AS LEVEL CHEMISTRY

PAPER 1

PRACTICE PAPER 18

(structured questions only)

Answer all questions

Max 80 marks

Name ……..
Mark ……../80 ……....% Grade ……

Note – this paper only contains structured questions

1. (a) Ionisation is the first of the four main stages involved in obtaining the mass spectrum of a sample of gaseous titanium atoms. Explain how ionisation is achieved. Name the remaining three stages and, in each case, state how each stage is achieved. Explain why it would be difficult to distinguish between $^{48}Ti^{2+}$ and $^{24}Mg^{+}$ ions using a mass spectrometer.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(10)

(b) State any differences and similarities in the atomic structure of the isotopes of an element. State the difference, if any, in the chemistry of these isotopes. Explain your answer.

.....

.....

.....

.....

(4)

(c) The table below gives the percentage abundance of each isotope in the mass spectrum of a sample of titanium.

m/z	46	47	48	49	50
% abundance	8.02	7.31	73.81	5.54	5.32

Define the term *relative atomic mass* of an element. Use the above data to calculate the value of the relative atomic mass of titanium in this sample. Give your answer to two decimal places.

.....

.....

.....

.....

(4)

(Total 18 marks)

2. The elements phosphorus, sulfur, chlorine and argon are in the p block of the Periodic Table.

(a) State why these elements are classified as p block elements.

.....

(1)

(b) State the trend in atomic radius from phosphorus to chlorine and explain the trend.

Trend .....

Explanation .....

.....

.....

(3)

(c) In terms of structure and bonding, explain why sulfur has a higher melting point than phosphorus.

.....

.....

.....

.....

(3)

(d) In terms of atomic structure, explain why the van der Waals' forces in liquid argon are very weak.

.....

.....

.....

(2)
(Total 9 marks)

3. (a) Analysis of a pure sample of the unknown acid showed that it contained 14.42% of nitrogen, 3.09% of hydrogen and 33.06% of sulfur by mass, the rest being oxygen. Use these data to calculate the empirical formula of the acid.

.....

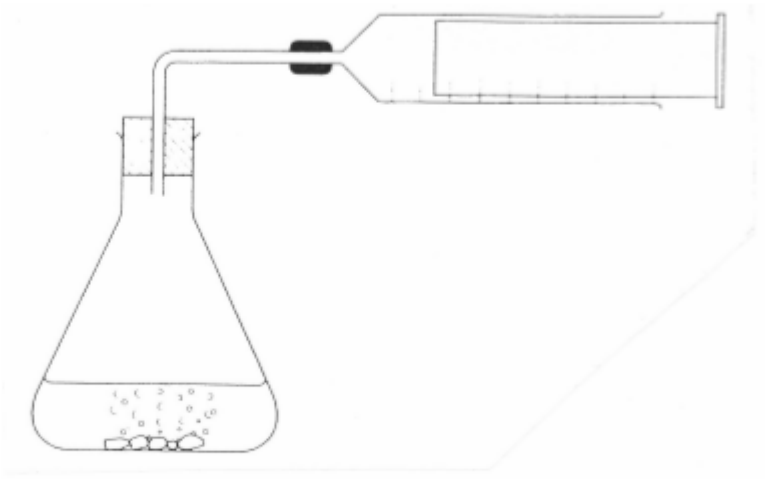
.....

.....

.....

(2 marks)

(b) The chemist then carried out an experiment to determine the M_r of sulfamic acid. The chemist set up the apparatus shown below.



A 1.60 g sample of pure sulfamic acid was dissolved in water and then transferred to the conical flask. An excess of magnesium ribbon was added to the flask and the bung was quickly replaced.

When the reaction was complete the volume of gas produced was then recorded.

Representing sulfamic acid as HA, the equation for the reaction with magnesium is shown below.

$$Mg + 2HA \rightarrow MgA_2 + H_2$$

The experiment was repeated with further 1.60 g samples of pure sulfamic acid. The chemist's results are shown below. All measurements were taken at 20 °C and a pressure of 9.95×10^4 Pa.

Experiment	1	2	3	4
Volume of hydrogen/cm^3	198	203	185	199

(a) Identify any anomalous results in the chemist's experiments and give a reason for your choice

.....

.....

(2 marks)

(b) Calculate the average volume of hydrogen produced by 1.60 g of sulfamic acid at 20 °C and a pressure of 9.95×10^4 Pa.

.....

(1 mark)

(c) State the ideal gas equation.

.....

(1 mark)

(d) Use the ideal gas equation and your answer to **Part 2(b)** to predict the number of moles of hydrogen formed in the reaction at 20 °C and 9.95×10^4 Pa.

.....

.....

.....

.....

(2 marks)

(e) Deduce the number of moles present in of 1.60 g of sulfamic acid.

.....

(1 mark)

(f) Use your answer to **Part 2(e)** to calculate the M_r of sulfamic acid.

.....

(1 mark)

(g) Use your answers to **Part 1** and **Part 2(f)** to deduce the molecular formula of sulfamic acid.

.....

.....

(1 mark)

Assuming that any sulfur atom forms six covalent bonds, any nitrogen atom forms three covalent bonds, any oxygen atom forms two covalent bonds and any hydrogen atom forms one covalent bond draw a structure for a molecule of sulfamic acid.

(1 mark)

(Total 12 marks)

4. (a) Explain why the shape of the NH_4^+ ion is regular tetrahedral. Explain why the bond angle in the NH_3 molecule is less than that in the NH_4^+ ion.

.....

.....

.....

.....

.....

(4)

(b) Draw the shape, including any lone pairs of electrons, of the NH_2^- ion. Name the shape produced by the arrangement of **atoms** in the NH_2^- ion.

Name of shape.....

(2)

(Total 6 marks)

5. There are trends in the properties of the elements, and of their compounds, both across periods and down groups in the Periodic Table.

There is a general increase in the values of the first ionisation energies of the Period 3 elements Na to Ar

(a) (i) State the meaning of the term *first ionisation energy* of an element.

.....

.....

.....

(2 marks)

(a) (ii) Explain this general increase in the values of the first ionisation energies.

.....

.....

.....

(2 marks)

(a) (iii) Explain why the value of the first ionisation energy of Al is lower than that of Mg

.....

.....

.....

(2 marks)

(b) There is a trend in the solubility in water of the Group II metal hydroxides.

(b) (i) State the observations you would make when dilute aqueous sodium hydroxide is added to separate aqueous solutions of $MgCl_2$ and $BaCl_2$

Observation with $MgCl_2(aq)$ .....

.....

Observation with $BaCl_2(aq)$ .....

.....

(2 marks)

(b) (ii) Write an ionic equation, including state symbols, for a reaction which occurs in part (b)(i).

.....

(1 mark)

(c) The hydrogen halides contain polar covalent bonds.

(c) (i) State what is meant by the term *polar* as it applies to a covalent bond.

.....

.....

(1 mark)

(c) (ii) Explain why the H—Cl bond is more polar than the H—I bond.

.....

.....

.....

(2 marks)

(Total 12 marks)

6. This question is about the extraction of metals.

(a) Coke is mainly carbon and is a raw material used in the extraction of iron from iron(III) oxide.

(i) Write an equation for the formation of carbon monoxide from carbon.

.....

(1)

(ii) Write an equation for the reduction of iron(III) oxide to iron by carbon monoxide.

.....

(1)

(b) Pure titanium is extracted by the reduction of titanium(IV) chloride, but not by the direct reduction of titanium(IV) oxide using carbon.

Write an equation for the extraction of titanium from titanium(IV) chloride.

.....

(1)
(Total 3 marks)

7. The following equation represents a reaction in equilibrium.

$$\mathbf{X}(g) + 2\mathbf{Y}(g) \rightleftharpoons 2\mathbf{Z}(g)$$

(a) Explain what is meant by a *reaction in equilibrium*.

.....

.....

(2 marks)

(b) State and explain the effect on the yield of **Z** if the overall pressure is increased.

Effect .....

Explanation .....

.....

.....

(3 marks)

(c) An increase in temperature causes a decrease in the yield of **Z**. State and explain what can be deduced about the enthalpy change for the forward reaction.

Enthalpy change .....

Explanation .....

.....

(2 marks)

(Total 7 marks)

8. Chlorine and bromine are both oxidising agents.

(a) Define an *oxidising agent* in terms of electrons.

.....

(1)

(b) In aqueous solution, bromine oxidises sulphur dioxide, SO_2, to sulphate ions, SO_4^{2-}

(i) Deduce the oxidation state of sulphur in SO_2 and in SO_4^{2-}

SO_2 .....

SO_4^{2-} .....

(ii) Deduce a half-equation for the reduction of bromine in aqueous solution.

.....

(iii) Deduce a half-equation for the oxidation of SO_2 in aqueous solution forming SO_4^{2-} and H^+ ions.

.....

(iv) Use these two half-equations to construct an overall equation for the reaction between aqueous bromine and sulphur dioxide.

.....

(5)

(c) Write an equation for the reaction of chlorine with water. Below each of the chlorine-containing products in your equation, write the oxidation state of chlorine in that product.

.....

.....

(3)

(d) Give a reason why chlorine is not formed when solid potassium chloride reacts with concentrated sulphuric acid.

.....

(1)

(e) Write an equation for the reaction between solid potassium chloride and concentrated sulphuric acid.

.....

(1)

(f) Solid potassium bromide undergoes a redox reaction with concentrated sulphuric acid.

(i) Give the oxidation product formed from potassium bromide.

.....

(ii) Give the reduction product formed from sulphuric acid.

.....

(2)

(Total 13 marks)