MAASAI MARA UNIVERSITY

REGULAR UNIVERSITY EXAMINATIONS
2018/2019 ACADEMIC YEAR

FIRST YEAR SECOND SEMESTER EXAMINATION
FOR
THE DEGREE OF BACHELOR OF SCIENCE IN CHEMISTRY, AND BACHELOR OF EDUCATION (SCIENCE)

COURSE CODE: CHE 1207
COURSE TITLE: ANALYTICAL CHEMISTRY I

DATE: 18TH APRIL 2019 **TIME: 2.30 PM – 4.30 PM**

INSTRUCTIONS

1. This paper contains **FOUR** (4) questions in two sections A and B.
2. Section A is compulsory

3. Answer question **ONE (1)** in section A and any **Two** (2) questions from section B.
4. Do not forget to write your Registration Number.

Question ONE (30 Marks)

a. Define the following terms:

i. Molarity. ***(1 mark)***

ii. Mol fraction. ***(1 mark)***

iii. Weight-weight percent (***1 mark)***

iv. Mass-volume concentration. ***(1 mark)***

v. Accuracy and Precision ***(2 marks)***

vi. Percent chemical yield ***(2 marks)***

b. i. Define the term Solubility of a solute in a solution. ***(1 Mark)***

ii. What is a saturation point of a solution? ***(1 Mark)***

iii. The concentration of each ion of Sr^{+2} and CO_3^{-2} is 2.5 x 10^{-5} mol/L in the saturated solution of $SrCO_3$ at 25 °C. What is the solubility product for $SrCO_3$ at this temperature? ***(3 Marks)***

c. i. State the number of significant figures (***s.fs***) in each of the following number of moles; 0.00123 mols, 1.02 mols, 2.0 mols, and 12.500 x 10^{-12} mols ***(2 marks)***

ii. In rounding off numbers, certain conventions have been adopted. State with examples in each, three conventions used. **(3 marks)**

iii. The radius of a phosphorus atom is 1.10 Å. What is the distance expressed in centimeters and nanometers? ***(3 marks)***

d. During bromination of benzene, phenylbromide is produced as shown in the reaction $C_6H_6 + Br_2 \rightarrow C_6H_5Br + HBr$

i. What is the theoretical yield of C_6H_5Br if 42.1 g of C_6H_6 react with 73.0 g of Br_2? ***(2 marks)***

ii. If the actual yield of C_6H_5Br is 63.6 g, what is the percent yield? ***(2 marks)***

e. A reaction container holds 5.77 g of P_4 and 5.77 g of O_2. The following reaction occurs:

$P_4 + O_2 \rightarrow P_4O_6$. If enough oxygen is available then the P_4O_6 reacts further:

$P_4O_6 + O_2 \rightarrow P_4O_{10}$. (P=31, 0 =16)

i. What is the limiting reagent for the formation of P_4O_{10}? ***(1mark)***

ii. What mass of P_4O_{10} is produced? ***(3marks)***

iii. What mass of excess reactant is left in the reaction container? ***(1mark)***

Question TWO

a. i. Define the term Measured numbers. ***(2 Marks)***

ii. A copper wire is put into silver nitrate. Silver metal appears and the solution turns blue from copper II nitrate. Write a balanced chemical equation using oxidation number method. ***(5 Marks)***

b. i. Name the ionic compounds: $(NH_4)_2SO_4$, $Cu(NO_3)_2$, $ZnCl_2$, $Fe_2(CO_3)_3$ ***(2 marks)***

ii. Hydrocarbons are organic compounds composed entirely of hydrogen and carbon. A 0.1647-gram sample of a pure hydrocarbon was burned in a C-H combustion train to produce 0.4931 gram of CO_2 and 0.2691 gram of H_2O. Determine the masses of C and H in the sample and the percentages of these elements in this hydrocarbon. ***(5 marks)***

c. i. Define the term percent purity of sodium hydroxide. ***(2 mark)***

ii. Calculate the masses of NaOH and impurities in 45.2 g of 98.2% NaOH. ***(4 marks)***

Question Three (20 Marks)

a. Giving relevant examples define;

i. An electrolyte ***(1mark)***

ii. A strong electrolyte ***(2marks)***

iii. A non-electrolyte ***(2marks)***

b. The amount of calcium carbonate ($CaCO_3$; molar mass = 100.1 g mol^{-1}) in the ore dolomite can be determined by gravimetric analysis. The dolomite sample is dissolved in acid (say HCl) and the calcium ions

(Ca^{2+}) present are precipitated as calcium oxalate (CaC_2O_4; molar mass = 128.1 g mol^{1-}). The calcium oxalate is filtered, dried and strongly heated to form calcium oxide (CaO; molar mass = 56.1 g mol^{1-}) as indicated in the equation below; $CaC_2O_4 \longrightarrow CaO + CO + CO_2$.

i. In one analysis the mass of dolomite used was 3.72 g. The mass of calcium oxide formed was found to be 1.24 g. Calculate the percentage of calcium carbonate in the dolomite sample ***(6 marks)***

ii. State two possible sources of error in this analysis ***(2 marks)***

c. i. Describe the common ion effect ***(3 marks)***

ii. State two applications of common ion effect ***(2 marks)***

d. Complexation reactions involve formation of a complex ion/molecule by a central metal and ligands. Identify with reasons the lewis acid and base in the complex $Cu(NH_3)_4Cl_2$. ***(2 Marks)***

Question FOUR (20 Marks)

a. A 5.0000-g sample of coal was combusted in a pure oxygen atmosphere. The sulfur dioxide generated was catalytically converted to sulfate, trapped in a reagent solution, and precipitated as insoluble calcium sulfate, $CaSO_4$ (136.14 g/mol). The calcium sulfate precipitate was filtered, dried, and weighed to be 0.2909 g. If the atomic mass of sulfur is 32.06 g/mol, calculate the % S by mass in the coal sample. ***(7 marks)***

b.i) A 15.6-gram sample of C_6H_6 is mixed with excess HNO_3. We isolate 18.0 grams of $C_6H_5NO_2$. The balanced equation for the reaction may be written as;

$$C_6H_6 + HNO_3 \rightarrow C_6H_5NO_2 + H_2O.$$

i. What is the percent yield of $C_6H_5NO_2$ in this reaction? ***(6 marks)***

ii. Comment on why the actual yield is lower than the Theoretical yield. ***(3 marks)***

ii. Calculate the area in m^2 of a rectangular surface of a catalyst, measuring 1.23 nm wide and 12.34 nm long and justify the number of significant figures in your answer. ***(4 Marks)***

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