AS LEVEL CHEMISTRY

PAPER 1

PRACTICE PAPER 19

(structured questions only)

Answer all questions

Max 80 marks

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

Note – this paper only contains structured questions

1.

A sample of iron from a meteorite was found to contain the isotopes ^{54}Fe, ^{56}Fe and ^{57}Fe.

(a) The relative abundances of these isotopes can be determined using a mass spectrometer. In the mass spectrometer, the sample is first vaporised and then ionised.

(i) State what is meant by the term *isotopes*.

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(ii) Explain how, in a mass spectrometer, ions are detected and how their abundance is measured.

How ions are detected .....

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How abundance is measured .....

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(5 marks)

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

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(ii) The relative abundances of the isotopes in this sample of iron were found to be as follows.

m/z	54	56	57
Relative abundance (%)	5.8	91.6	2.6

Use the data above to calculate the relative atomic mass of iron in this sample. Give your answer to one decimal place.

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(4 marks)

(c) (i) Give the electron arrangement of an Fe^{2+} ion.

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(ii) State why iron is placed in the d block of the Periodic Table.

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(iii) State the difference, if any, in the chemical properties of isotopes of the same element. Explain your answer.

Difference .....

Explanation .....

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(4 marks)

(Total 13 marks)

2. A student studying GCSE science is puzzled by data which indicate that a sodium atom is larger than a chlorine atom and that a sodium ion is smaller than a chloride ion. How should an A–level Chemistry student explain this apparently conflicting information.

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(Total 6 marks)

2.

(a) An acid, H_2X, reacts with sodium hydroxide as shown in the equation below.

$$H_2X(aq) + 2NaOH(aq) \longrightarrow 2Na^+(aq) + X^{2-}(aq) + 2H_2O(l)$$

A solution of this acid was prepared by dissolving 1.92 g of H_2X in water and making the volume up to 250 cm^3 in a volumetric flask.

A 25.0 cm^3 sample of this solution required 21.70 cm^3 of 0.150 mol dm^{-3} aqueous NaOH for complete reaction.

(i) Calculate the number of moles of NaOH in 21.70 cm^3 of 0.150 mol dm^{-3} aqueous NaOH

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(ii) Calculate the number of moles of H_2X which reacted with this amount of NaOH Hence, deduce the number of moles of H_2X in the 1.92 g sample.

Moles of H_2X in 25.0 cm^3 of solution .....

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Moles of H_2X in 1.92 g sample .....

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(iii) Calculate the relative molecular mass, M_r, of H_2X

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(5 marks)

(b) Analysis of a compound **Y** showed that it contained 49.31 % of carbon, 6.85 % of hydrogen and 43.84 % of oxygen by mass. The M_r of **Y** is 146.0

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

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(ii) Use the above data to calculate the empirical formula and the molecular formula of **Y**.

Empirical formula of ***Y*** .....

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Molecular formula of ***Y*** .....

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(4 marks)

(c) Sodium hydrogencarbonate decomposes on heating as shown in the equation below.

$$2NaHCO_3(s) \longrightarrow Na_2CO_3(s) + CO_2(g) + H_2O(g)$$

A sample of $NaHCO_3$ was heated until completely decomposed. The CO_2 formed in the reaction occupied a volume of $352\,cm^3$ at 1.00×10^5 Pa and 298 K.

(i) State the ideal gas equation and use it to calculate the number of moles of CO_2 formed in this decomposition.
(The gas constant $R = 8.31\,J\,K^{-1}\,mol^{-1}$)

Ideal gas equation .....

Moles of CO_2 .....

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(ii) Use your answer from part (c)(i) to calculate the mass of the $NaHCO_3$ that has decomposed.
(If you have been unable to calculate the number of moles of CO_2 in part (c)(i), you should assume this to be 0.0230 mol. This is not the correct value.)

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(7 marks)

(Total 16 marks)

4. Topic 3 – 17 (S7-1-4)

Molecules of NH_3, H_2O and HF contain covalent bonds. The bonds in these molecules are polar.

(a) State what is meant by a *covalent bond* and by a *polar bond*.

Covalent bond .....

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Polar bond .....

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(2 marks)

(b) (i) Explain why the H–F bond is polar.

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(ii) State which one of the molecules NH_3, H_2O or HF contains the least polar bond.

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(iii) Explain why the bond in your chosen molecule from part (b)(ii) is less polar than the bonds found in the other two molecules.

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(4 marks)

(c) The boiling points of NH_3, H_2O and HF are all high for molecules of their size. This is due to the type of intermolecular force present in each case.

(i) Identify the type of intermolecular force responsible.

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(ii) Draw a diagram to show how two molecules of ammonia are attracted to each other by this type of intermolecular force. Include partial charges and all lone pairs of electrons in your diagram.

(4 marks)

(d) When an H^+ ion reacts with an NH_3 molecule, an NH_4^+ ion is formed.

(i) Give the name of the type of bond formed when an H^+ ion reacts with an NH_3 molecule. Describe how this bond is formed in the NH_4^+ ion.

Type of bond .....

Description .....

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(ii) Draw the shape, including any lone pairs of electrons, of an NH_3 molecule and of an NH_4^+ ion.

NH_3 NH_4^+

(iii) Name the shape produced by the arrangement of the **atoms** in the NH_3 molecule.

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(iv) Give the bond angle in the NH_4^+ ion.

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(7 marks)

(Total 17 marks)

5.

(a) Explain the meaning of the term *enthalpy change* of a reaction.

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(2 marks)

(b) Write the equation for the reaction for which the enthalpy change is the standard enthalpy of formation of the gas nitrous oxide, N_2O

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(1 mark)

(c) The equation for the formation of nitrogen trifluoride is given below.

$$\tfrac{1}{2}N_2(g) + 1\tfrac{1}{2}F_2(g) + \longrightarrow NF_3(g)$$

(i) Using the mean bond enthalpy values given in the table, calculate a value for the enthalpy of formation of nitrogen trifluoride.

Bond	N–F	N≡N	F–F
Mean bond enthalpy / kJ mol^{-1}	278	945	159

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(ii) A data book value for the enthalpy of formation of nitrogen trifluoride is –114 kJ mol^{-1}. Give one reason why the answer you have calculated in part (c)(i) is different from this data book value.

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(4 marks)

(d) Some standard enthalpies of formation are given in the table below.

Substance	$NH_3(g)$	$F_2(g)$	$NF_3(g)$	$NH_4F(s)$
$\Delta H_f^{\ominus}$ / kJ mol^{-1}	−46	0	−114	−467

(i) State why the enthalpy of formation of fluorine is zero.

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(ii) Use these data to calculate the enthalpy change for the following reaction.

$$4NH_3(g) + 3F_2(g) \longrightarrow NF_3(g) + 3NH_4F(s)$$

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(4 marks)

(Total 11 marks)

6.

There is a trend in the reactivity of the Group II metals, Be–Ba, with water. State this trend and give the conditions under which magnesium reacts rapidly with water. Write an equation to represent this reaction.

Trend Be to Ba .....

Conditions .....

Equation .....

(3 marks)

(Total 3 marks)

7.

(a) When silver nitrate solution is added to a mixture containing two different halide ions in solution, two different precipitates, **R** and **S**, are formed. When concentrated ammonia solution is then added, **R** remains as a precipitate and **S** dissolves completely.

(a) (i) Identify the halide ion in **R**.

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(1 mark)

(a) (ii) Identify a possible halide ion in **S**.

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(1 mark)

(a) (iii) Write an ionic equation for the formation of the precipitate **R** from silver nitrate.

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(1 mark)

(b) When concentrated sulphuric acid is added to solid sodium chloride a reaction occurs in which misty fumes are formed.

(b) (i) Write an equation for this reaction.

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(1 mark)

(b) (ii) State the role of sulphuric acid in this reaction.

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(1 mark)

(c) When concentrated sulphuric acid is added to solid sodium bromide, a redox reaction occurs. A mixture of gases, including sulphur dioxide, is formed.

(c) (i) State the oxidation state of sulphur in sulphuric acid and in sulphur dioxide.

Oxidation state of sulphur in sulphuric acid .....

Oxidation state of sulphur in sulphur dioxide .....

(2 marks)

(c) (ii) Write an equation for the redox reaction between concentrated sulphuric acid and solid sodium bromide. State the role of sulphuric acid in this reaction.

Equation .....

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Role of sulphuric acid .....

(3 marks)

(d) When concentrated sulphuric acid is added to solid sodium iodide a redox reaction occurs to produce sulphur dioxide. Two other reduction products are formed.

Identify these two other reduction products. In each case, state an observation that would confirm the identity of the product.

Reduction product 1 .....

Observation .....

Reduction product 2 .....

Observation .....

(4 marks)

(Total 14 marks)