O715/2/2022

CHM A/L

SOUTH WEST REGIONAL MOCK EXAMINATION

GENERAL EDUCATION

THE TEACHERS' RESOURCE UNIT (TRU)
IN COLLABORATION WITH

THE REGIONAL INSPECTORATE OF PEDAGOGY FOR SCIENCE EDUCATION
AND

THE SOUTH WEST CHEMISTRY TEACHERS' ASSOCIATION (SWECTA)

TUESDAY Afternoon 29/03/2022   ADVANCE. LEVEL

Subject Title	CHEMISTRY
Paper Number	Paper 2
Subject Code Number	0715

THREE HOURS

INSTRUCTIONS TO CANDIDATES:

Enter the information required in the boxes of the flap.

Answer ALL the SIX questions in this booklet.

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

Verify that this booklet contains six questions, no questions are repeated and there are no blank pages. Inform the invigilator in case this booklet contains less than six questions; questions are repeated or there are blank pages so that the booklet should be changed.

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 may be used.
Noiseless and non-programmable Calculators are allowed

USEFUL DATA:

One (1) atmosphere (1 atm) = 1 Pa = $1.01 \times 10^5 Nm^{-2}$. Molar gas volume = 24,000 Cm^3 at rtp

Molar gas constant R = 0.082 $atmdm^{-3}K^{-1}mol^{-1}$ (Or R = 8.314$JK^{-1}mol^{-1}$)

RAM: C = 12.0, H =1.0, 0 = 16.0, Cu = 64, S = 32.0,

SECTION A: PHYSICAL AND GENERAL CHEMISTRY

1. (a) i) What do you understand by "A mole"

_____

_____

ii) 7.50 g of a hydrated copper (II) sulphate ($CuSO_4 . nH_2O$) on heating gave 4.8 g of anhydrous copper (II) sulphate. Determine the value of n (moles of water of crystallization).

_____

_____

_____

_____

(3 marks)

b) i) State Raoult's law.

_____

(ii) At 25 $^{\circ}$C, the vapour pressure of pure methanol and ethanol are 8.1×10^4 Pa and 4.5×10^4 Pa respectively. For a mixture of 12.8 g methanol and 9.2 g ethanol, calculate;

(A) The mole fraction of each component.

_____

_____

_____

(B) The partial pressure of each component.

_____

_____

_____

(4 marks)

(c) i) For the molecule NCl_3

(A) Draw its dot and cross diagram

_____

_____

(B) Draw and state its shape

_____

(ii) Account for the regular increase in boiling point of the hydrides of Group IV (Group 14), carbon to lead and the abnormally high boiling point of water compared to the other hydrides of group VI (Group 16), Oxygen to Tellurium.

_____

_____

_____

_____

(4 marks)

(d) i) Given the following standard enthalpies of combustion in KJmol^{-1}

$CH_2 = CH_{2(g)} = -1411.1$, $CH_3CH_2OH_{(l)} = -1367.0$
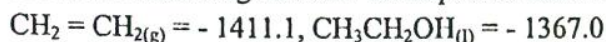
Calculate the enthalpy change when 23.0 g of ethanol are formed according to the equation;

$C_2H_{4(g)} + H_2O_{(l)} \longrightarrow C_2H_5OH_{(l)}$

_____

_____

_____

_____

_____
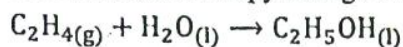
(ii) The Braggs equation is important in solid state chemistry

(A) Write down the equation.

_____

_____

(B) What is a unit cell?

_____

_____

(5 marks)

(e) The equilibrium constant for the reaction given below can be determine experimentally when known amounts of hydrogen and nitrogen are heated in a sealed tube until equilibrium is attained.

$3H_{2(g)} + N_{2(g)} \rightleftharpoons 2NH_{3(g)}$; $\Delta H = -92KJ/mol$
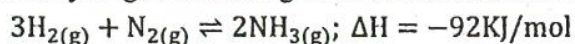
(i) State the equilibrium law.

_____

_____

_____

_____

(ii) Write the equilibrium constant expression (Kc) for the reaction.

_____

_____

(iii) State and explain how the value of the equilibrium constant would be affected by increase in temperature.

_____

_____

_____

(4 marks)

(Total = 20 marks)

2 (a) Give reason(s) for the following observations

(i) The relative atomic mass of an element is not always a whole number.

_____

_____

(ii) When a thin gold foil is bombarded with alpha particles
(A) Most of the particles passed through unaffected.

_____

(B) A few are deviated through large angles

_____

(3 marks)

(b) The mass spectrometer is used to determine the relative atomic masses of elements. Explain:
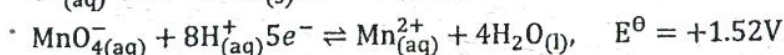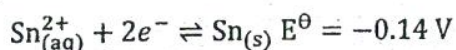(i) How the ions are produced?

_____

(ii) How the ions are deflected

_____

(2 marks)

c) Apart from the line emission spectrum, suggest another method which could be used to determine the ionization energies of elements?

_____

(1 mark)

(d) Use the following standard electrode potentials of the half-cells at 298K to answer the questions which follow.

$$Sn^{2+}_{(aq)} + 2e^- \rightleftharpoons Sn_{(s)} \quad E^\theta = -0.14 \text{ V}$$
$$MnO^-_{4(aq)} + 8H^+_{(aq)} 5e^- \rightleftharpoons Mn^{2+}_{(aq)} + 4H_2O_{(l)}, \quad E^\theta = +1.52V$$

i) Write a cell diagram when the two half cells are coupled.

_____

ii) Calculate the emf of the cell.

_____

iii) What would be observed when the cell is functioning?

_____

iv) In what direction would electrons flow in the external circuit?

_____

v) What is the use of a salt bridge in the experimental set up?

_____

(5 marks)

(e) i) Define an acid according to the Bronsted – Lowry theory.

(ii) For the acid - base equilibrium given below, identify the acids and their conjugate bases.
$$NH_3 + H_2O \rightleftharpoons NH^+_4 + OH^-$$

_____

iii) Calculate the pH of a solution containing 0.02 moldm^{-3} sodium benzoate and 0.03 moldm^{-3} benzoic acid with Ka = 6.4 x 10^{-5} moldm^{-3}

_____

_____

(5 marks)

(f) Mercury(II)chloride reacts with oxalate ions, $C_2O_4^{2-}$, in solution with the precipitate of Hg_2Cl_2 formed.

$2HgCl_{2(aq)} + C_2O_4^{2-} \longrightarrow 2Cl^-_{(aq)} + 2CO_{2(g)} + Hg_2Cl_{2(s)}$
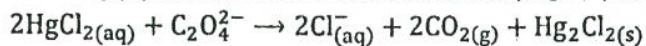
The initial rates at 373K for solutions of the concentrations expressed as moldm^{-3}min^{-1} of $HgCl_2$ reacted as shown in the table below;

Experiment	$HgCl_2$ moldm^{-3}	$C_2O_4^{2-}$ moldm^{-3}	Rate x 10^{-4} moldm^{-3}min^{-1}
1	0.0836	0.202	0.52
2	0.0836	0.404	2.08
3	0.0418	0.404	1.06

i) Considering the products of this reaction, what technique can be used to determine the rate of the reaction?

_____

ii) Showing clearly how you arrive at your answer, determine the order of the reaction with respect to;
A: $HgCl_2$:

_____

_____

_____

B: $C_2O_4^{2-}$:

_____

_____

_____

iii) Calculate the rate constant, K, using data from the experiment.

_____

_____

_____

(4 marks)

(Total = 20 marks)

SECTION B: INORGANIC CHEMISTRY

3) This question concerns Periodic Table and Periodicity, Transition metals and S- Block elements.
(a) The elements in period 2 (Li to Ne) of the Periodic Table show periodic trends in their properties
(i) What do you understand by "Periodic Trends"

_____

(ii) State and explain how atomic radius varies across the period

_____

_____

(3 marks)

(b)(i) In the table below, give the formulae of the stable oxides of the elements.

Element	Li	Be	B	C	N	O	F
Oxide							

(ii) From the table above, identify an amphoteric oxide:

_____

(3 marks)

(c) Lithium, sodium, potassium, magnesium and calcium are S- block elements (Groups I and II elements)

(i) State and explain the trend in the following physical properties.

(A) Melting point from sodium to magnesium

_____
_____
_____

(B) Ionic radius from potassium to sodium

_____

(ii) Identify one common feature of the electronic configuration of the ions of S- block elements.

_____

(iii) Lithium has a diagonal relationship with magnesium. Why are the two elements diagonally related?

_____

(iv) The hydroxides of Group I elements are more soluble than those of Group II elements: Explain:

_____
_____

(7 marks)

(d) Cobalt, iron and manganese are d- block elements as well as transition elements.

(i) Differentiate between a d- block element and a transition element

_____
_____
_____

(ii) Explain in terms of their electronic configurations why Fe^{2+} ions are readily oxidized to Fe^{3+} ions while Mn^{2+} ions are not readily oxidized to Mn^{3+} ions

_____
_____
_____

(iii) What is the oxidation state and coordination number of cobalt in the complex
$[CO(NH_3)_4Cl_2]^+Cl^-$ oxidation state _____ coordination number _____

(iv) What is a complex ion?

_____
_____

(7 marks)

(Total = 20 marks)

4) This question is on elements of Group VII (Halogens), Group IV, Nitrogen and Sulphur.
(a) This part of the question concerns the elements in group VII of the Periodic Table.
(i) Give the symbols and physical states of the first FOUR members of the group.

SYMBOL	PHYSICAL STATE

Explain any observable variations in the physical states of the elements.

_____

_____

(ii) How could one prepare an aqueous solution of iodine starting from the element

_____

iii) Write a balanced equation for the reaction between iodine and aqueous sodium thiosulphate ($Na_2 S_2 O_3$)

iv) Give the formula and name of one Oxo – acid of chlorine.

_____

v) Write an equation in each case to show how HCl and HBr can be prepared in the laboratory.
HCl: _____

_____

HBr: _____

_____

(8 marks)

(b) The following questions concern the chemistry of Group IV elements (Carbon to Lead)
(i) What are the principal oxidation states of the elements in their chlorides?

_____

(ii) What is the trend in the stability of these oxidation states?

_____

Give two reactions to illustrate the trend in stability of these oxidation states.

_____

_____

_____

$SiCl_4$ is easily hydrolyzed by water while CCl_4 is not.
A) Give a reason for this observation.

_____

B) Write a balanced equation for the reaction of $SiCl_4$ with water.

_____

(iv) State two ways in which carbon differs from the rest of the elements in the group.

_____

_____

_____

(8 marks)

(c)(i) Using equations only, show how ammonia is converted to nitric acid

_____
_____
_____
_____

(ii) One environmental hazard in the industrial manufacture of both sulphuric acid and nitric acid is the production of "acid rain". How is "acid rain" brought about?

_____
_____

(3 marks)

(d) Write a balanced equation showing how a compound of sulphur undergoes disproportion reaction.

_____
_____

(1 mark)

(Total = 20 marks)

SECTION C: ORGANIC CHEMISTRY

5(a) What do you understand by the following terms;
(i) Catenation

_____
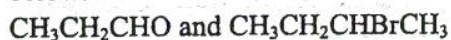_____

(ii) Heterolytic fission

_____
_____

(iii) Mesomeric effect

_____
_____

(3 marks)

(b) Organic compounds undergo different types of organic reactions.
(i) What is a nucleophilic substitution reaction?

_____
_____

(iii) Write equations to illustrate the following reaction types using the correct compound from the list below.
CH_3CH_2CHO and $CH_3CH_2CHBrCH_3$

(A) Nucleophilic addition

_____
_____

(B) Elimination reaction

_____
_____

(3marks)

(c) Write the reaction mechanism showing:
(i) The conversion of benzene to methylbenzene

_____
_____

(ii)   The reaction of $CH_3CH=CH_2$ with hydrogen bromide

(iii)   State the rule which governs the reaction in (c) ii above

(6 marks)

(d)   This compound $CH_3CH(NH_2)COOH$ exhibits stereoisomerism.
(i)   Identify the type of stereoisomerism

(ii)   Write the structures of its isomers

(iii)   Briefly explain how you would distinguish between these isomers experimentally
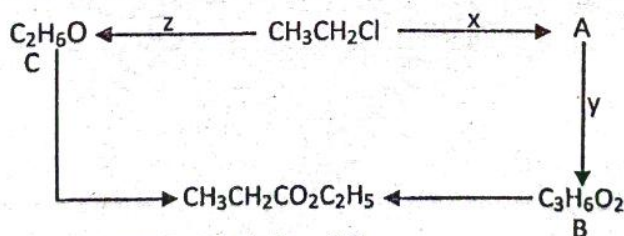
(5 marks)

(e)   Write the structural formulae and names of all the aldehydes with molecular formula $C_5H_{10}O$

(3 marks)

(Total = 20 marks)

6.(a)   The diagram below represents the conversion of chloroethane into a number of organic compounds

$$C_2H_6O \xleftarrow{\quad z \quad} CH_3CH_2Cl \xrightarrow{\quad x \quad} A$$
$$C$$
$$\downarrow y$$
$$CH_3CH_2CO_2C_2H_5 \longleftarrow C_3H_6O_2$$
$$B$$

(i)   Give the names of the compounds A, B and C

COMPOUND	NAME
A	
B	
C	

(ii)   Give the reagents and reaction conditions represented by x, y, and z

REACTION ROUTE	REAGENT	REACTION CONDITION
x		
y		
z		

(9 marks)

(b)   i) Give the structure and name of a primary and secondary amine with molecular formula C_3H_9N.

Primary:

Secondary:

(2 marks)

c)   Using a chemical test, show how you would distinguish between ethene and ethyne.

_____

_____

_____ (2 marks)

(d)   0.2 g of an organic compound made up of carbon hydrogen and oxygen on combustion yields 0.44 g of carbon dioxide and 0.23 g of water

Given that the relative molecular mass of the compound is 60, deduce its molecular formula

_____

_____

_____

_____ (3 marks)

(e)   Amino ethanoic acid (H_2NCH_2COOH) exists mainly as a zwitterion

(i)   Explain using an equation how a zwitterion is formed

_____

_____

_____

(ii)   Write the equations for the reaction of amino ethanoic acid (indicating the reaction conditions) with

(A) Lithium aluminum hydride ($LiAlH_4$)

_____

(B) Nitrous acid ($NaNO_{2(aq)}$ + dil HCl)

_____

_____

(C) Sodium hydroxide (NaOH)

_____

_____

(4 marks)

(Total = 20 marks)

STOP

GO BACK AND CHECK YOUR WORK