CHUKA  **UNIVERSITY**

UNIVERSITY EXAMINATION

RESIT/SUPPLEMENTARY / SPECIAL EXAMINATIONS EXAMINATION FOR THE AWARD OF DEGREE IN BACHELOR OF

CHEM 110: INORGANIC CHEMISTRY

STREAMS: **TIME: 2 HOURS**

DAY/DATE: TUESDAY 04/05/2021 **11.30 A.M - 1.30 P.M.**

INSTRUCTIONS

Answer Question One and any other Two Questions

QUESTION ONE [30 MARKS]

(a) Calculate the number of carbon atoms in 10.0 g of $NaHCO_3$ **(2 Marks)**

(b) Acetic acid contains the elements carbon, hydrogen, and oxygen. A 4.24 mg sample of acetic acid is completely burned in air to give 6.21 mg of carbon dioxide and 2.54 mg of water.

(i) Determine the empirical formula of acetic acid **(5 Marks)**

(ii) Determine the molecular formula of acetic acid, given that the molecular mass of acetic acid is 60.0 g/mol **(2 Marks)**

(c) Calculate the mass of $Ba(OH)_2$ required to prepare 2.50 L of a 0.060 M solution of barium hydroxide **(2 Marks)**

(d) A bottle of concentrated hydrochloric acid is labeled 12.3M HCl. The specific density is given as 1.1906. Calculate:

(a) The mole fraction of HCl **(2 Marks)**

(b) The molality of HCl **(2 Marks)**

(c) The mass percent of HCl **(2 Marks)**

(e) Calculate the wavelength of a photon whose energy is 4.10×10^{-19} J **(2 Marks)**

(f) Calculate the wavelength in nanometers of the line in the Lyman series that results from the transition n = 4 to n = 1 **(2 Marks)**

(g) Calculate the wavelength in meters of an electron traveling at 1.24×10^{7} m/s **(2 Marks)**

(h) Write the electronic configuration of the following species **(3 Marks)**

(i) Cl (ii) S^{2-} (iii) V^{2+}

(i) State whether the following sets of qunatum numbers (n, l, m_l, m_s) are valid or invalid for an electron in an atom. For invalid sets explain why they are impossible **(4 Marks)**

(i) (1, 0, 0, +1) (ii) (1, 3, 3, + ½) (iii) (0, 1, 0, + ½) (iv) (2, 1, -1, + 3/2)

QUESTION TWO [20 MARKS]

(a) Consider the following species: CO_3^{2-} ; H_2O; and NCl_3:

(i) Write the Lewis structure for each of the species **(6 Marks)**

(ii) Write the resonance structures of the CO_3^{2-} ion **(3 Marks)**

(iii) Determine the molecular geometry and bond angle(s) of H_2O and NCl_3 **(3 Marks)**

(b) State the main postulates of Bohr's model for the hydrogen atom. **(5 marks)**

(c) State the type(s) of intermolecular forces that are present in each of the following molecules **(3 Marks)**

(i) Br_2 (ii) H_2O (iii) ICl

QUESTION THREE [20 MARKS]

(a) Discuss the following intermolecular forces: **(6 Marks)**

(i) Dipole-dipole forces (ii) Hydrogen bonding (iii) London dispersion forces

(b) State the postulates of Dalton's atomic theory **(3 marks)**

(c) Explain the periodic trends of the following **(6 marks)**

(i) Ionization energy (ii) Electron affinity (iii) Atomic radii

(d) (f) Calculate each of the following quantities:

(i) the volume in milliliters of 2.26 M potassium hydroxide that contains 8.42 g of the solute (**3 Marks**)

(ii) the number of Cu^{2+} ions in 52 L of a 2.3 M copper (II) chloride solution (**2 Marks**)

QUESTION FOUR [20 MARKS]

(a) Describe how to prepare 60.0 mL of 0.20 M HNO_3 solution, starting with a 4.00 M HNO_3 stock solution (**2 Marks**)

(b) Draw a well labelled Born-Haber cycle for NaCl (**5 Marks**)

(c) Write an orbital diagram for the ground state of the following species (**3 Marks**)

(a) F (b) Co (c) P

(d) A sucrose ($C_{11}H_{22}O_{11}$) solution that is 45.0% sucrose by mass has a density of 1.203 g/mL at 25°C. Calculate:

(i) the molality of the solution (**2 Marks**)

(ii) the molarity of solution (**2 Marks**)

(iii) the mole fraction of sucrose (**2 Marks**)

(e) Magnesium has three naturally occurring isotopes, Mg-24 (23.99 amu), Mg-25 (24.99 amu) and Mg-26 (25.98 amu). Calculate the atomic mass for magnesium given that the isotopic abundance of Mg-24 and Mg-26 are 78.70% and 11.17%, respectively (**4 Marks**).

Useful Constants

$h = 6.626 \times 10^{-34}$ J/s

$c = 3.0 \times 10^{8}$ m/s

$N_A = 6.022 \times 10^{23}$

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