AS LEVEL CHEMISTRY

PAPER 1

PRACTICE PAPER 23

(structured questions only)

Answer all questions

Max 80 marks

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

Note – this paper only contains structured questions

1. (a) Define the term *atomic number* of an element.

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(1 mark)

(b) Give the symbol, including mass number and atomic number, for an atom of an element which contains 12 neutrons and 11 electrons.

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(2 marks)

(c) In terms of s and p sub-levels, give the electronic configuration of an aluminium atom.

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(1 mark)

(d) How many neutrons are there in one ^{27}Al atom?

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(1 mark)

(e) Define the term *relative atomic mass* of an element.

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(2 marks)

(f) A meteorite was found to contain three isotopes of element **X**. A mass spectrometer gave the following information about these isotopes.

m/z	24.0	25.0	26.0
Relative abundance	64.2	20.3	15.5

(i) Calculate the relative atomic mass of **X**.

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(ii) Using the Periodic Table, suggest the most likely identity of element **X**.

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(iii) Suggest **one** reason why the relative atomic mass of **X**, given in the Periodic Table, differs from your answer to part (g)(i).

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(5 marks)

(Total 12 marks)

2. (a) Oxygen may be prepared by the decomposition of hydrogen peroxide, H_2O_2, as shown in the equation below.

$$2H_2O_2(aq) \longrightarrow 2H_2O(l) + O_2(g)$$

A 150 cm^3 sample of 2.72 mol dm^{-3} aqueous hydrogen peroxide was decomposed completely.

Calculate the number of moles of hydrogen peroxide in the 150 cm^3 sample and hence deduce the number of moles of oxygen gas produced.

Moles of H_2O_2 in sample .....

.....

Moles of O_2 produced .....

.....

(3 marks)

(b) Phosphine, PH_3, and oxygen can react to form phosphoric acid, H_3PO_4, as shown in the equation below.

$$PH_3 + 2O_2 \longrightarrow H_3PO_4$$

An excess of oxygen was mixed with 1.43 g of phosphine in a sealed container and allowed to react.

(b) (i) Calculate the number of moles of PH_3 in 1.43 g of phosphine.

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(b) (ii) Calculate the number of moles of oxygen which reacted with this amount of phosphine.

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(b) (iii) Calculate the mass of phosphoric acid formed in this reaction.

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(4 marks)

(c) After the reaction in part (b) was complete, 0.166 mol of oxygen was left unreacted. The final temperature was 300 K. The volume of the sealed container was 1725 cm^3.

State the ideal gas equation and use it to calculate the pressure of the oxygen in the container after the reaction was complete.
(The gas constant $R = 8.31\ J\ K^{-1}\ mol^{-1}$)

Ideal gas equation .....

Pressure .....

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(4 marks)

(Total 11 marks)

3. (a) Balance the equation, given below, for the reaction in which H_2Se is formed from Al_2Se_3

$$Al_2Se_3 + \ldots\ldots H_2O \longrightarrow \ldots\ldots Al(OH)_3 + \ldots\ldots H_2Se$$

(1 mark)

(b) (i) Draw the shape of an H_2Se molecule and the shape of an NH_3 molecule. In each case show any lone pairs of electrons.

H_2Se NH_3

(2 marks)

(b) (ii) Name the shape produced by the arrangement of **atoms** in an H_2Se molecule.

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(1 mark)

(b) (iii) State the bond angle in an NH_3 molecule and explain why the bond angle in an H_2Se molecule is smaller than this.

Bond angle in NH_3 .....

Explanation for smaller bond angle in H_2Se .....

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(3 marks)

(c) Describe how the covalent bonds are formed in an H_2Se molecule.

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(2 marks)

(Total 9 marks)

4. Iodine and graphite crystals both contain covalent bonds and yet the physical properties of their crystals are very different.
For iodine and graphite, state and explain the differences in their melting points and in their electrical conductivities.

(Total 9 marks)

5. (a) Define the term *standard enthalpy of formation*.

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(3 marks)

(b) Write an equation, including state symbols, for the reaction with an enthalpy change equal to the standard enthalpy of formation of liquid nitric acid, HNO_3

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(2 marks)

(c) State Hess's Law.

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(1 mark)

(d) Nitric acid can be made by reacting water, nitrogen dioxide and oxygen according to the following equation.

$$H_2O(l) + 2NO_2(g) + \tfrac{1}{2}O_2(g) \longrightarrow 2HNO_3(l) \qquad \Delta H^{\ominus} = -128\,kJ\,mol^{-1}$$

Some standard enthalpies of formation, $\Delta H_f^{\ominus}$, are given in the table below.

Substance	$H_2O(l)$	$NO_2(g)$	$O_2(g)$
$\Delta H_f^{\ominus}$ / kJ mol^{-1}	–286	+34	0

(i) State why the standard enthalpy of formation of $O_2(g)$ is zero.

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(1 mark)

(ii) Use the data above to calculate a value for the standard enthalpy of formation of nitric acid.

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(4 marks)

(Total 11 marks)

6. (a) A small sample of barium metal was added to water in a flask. When the reaction had ceased, the contents of the flask were treated with a small amount of dilute aqueous sodium sulphate.
Describe all that you would observe and write equations, with state symbols, for the reactions that occur.

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(8)

(b) Dilute sodium hydroxide solution was added dropwise until in excess to separate dilute aqueous solutions of magnesium chloride and barium chloride.
Describe what you would observe in each case and account for your observations.

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(4)

(c) (i) A naturally occurring compound of calcium contains by mass 23.29% of calcium, 18.64% of sulphur and 2.32% of hydrogen, the remainder being oxygen. Determine the empirical formula of this compound.

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(ii) For any compound, what is the relationship between empirical and molecular formula? What additional information is required to determine a molecular formula from an empirical formula?

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(5)
(Total 17 marks)

7. (a) Identify the halogen that is the strongest oxidising agent.

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(1 mark)

(b) Give the formula of the halide ion that is the strongest reducing agent.

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(1 mark)

(c) Describe what you would observe in each case when aqueous silver nitrate is added separately to dilute aqueous sodium fluoride and to dilute aqueous sodium iodide. Write an equation, including state symbols, for the reaction between aqueous sodium iodide and aqueous silver nitrate.

Observation with NaF(aq) .....

Observation with NaI(aq) .....

Equation .....
(3 marks)

(d) Describe what you would observe when concentrated sulphuric acid is added to solid sodium chloride. Write an equation for the reaction that occurs.

Observation .....

Equation .....
(2 marks)

(e) Describe two observations that you would make when concentrated sulphuric acid is added to solid sodium iodide. Write an equation for a reaction that occurs in which iodide ions are oxidised by the sulphuric acid.

Observation 1 .....

Observation 2 .....

Equation .....

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(4 marks)

(Total 11 marks)