UNIVERSITY OF MALAYA

EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE

ACADEMIC SESSION 2007/2008 : SEMESTER 1

SCES1210 : INORGANIC CHEMISTRY I

OCT/NOV 2007 TIME: 2:00 HOURS

INSTRUCTION TO CANDIDATES:

THIS PAPER CONSISTS OF SECTION A AND B.

QUESTIONS SHOULD BE ANSWERED ACCORDING TO THE INSTRUCTIONS GIVEN IN EACH SECTION.

(This question paper consists of 11 questions on 5 printed pages)

SECTION A (40 MARKS)

Answer **ALL** questions.

1. (11 marks)

   Draw electron-dot resonance structures and calculate the formal charges for the following species:

   a) N_2O

   b) O_3

   c) $[NCS]^-$

2. (12 marks)

   State the geometry and the hybridization of the central atom in the following molecules:

   a) HCN

   b) SF_6

   c) ClF_3

3. (17 marks)

   a) Draw the Molecular Orbital diagram for B_2 and F_2. Calculate the bond orders and determine which molecule is paramagnetic.

   b) For N_2, N_2^+ and N_2^-, estimate the bond lengths and predict which species has the highest dissociation energy by using the Molecular Orbital theory.

   c) Explain the differences in the internuclear distances of the following oxygen species in term of the Molecular Orbital theory,:

Oxygen species	Internuclear distance (pm)
O_2^+(dioxygenyl)	112.3
O_2 (dioxygen)	120.1
O_2^- (superoxide)	128.0
O_2^{2-} (peroxide)	149.0

   Atomic number: N=7, O=8, S=16, F=9, Cl=17, O=16 and B=5

SECTION B (60 MARKS)

Answer **ALL** questions.

4. (10 marks)

Iron crystallizes in the body-centered cubic (BCC) unit cell with dimension 2.94 Å.

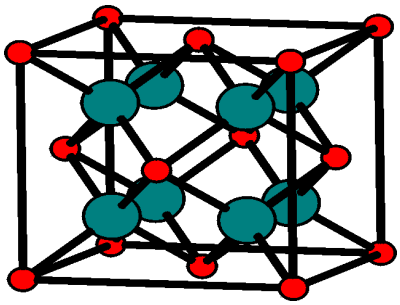
(i) Draw the unit cell.

(ii) Calculate the radius of iron atom.

(iii) Calculate the density of iron metal.

5. (10 marks)

The unit cell of CaF_2 is shown below:



(i) Explain the type of packing adopted by CaF_2.

(ii) What is the coordination number for the cation and anion in this unit cell?

(iii) Derive the radius ratio for this unit cell.

6. (12 marks)

(a) Balance the reaction $Nb(s) + Sb_2O_5(s) \rightarrow Nb_2O_3(s) + SbO^+(aq)$ in acidic solution.

(b) If $E^o(Nb_2O_3/Nb) = -0.644$ V and $E^o(Sb_2O_5/SbO^+) = 0.581$ V, calculate the E^o_{cell} of the reaction in (a).

(c) If the concentration of SbO^+ is 0.1 M, calculate the E_{cell} and equilibrium constant, K.

7. (13 marks)

Given the Latimer diagram for americium in acidic solution:

$$AmO_2^{2+} \xrightarrow{1.60} AmO_2^{+} \xrightarrow{0.82} Am^{4+} \xrightarrow{2.62} Am^{3+} \xrightarrow{-2.3} Am^{2+} \xrightarrow{-1.95} Am$$

(a) Construct a Frost diagram from the above Latimer diagram.

(b) Calculate the E^o for the reduction couples of AmO_2^{2+}/Am^{3+} and Am^{4+}/Am.

(c) Prove that Am^{4+} can disproportionate into AmO_2^{2+} and Am^{3+}.

8. (3 marks)

By applying the hard-soft concepts for acids and bases, predict which of the reactions is favorable.

(a) $HgI_2(s) + MgF_2(s) \rightleftharpoons MgF_2(s) + HgI_2(s)$

(b) $[Cu(CN)_4]^{2-}(aq) + [CuCl_4]^{3-}(aq) \rightleftharpoons [CuCl_4]^{2-}(aq) + [Cu(CN)_4]^{3-}(aq)$

(c) $(CH_3COO)_2Hg + HI \rightleftharpoons CH_3COOH + HgI_2$

Given the order of hardness for the following acids and bases in ascending order: $Hg^{2+} < Cu^{+} < Cu^{2+} < Mg^{2+} < H^{+}$ and $I^{-} < CN^{-} < CH_3COO^{-} < F^{-}$.

9. (4 marks)

By applying the Pauling's rules, arrange the strength of the following oxoacids in ascending order.

HNO_3 , $HClO$, H_3AsO_4, $HClO_4$

10. (4 marks)

Select the best answer and give the reason for your selection.

(a) Thermally most stable complex:

Me_3N-BMe_3, HMe_2N-BMe_3, H_2MeN-BMe_3

(b) Most basic ligand towards BMe_3: $(H_3Si)_3N$, $(H_3C)_3N$

11. (4 marks)

The Drago-Wayland parameters for $SbCl_5$, acetone, ammonia and dimethylsulfoxide are given below:

	E	C
$SbCl_5$	15.1	10.5
Acetone	2.02	4.67
Ammonia	2.78	7.08
Dimethylsulfoxide	2.76	5.83

Arrange the stability of the products formed from the reactions of $SbCl_5$ with the bases given above in ascending order.

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