

The Regional Inspectorate of Pedagogy for Science Education, in collaboration with the South West Chemistry Teachers' Association (SOWECTA) and the Teachers' Resource Unit (TRU) Buea. South West Regional Mock Exams, March 2021 GENERAL CERTIFICATE OF EDUCATION EXAMINATION	SUBJECT CODE NUMBER 715	PAPER NUMBER 2
ADVANCED LEVEL	SUBJECT TITLE AND SYLLABUS CHEMISTRY	
Candidate Name: _____ Candidate Number: _____	DATE THURSDAY, 18/03/2021, AFTERNOON	
FOR EXAMINER'S USE ONLY Name of Examiner: Signature of Examiner: Date:	FOR OFFICE USE ONLY	FOR EXAMINER'S USE ONLY

Three hours

Open wide the flap attached to this booklet and enter the information required in the boxes of the flap.

Answer all questions. The mark allocation is indicated for each question. Each question carries 20 marks.

Blank spaces in this question booklet may be used for rough work.

In calculations you are advised to show all the steps in your working, giving your answer at each stage.

All necessary working must be shown. No marks will be awarded for answers without brief statements showing how the answers have been obtained. Calculators are allowed.

Useful Data

One (1) atmosphere (1 atm) = 1 Pa = $1.01 \times 10^5 \text{ N m}^{-2}$. Molar gas volume = 24 000 cm³ at rtp.

Molar gas constant R = 0.082 atm dm³ K⁻¹ mol⁻¹ (Or R = 8.314 JK⁻¹ mol⁻¹) Relative atomic masses (RAM): C = 12; O = 16.0; H = 1.0

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Turn over

SECTION A: PHYSICAL AND GENERAL CHEMISTRY

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1.) (a) Define the following terms:

i) A mole of a substance

ii) Molar mass

b) In an experiment to determine the molar mass of a volatile organic liquid X, 0.46 g of the liquid was injected into a graduated glass syringe. On vaporisation, it occupied a volume of 240 cm^3 at 20°C and 760 mmHg .

i) How would you know if the liquid has been completely vaporized?

ii) Calculate the molar mass of X:

c) Chemical bonds and intermolecular forces are binding forces which affect the shapes and properties of substances

i) Identify the bond types and the shapes of the species in the table below

Species	Bond type	Shape
BF_3		
NH_3		

ii) AlCl_3 readily dimerises in the gaseous phase. Draw the structure of the dimer and label the different types of bonds present.

iii) Water and hydrogen sulphide are the first two hydrides of group VI of the periodic table. Explain why the first is a liquid while the latter is a gas at r.t.p.

d) The saturated vapour pressure at 100°C of heptane and octane are 791 mmHg and 352 mmHg respectively. Calculate:

i) The mole fraction of each component in a mixture of 25.0 g of heptane and 35.0 g of octane.

ii) The partial pressure of each component in the mixture.

e) i) What do you understand by pH of a solution?



ii) Calculate the pH of:

A) a 0.1M solution of H_2SO_4

B) a solution prepared by mixing 75 cm^3 of 0.1M HCl and 25 cm^3 of 0.1M NaOH solutions.

(4mks)

f) i) The following data was obtained for the reaction: $\text{A} + \text{B} \rightarrow \text{C}$

Experiment	Initial [A] / mol dm^{-3}	Initial [B] / mol dm^{-3}	Initial rate ($\text{mol dm}^{-3} \text{ s}^{-1}$)
1	0.100	0.100	5.5×10^{-6}
2	0.200	0.100	2.2×10^{-5}
3	0.100	0.300	1.65×10^{-5}
4	0.100	0.600	3.30×10^{-5}

i) Determine the order of the reaction with respect to [A]

ii) Determine the order of the reaction with respect to [B]

iii) What is the overall order of the reaction?

iv) Write the rate expression for the reaction.

(4mks)

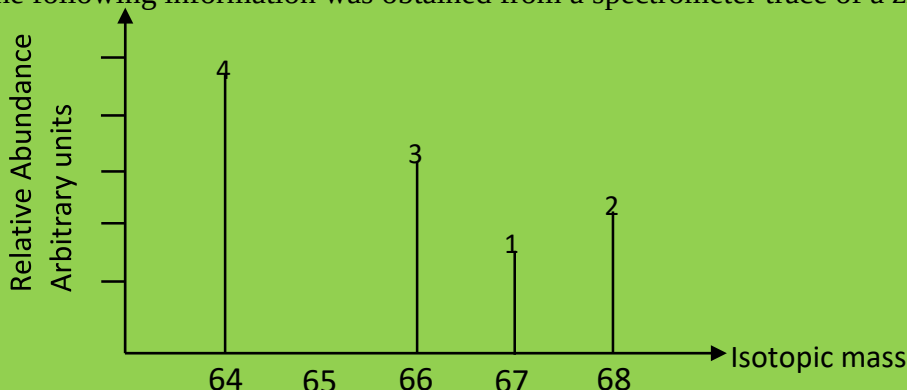
(Total = 20 marks)

2.) a) An atom is composed of three fundamental particles. Complete the table below with respect to these particles.

Name of particle	Relative mass	Discovered by	Experiment used
	1.0	Chadwick	
proton			discharge tube

(2mks)

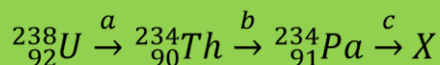
b) The following information was obtained from a spectrometer trace of a zinc sample.



Use the information and determine the relative atomic mass of Zinc.

(2mks)

c) Below is part of the uranium decay series.



i) Which particle is emitted in a and b.?

ii) If a beta particle is emitted in process c, identify the isotope X.

(3mks)

d) (i) Name any two ways of close packing of identical atoms, such that the environment of each atom is the same with that of the other.

(ii) In an x-ray diffraction experiment on a Sodium chloride crystal, a first order diffracted ray occurred at an angle of 22.77° . Given that the wavelength of the x-rays is 0.153 nm, calculate the distance between the layers of the ions in the crystal.

(3mks)

e) i) Define the following:

A) Standard enthalpy of atomization of an element.

B) Bond energy term.

C) Lattice energy.

ii) Write an equation that represents the standard enthalpy of atomization of methane

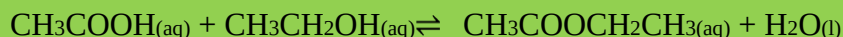
iii) Given that the standard enthalpy of atomization of methane is +1662 KJ/mol, calculate the average bond energy of the C-H bond in methane.

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(6mks)

f)i) State the equilibrium law.

ii) The ester, ethyl ethanoate may be produced by the reaction:



Given that initially, one mole of each of CH_3COOH and $\text{CH}_3\text{CH}_2\text{OH}$ were mixed together in a 1L container and that at equilibrium, 0.8 mol of CH_3COOH was found to be present. Calculate the value of the equilibrium constant, K_c , and state its units

_____(3mks)

g) Consider the electrode potential systems below

	Electrode potential system	E°/Volts
A	$\text{Fe}^{2+}(\text{aq}) + 2\text{e}^{-} \rightleftharpoons \text{Fe}(\text{s})$	-0.44
B	$\text{Cl}_2(\text{aq}) + 2\text{e}^{-} \rightleftharpoons 2\text{Cl}^{-}(\text{aq})$	+1.36
C	$\text{O}_2(\text{g}) + 4\text{H}^{+}(\text{aq}) + 4\text{e}^{-} \rightleftharpoons 2\text{H}_2\text{O}(\text{l})$	+1.23



i) Write a cell diagram for the cell formed when the half-cells A and C are coupled. Calculate the e.m.f. of the cell formed.

ii) Explain why chlorine gas cannot be stored in an iron vessel.

(3mks)

(Total = 20 marks)

SECTION B: INORGANIC CHEMISTRY

3.) This question concerns the elements across periods 2 and 3, group IV and the chemistry of the elements sulphur and nitrogen.

a.(i) Define *electronegativity* of an element.

ii) State and explain the trend in electronegativity from left to right across period 2 of the Periodic Table.

(3mks)

b) For the periods 2 and 3 oxides, give the formula of:

i) An amphoteric oxide in period 3 _____

ii) A neutral oxide in period 2 _____

iii) A period 2 oxide which causes acid rain oxide _____ (3mks)

c) i) Define first ionisation energy.

ii) Sketch a graph of first ionisation energy across periods 2 and 3 of the periodic table (Lithium to Argon).

(3mks)

d) This question concerns the elements of group IV or 14 (C, Si, Ge, Sn, Pb)

i) Write out the general outer electronic configuration of the group IV elements.

ii) Give an example of a group IV compound that is;

A: A strong reducing oxide. _____

B: A covalent chloride which does not hydrolyse in water: _____

iii) Write balanced chemical equations to show the amphoteric nature of PbO_2

(5mks)

e) i) Give two uses of nitric acid.

ii) The Haber process is used to convert Nitrogen and Hydrogen to ammonia.

Give the sources of the raw materials.

iii) Give a named compound of Sulphur with oxidation state of +6.

iv) Write an equation to show how sulphur dioxide brings about acid rain.

(6 mks)

(Total = 20 marks)

4) a) The elements Li, Na, K, Be, Mg and Ca are s-block elements. i) Why are they called s-block elements?

ii) Using equations only, show how Sodium and Be react with water.

A) $\text{Na} + \text{H}_2\text{O}$:

B) $\text{Be} + \text{H}_2\text{O}$:

iii) State and explain the trend in solubility of group II sulphates down the group.

Trend:

Explanation:

(5mks)

b) This question concerns the group VII elements or Halogens (F_2 , Cl_2 , Br_2 , I_2).

Give two reasons why fluorine exhibits only one oxidation state in all its compounds whereas the other halogens show several oxidation states.

(2mks)

c) Write a balanced equation for the laboratory preparation of;

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i) Hydrogen chloride (HCl) from Sodium chloride.

ii) Hydrogen iodide(HI) from Sodium iodide.

iii) Explain why your equations in (i) and (ii) are similar or different.

(3mks).

d) Account for the following:

i) Hydrogen fluoride is a much weaker acid than expected in aqueous solutions.

ii) Hydroiodic acid is a stronger acid than hydrochloric acid in aqueous solution.

(2 mks)

e) Write balanced equations for the following reactions

i) Iodine and hot concentrated Potassium hydroxide.

ii) Chlorine and dilute Potassium hydroxide.

(2 mks)

f) Transition metals are located between groups II and III elements of the Periodic Table.

i) Why are Zinc and Scandium not considered as transition metals?

ii) It is easy to oxidise Fe^{2+} into Fe^{3+} but not Mn^{2+} into Mn^{3+} . Explain

iii) What is a ligand?

iv) What property enables some transition metal ions or their compounds to be used as homogeneous catalysts in some reactions?

(4mks)

g) Cobalt forms a complex compound with the formula $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]^+\text{Cl}^-$

(i) What is the coordination number of cobalt in the complex?

ii) Write the equation for the reaction between the complex compound and Silver nitrate.

iii) What type of isomerism could be exhibited by this compound?

(3 mks)

(Total = 20 marks)



SECTION C:ORGANIC CHEMISTRY

5.) a) 2.648 g of an organic compound has composition as 0.80 g of carbon, 0.198 g of hydrogen, 0.47 g of nitrogen and 1.18 g of chlorine. If the molar mass of the compound was found to be 79.5 g/mol, calculate the empirical formula and hence the molecular formula of the compound.

i) Empirical formula:

ii) Molecular formula :

b) Briefly describe how the presence of the following elements can be confirmed in an organic compound after the sodium fusion test: i) Chlorine.

LA STORIA

ii) Nitrogen.

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c) State the spectroscopic method which is suitable for the identification of the following aspects in organic compounds: i) Multiple bonds:

ii) The position of hydrogen atoms: (2mks)

d) Write out the structures of two optically active isomers with the structural formula: $\text{CH}_3\text{CHOHCOOH}$.

e) You are given the following compounds:



i) Use the organic compounds above to write suitable equations that will illustrate the following types of organic reactions and name the major products.

A) Electrophilic addition reaction:

B) Electrophilic substitution reaction:

C) Nucleophilic substitution reaction:

ii) Write a reaction for the nitration of Benzene.

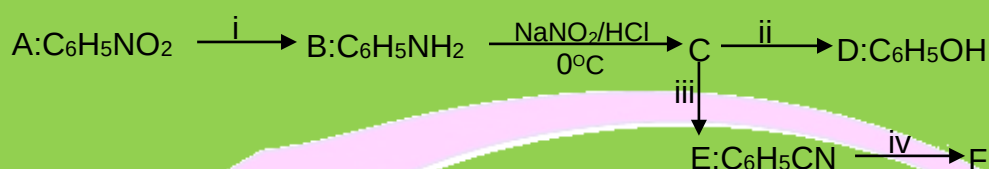


Give the mechanism for the reaction.

(9 mks)

(Total = 20 marks)

6.) a) Consider the reaction sequence below ;



i) Give the reagents and reaction conditions for the processes below.

Process	Reagent	Reaction Condition
i)		
ii)		
iii)		
iv)		

ii) Give the formula and name of compounds C and F.

Compound	Formula	Name
C		
F		

(6mks)

b) Consider the organic compounds:

A: $\text{C}_6\text{H}_5\text{OH}$ B: $\text{C}_6\text{H}_5\text{CH}_2\text{OH}$ C: $\text{C}_6\text{H}_5\text{COOH}$ D: $\text{CH}_3\text{CH}=\text{CH}_2$ E: $\text{CH}_3\text{C}\equiv\text{CH}$ How can you distinguish chemically between compounds: i) A and B?

ii) D and E?

iii) A and C?

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(6mks)

c) i) What is a zwitterion?

ii) Write the structure of alanine ($\text{H}_2\text{NCH}(\text{CH}_3)\text{COOH}$) in a neutral medium.

iii) State the physical method by which a mixture of zwitterions can be separated.

(3mks)

d) $\text{CH}_3\text{CH}_2\text{CHO}$ and CH_3COCH_3 react with 2,4-dinitrophenylhydrazine to give an orange precipitate.

i) What general name is given to this type of reaction?

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ii) Write an equation for the reaction between 2,4-dinitrophenylhydrazine and CH_3COCH_3 . State the condition for the reaction.

_____ (3mks)

e) State suitable reagents and reaction conditions for the following conversions:

i) $\text{CH}_3\text{CH}_2\text{Br}$ to $\text{CH}_3\text{CH}_2\text{CN}$. _____

ii) $\text{CH}_3\text{CH}_2\text{CONH}_2$ to $\text{CH}_3\text{CH}_2\text{NH}_2$ _____ (2mks)

(Total = 20 marks)

STOP ! GO BACK AND CHECK YOUR WORK.



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