NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF APPLIED CHEMISTRY
BACHELOR OF SCIENCE HONOURS DEGREE
END OF FIRST SEMESTER EXAMINATIONS – JANUARY 2011
INORGANIC CHEMISTRY I – SCH 1101
FOR SCH AND TTE STUDENTS
TIME: 3 HOURS

INSTRUCTIONS TO CANDIDATES

This paper comprises five (5) questions. Attempt to answer ***all*** the questions. Each question carries twenty (20) marks. Start your answer to each question on a new page.

Periodic Table to be supplied
Plank's constant $h=6.626 \times 10^{-34}$ Js Velocity of light $c=2.998 \times 10^{8}$ ms^{-1}
Charge on an electron $e=1.602 \times 10^{-19}$ C Mass of electron $m_e=9.1091 \times 10^{-19}$ kg
Avogadro's number $N_A=6.022045 \times 10^{23}$ mol^{-1} ; Rydberg constant $R=1.0974 \times 10^{-7}$ m^{-1}

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1. a) Specify the set of quantum numbers used to describe an orbital and state what values of each are possible. (8 marks)

   b) Draw diagrams for each of the orbitals: 2s, $2p_z$, $3d_z^2$, $3d_{yz}$ (6 marks)

   c) What is the frequency of a photon emitted when an electron in a hydrogen atom jumps from n = 3 to n = 2? (6 marks)

2. For each of the following four molecules,

   a) Count the number of valence electrons;

   b) Draw the Lewis Structures including all resonance structures;

   c) Identify the hybridization of the center atom;

   d) Draw out the shape of the molecule according to VSEPR; and

   f) Name the molecular geometry.

   i) ClO_3^- ii) Fe_2SeO iii) $IO_2F_2^-$ iv) $(CH_3)_2S$

   (20 marks)

3. a) Using the molecular orbital energy level diagrams draw the expected electronic arrangements for CO and CN^- molecules. What are the bond orders of each of these? Which of the two would be expected to be more stable? Explain.

   (14 marks)

b) Calculate the yield of tungsten prepared by reduction of 33.14g of ore concentrate containing 70% WO_3 with aluminium if 12.75g of metallic tungsten is produced. (6 marks)

4. a) Using the Born-Haber cycle, calculate the energy of electron attachment to O(g) to form $O^{2-}(g)$. Given is the following information.

ΔH^o_f of MgO(s) = -602 $KJmol^{-1}$

ΔH_{vap} of Mg = 150.2 $KJmol^{-1}$

ΔH_{diss} of O_2 = 497.4 $KJmol^{-1}$

$\Delta H_{ion\ (1)} + \Delta H_{ion\ (2)}$ for Mg = 2 188 $KJmol^{-1}$

(10 marks)

b) The bond angle in H_2O is 104.5^o. Explain this observation using VSEPR theory. (5 marks)

c) 3.17 grams of chlorine gas occupy 1 litre (at standard conditions). Calculate the molecular mass of the chlorine. (5 marks)

5. a) Define the coordination number of a cation in a crystal lattice. Why are we more concerned with the coordination number of the cation than the anion? (5 marks)

b) Show, with drawings, the difference between cubic and hexagonal close packing. (10 marks)

c) Write a balanced reaction between B_2Br_6 and HNO_3. (5 marks)

End of question Paper!!!