text{ }^\circ\text{C}$.

The gas constant $R = 8.31\text{ J K}^{-1}\text{ mol}^{-1}$

Give your answer to 3 significant figures.

[4 marks]

(b) In the second step of the first method, phosphorus(V) oxide reacts with water to form phosphoric(V) acid.



Calculate the mass of phosphorus(V) oxide required to produce 3.00 m^3 of 5.00 mol dm^{-3} phosphoric(V) acid solution.

[3 marks]

- (c) In the second method to produce phosphoric(V) acid, 3.50 kg of $\text{Ca}_3(\text{PO}_4)_2$ are added to an excess of aqueous sulfuric acid.



1.09 kg of phosphoric(V) acid are produced.

Calculate the percentage yield of phosphoric(V) acid.

[4 marks]

- (d) Explain whether the first method or the second method of production of phosphoric acid has the higher atom economy.
You are not required to do a calculation.

[1 mark]

[Total 12 marks]

5. This question is about the Group 2 metals and their compounds.

(a) Explain why the first ionisation energy of barium is less than the first ionisation energy of calcium.

[2 marks]

(b) Magnesium reacts readily with steam.

State **two** observations you would make when magnesium reacts with steam. Write an equation for the reaction.

[3 marks]

Observation 1 _____

Observation 2 _____

Equation _____

(c) Explain why different observations are made when aqueous barium chloride is added separately to aqueous magnesium sulfate and to aqueous magnesium nitrate.

Write the simplest ionic equation, including state symbols, for any reaction that occurs.

[2 marks]

Explanation _____

Equation _____

[Total 7 marks]

6. (a) The electronegativities of the halogens are shown in Table 4.

Table 4

Halogen	Fluorine	Chlorine	Bromine	Iodine
Electronegativity	4.0	3.0	2.8	2.5

Explain the trend in electronegativities shown by the halogens.

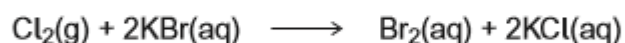
[2 marks]

- (b) The halogens can all behave as oxidising agents in reactions.

(b) (i) Explain, in terms of electron transfer, the meaning of the term oxidising agent.

[1 mark]

- (b) (ii) An equation for the reaction that takes place when chlorine gas is bubbled through aqueous potassium bromide is shown.



Explain, with reference to the oxidation states, why this is a redox reaction.

[1 mark]

(c) Solid sodium halides react with concentrated sulfuric acid.

(c) (i) A sample of solid sodium iodide is reacted with concentrated sulfuric acid. A black solid forms and hydrogen sulfide gas is produced.

Write a half-equation for the reaction of sulfuric acid to form hydrogen sulfide.

[1 mark]

(c) (ii) Write a half-equation for the formation of the black solid.

[1 mark]

(c) (iii) Use your answers to parts (c) (i) and (c) (ii) to write an overall equation for the reaction of sodium iodide with concentrated sulfuric acid.

[1 mark]

(c) (iv) Give the role of sulfuric acid in its reaction with sodium iodide. Tick (✓) **one** box.

[1 mark]

Acid

Oxidising agent

Reducing agent

(c) (v) Write an equation for the reaction of concentrated sulfuric acid with solid sodium fluoride.

[1 mark]

(c) (vi) Suggest **one** reason why the reaction of sodium fluoride with concentrated sulfuric acid is different from the reaction with sodium iodide.

[1 mark]

(d) Chlorine reacts with water to form an equilibrium mixture containing hydrochloric acid and chloric(I) acid.

(d) (i) Write an equation for the formation of this equilibrium mixture.

[1 mark]

(d) (ii) Household bleach contains sodium chlorate(I) and sodium chloride. State and explain, with reference to your equation in part (d)(i), why it is dangerous to acidify an aqueous mixture of sodium chlorate(I) and sodium chloride.

[2 marks]

[Total 13 marks]

7. A different kind of kiln is used to manufacture Portland cement. The main active minerals in Portland cement are called alite and belite.

(a) Table 1 shows the composition of a compound found in alite that contains only the elements calcium, silicon and oxygen. Use these percentage by mass data to determine the empirical formula of this compound.

Table 1

	Ca	Si	O
% by mass	52.67	12.30	To be calculated

[3 marks]

(b) A compound (Ca_2SiO_4) in belite reacts with water to produce $\text{Ca}_3\text{Si}_2\text{O}_4(\text{OH})_6$ and $\text{Ca}(\text{OH})_2$. Write an equation for this reaction.

[1 mark]

- (c) Bags of Portland cement are labelled with hazard warnings.
Suggest an item of personal safety equipment, other than eye protection, that the warning label recommends.
Give a reason why this safety equipment is recommended.

[2 marks]

Safety equipment _____

Reason _____

[Total 6 marks]

8. A similar experiment was carried out with calcium instead of magnesium, and with 2.0 mol dm^{-3} sulfuric acid instead of 2.0 mol dm^{-3} hydrochloric acid. Both acids were in excess. At first the reaction of calcium with sulfuric acid was faster than the reaction of magnesium with hydrochloric acid. However, the reaction of calcium with sulfuric acid soon stopped even though some calcium remained. A white solid had formed.

- (a) Suggest **two** reasons why the reaction was faster at first with calcium and sulfuric acid than with magnesium and hydrochloric acid.

[2 marks]

Reason 1 _____

Reason 2 _____

- (b) Identify the white solid and write an equation for its formation in this reaction.
Explain why the reaction of calcium with sulfuric acid stopped even though some calcium remained.

[3 marks]

Identity of white solid _____

Equation _____

Explanation _____

[Total 5 marks]

9. Silver cyanide can be precipitated from sodium cyanide solution by adding an excess of silver nitrate solution.

Describe how you would obtain a pure dry sample of silver cyanide from this mixture.

[3 marks]

[Total 3 marks]

10. At the end of the preparation of the alcohol, the bromine from the Grignard reagent remains as the bromide ion.

Suggest reagents and observations to confirm that this halide ion is Br^- and not I^-

[4 marks]

[Total 4 marks]