

AS LEVEL CHEMISTRY

PAPER 1

PRACTICE PAPER 21

(structured questions only)

Answer all questions

Max 80 marks

Name		
Mark/80%	Grade

Note – this paper only contains structured questions

1. (a) Define the terms

(i) *mass number* of an atom,

.....

(ii) *relative molecular mass*.

.....

.....

(3 marks)

(b) (i) Complete the electron arrangement for a copper atom.

$1s^2$

(ii) Identify the block in the Periodic Table to which copper belongs.

.....

(iii) Deduce the number of neutrons in one atom of ^{65}Cu

.....

(3 marks)

(c) A sample of copper contains the two isotopes ^{63}Cu and ^{65}Cu only. It has a relative atomic mass, A_r , less than 64. The mass spectrum of this sample shows major peaks with m/z values of 63 and 65, respectively.

(i) Explain why the A_r of this sample is less than 64.

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(ii) Explain how Cu atoms are converted into Cu^+ ions in a mass spectrometer.

.....

.....

(iii) In addition to the major peaks at $m/z = 63$ and 65 , much smaller peaks at $m/z = 31.5$ and 32.5 are also present in the mass spectrum. Identify the ion responsible for the peak at $m/z = 31.5$ in the mass spectrum. Explain why your chosen ion has this m/z value and suggest **one** reason why this peak is very small.

Identity of the ion

Explanation for m/z value

.....

Reason why this peak is very small

.....

(6 marks)

(Total 12 marks)

2. (a) State and explain the trend in the atomic radius of the elements Na to Cl in Period 3.

Trend

Explanation

.....

.....

(3 marks)

- (b) The table below gives the values of the first three ionisation energies of magnesium.

	First ionisation energy	Second ionisation energy	Third ionisation energy
Ionisation energy / kJ mol ⁻¹	738	1451	7733

- (i) Write an equation to illustrate the process occurring when the **first** ionisation energy of magnesium is measured.

.....

- (ii) Explain why the third ionisation energy of magnesium is very much larger than the second ionisation energy of magnesium.

.....

.....

.....

- (iii) State and explain the trend in the first ionisation energy of the elements Mg to Ba in Group II.

Trend

Explanation

.....

.....

(6 marks)

- (c) There is a trend in the reactivity of the Group II metals with H₂O. State the conditions needed for Mg and Ca to react rapidly with H₂O. Write an equation for each of these reactions.

Conditions for Mg

Equation

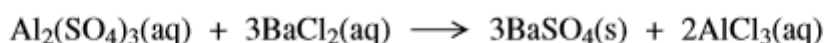
Conditions for Ca

Equation

(4 marks)

(Total 13 marks)

3. When aqueous aluminium sulphate reacts with aqueous barium chloride, a white precipitate of barium sulphate is formed. An equation for this reaction is shown below.



Hydrated aluminium sulphate has the formula Al₂(SO₄)₃.xH₂O, where xH₂O represents the water of crystallisation.

A sample of hydrated aluminium sulphate of mass 20.0 g was dissolved in water and the solution made up to 250 cm³.

An excess of aqueous barium chloride was added to a 25.0 cm³ portion of this aluminium sulphate solution.

All the sulphate ions reacted to form a precipitate of barium sulphate.

When filtered, washed and dried, the mass of the barium sulphate precipitate was 2.10 g.

- (a) (i) Calculate the number of moles of barium sulphate ($M_r = 233.4$) in the precipitate.

.....

.....

(1 mark)

- (a) (ii) Calculate the number of moles of aluminium sulphate in the 25.0 cm³ portion of the solution and in the original 20.0 g sample.

Moles in 25.0 cm³

.....

Moles in original sample

.....

(2 marks)

- (b) Calculate the M_r of this sample of hydrated aluminium sulphate and hence deduce the value of x in $\text{Al}_2(\text{SO}_4)_3 \cdot x\text{H}_2\text{O}$

(If you have been unable to obtain an answer for the number of moles of aluminium sulphate in the original sample, in part (a) (ii), you may assume that the answer is 3.17×10^{-2} mol. This is not the correct value.)

M_r

.....

Value of x

.....

.....

.....

.....

(5 marks)

- (c) A 1.37 g sample of a barium compound, X, contains 0.835 g of barium and 0.146 g of carbon, the rest being oxygen.

Use these data to calculate the empirical formula of X.

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.....

(3 marks)

- (d) An empirical formula can be used to deduce the molecular formula of a compound.

- (d) (i) State what is meant by the term *molecular formula*.

.....

.....

(1 mark)

- (d) (ii) State the information, other than the empirical formula, that you would need to deduce the molecular formula of a compound.

.....

(1 mark)

(Total 13 marks)

4. (a) (i) State what is meant by the term *polar* when applied to a covalent bond.

.....
.....

(ii) Consider the covalent bonds in molecules of hydrogen and of water. State whether the covalent bonds are polar or non-polar. Explain your answers.

Bonds in hydrogen

Bonds in water

Explanation

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.....
.....

(4 marks)

(b) Ammonia is very soluble in water because it is able to form hydrogen bonds with water molecules.

(i) Complete the diagram below to show how an ammonia molecule forms a hydrogen bond with a water molecule. Include partial charges and all the lone pairs of electrons.



(ii) The bond angle in a molecule of water is about 104.5° . State the bond angle in an ammonia molecule and explain why it is different from that in water.

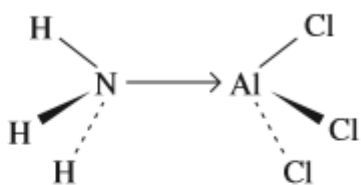
Bond angle in ammonia

Explanation

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.....

(6 marks)

(c) Ammonia reacts with aluminium chloride to form the molecule shown below.



Name the type of bond formed between the nitrogen and aluminium atoms. Explain how this bond is formed.

Type of bond

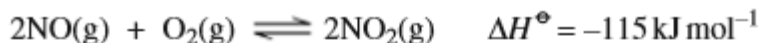
Explanation

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(2 marks)

(Total 12 marks)

6. When nitrogen monoxide reacts with oxygen, a dynamic equilibrium is established.



(a) State what is meant by *dynamic equilibrium*.

.....
.....
.....
(2 marks)

(b) State and explain how the total pressure in this equilibrium reaction should be changed to give a higher equilibrium yield of NO_2

Change in pressure

Explanation

.....
(3 marks)

(c) State and explain the effect of an increase in temperature on the yield of NO_2 in this equilibrium reaction.

Effect

Explanation

.....
(3 marks)

(d) Deduce the oxidation state of nitrogen in NO_3^- and in NO_2^+

NO_3^-

NO_2^+

(2 marks)

(Total 10 marks)

7. (a) State, in terms of electrons, what happens to an oxidising agent in a redox reaction.

.....
(1 mark)

(b) When concentrated sulphuric acid is added to solid sodium bromide, the acid reacts with Br^- ions to form SO_2 and Br_2

(b) (i) Write a half-equation to show how SO_2 is formed from sulphuric acid.

.....
.....
(1 mark)

(b) (ii) Write a half-equation to show how Br_2 is formed from Br^- ions.

.....
.....
(1 mark)

(b) (iii) Hence write an overall equation for the reaction of Br^- ions with sulphuric acid.

.....
.....
(1 mark)

(b) (iv) Deduce the role of Br^- ions in this reaction.

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.....
(1 mark)

(c) (i) Identify a halide ion that does **not** produce SO_2 when the solid sodium halide reacts with concentrated sulphuric acid.

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(1 mark)

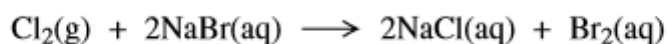
(c) (ii) Write an equation for the reaction of concentrated sulphuric acid with the halide ion that you identified in part (c)(i).

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.....
(1 mark)

(c) (iii) State the role of sulphuric acid in this reaction.

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.....
(1 mark)

- (d) When chlorine gas is bubbled into a solution of sodium bromide the following reaction occurs.



Deduce the role of Cl_2 in this reaction

.....
.....

(1 mark)

- (e) In aqueous solution, silver nitrate and ammonia can be used to test for halide ions.

- (e) (i) Identify a halide ion that reacts with silver nitrate solution to produce a precipitate which dissolves completely in dilute aqueous ammonia.

.....
.....

(1 mark)

- (e) (ii) Write an **ionic** equation for the reaction between silver nitrate and the halide ion you identified in part (e)(i).

.....
.....

(1 mark)

- (e) (iii) Identify the halide ion which cannot be detected using silver nitrate.

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(1 mark)

(Total 12 marks)