THE OPEN UNIVERSITY OF SRI LANKA
B.Sc/ B.Ed DEGREE PROGRAMME- 2007/2008
Level 4 - CHU 2123/ CHE 4123
INORGANIC CHEMISTRY

ASSIGNMENT TEST II (NBT)

Date: 11th February 2008 Time: 3.30- 5.00 p.m.

Part A- Multiple Choice Questions (90 marks)

Answer all the questions
Select the most correct answer to each question given below and mark a cross ***X*** over the answer on the **given answer sheet**. Any answer with more than one ***X*** will not be counted. 1/6 th of a mark will be deducted for each incorrect answer.

1. Which of the following is **not** a **chelating** ligand?
   1) H_2NNH_2 2) glycinate 3) acetylacetonate
   4) $H_2NCH_2CH_2NH_2$ 5) $C_2O_4^{2-}$

2. What is the **coordination number** of $[(en)PtCl_2]$? (en = $H_2NCH_2CH_2NH_2$)
   1) 3 2) 4 3) 5 4) 6 5) 2

3. What is the most likely **geometry** of $[Pt(en)(CO)Cl_2]$? (en = $H_2NCH_2CH_2NH_2$)
   1) Square planar 2) Tetrahedral 3) Octahedral
   4) Square pyramidal 5) Trigonal planar

4. The IUPAC name of the complex $Na[Fe(CN)_2Br(NH_3)_3]$ is
   1) Sodium triamminebromodicyanoferrate(II)
   2) Sodium triamminedicyanobromoferrate(II)
   3) Sodium dicyanotriamminebromoferrate(II)
   4) Sodium tramminedicyanobromoferrate(III)
   5) Sodium triaminedicyanobromoferrate(II)

5. Which of the following statements is **not true** about [RhCl(CO)(en)]
   1) Coordination number of Rh is four
   2) CO and chloride ligands are *cis* to each other
   3) It can undergo oxidative addition reactions.
   4) Oxidation number of Rh is +2
   5) It does not have geometrical isomers

6. Pick the **incorrect** statement from the following statements about $[CoF_6]^{3-}$ of which $\mu = 4.90$ BM.
   1) Hybridization of cobalt ion is sp^3d^2.
   2) It is an outer-orbital complex.
   3) It is a low-spin complex.
   4) It is a paramagnetic complex.
   5) Oxidation state of Co is +3.

7. Consider the following statements (a), (b) and (c).
   (a) σ-donors can be called as Lewis bases.
   (b) Back donation increases the electron density at the metal centre.
   (c) PPh_3 is a π-acceptor ligand.
   The **correct** statement/s is/are
   1) (a) only. 2) (b) only. 3) (a) and (c) only.
   4) (b) and (c) only. 5) (a), (b) and (c).

8. Predict the magnetic moment of the complex $[Mn(H_2O)_6]^{2+}$. Water is a **weak ligand** and ($\mu = [n(n+2)]^{1/2}$ B.M.
   1) 0 2) 1.73 3) 2.83 4) 4.89 5) 5.91

9. Consider the following statements regarding $[Ti(H_2O)_6]Cl_3$.
   (a) It is a paramagnetic complex with one *d*-electron in the t_{2g} level.
   (b) The crystal field stabilization energy is $-0.6\ \Delta_o$.
   (c) It is an octahedral complex where all the electrons lie in the e_g level.
   The **correct** statement/s is/are
   1) (a) only 2) (a) & (b) only 3) (a) & (c) only.
   4) (b) & (c) only. 5) (a), (b) & (c)

10. Which of the following complex would give the **largest** amount of AgCl precipitate on addition of silver nitrate solution (excess) to a solution containing one equivalent of the complex?
   1) $K_3[CrCl_6]$ 2) $[CrCl_2(NH_3)_4]Cl$
   3) $[Cr(CO)_2(NH_3)_4]Cl_3$ 4) $[CrCl(NH_3)_5]Cl_2$
   5) $[CrCl_3(NH_3)_3]$

11. Select the **correct** statement,
   1) In most nuclear reactions, the starting atomic nucleus remains unchanged.
   2) Most nuclei are radioactive and they emit small particles.
   3) Spontaneous emission of radiation from elements resulting in the formation of new elements is called radioactivity.
   4) Radioactivity depends on the physical state of the element.
   5) Only the heavier (Z > 83) nuclei are radio-active.

12. If the **mass defect** is 0.0300 amu, the **binding energy** is
   (assume the velocity of light (c) = 3×10^8 ms^{-1} and 1 amu = 1.661×10^{-27} kg)
   1) 0.03/c 2) $0.03/c^2$ 3) 0.448×10^{-11} J
   4) 0.27×10^{16} J 5) 0.149×10^{-19} J

13. ^{14}N combines with an **alpha** particle to give ${}_1^1H$ and another particle ${}_b^aX$. The particle X would be,
   1) ${}_6^{12}C$ 2) ${}_9^{19}F$ 3) ${}_8^{17}O$ 4) ${}_{11}^{23}Na$ 5) ${}_{10}^{20}Ne$

14. The SI unit of the **decay constant** is
   1) s^{-1} 2) s 3) counts/s 4) dps 5) no units

15. The half-life of an isotope is 1.83 hrs. How many minutes will it take for the activity to fall to 75% of its initial value?

1) 0.76 min 2) 6.5 min 3) 27.5 min 4) 45.9 min 5) 54.9 min

Part B- Structured Essay (110 marks)

1. (a) (i) Calculate the EAN of the metal centre in each of the following complexes.

I. $[MnBr(CO)_3(en)]$ (Atomic no. of Mn = 25)

II. $[Fe(NH_3)_3(H_2O)_3]^{3+}$ (Atomic no. of Fe = 26) (16 marks)

(ii) Co^{3+} forms a stable **neutral octahedral** complex (**A**) with the ligands NH_3 and Cl.

I. Write the composition of (**A**).

II. Draw the **structures** of the two geometrical isomers of (**A**). (24 marks)

(b) According to Crystal Field Theory,

(i) What is the **d-electron** configuration of chromium in $[Cr(H_2O)_6]^{2+}$?
(Atomic number of Cr = 24; H_2O is a weak ligand)

(ii) Calculate the **CFSE** and **Total Stabilization Energy** in **kJ mol^{-1}**
if $\Delta_0 = 213$ kJ mol^{-1} and The Pairing Energy = 150 kJ mol^{-1}

(iii) What is the μ_s value of this complex? (30 marks)

2. (a) (i) **Write** the relationship between **decay constant** (λ) and **half-life** ($t_{½}$)?

(ii) Nitrogen-16 undergoes a β decay with a half-life of 100 years.

(α) Calculate the decay constant.

(β) Write the balance equation for the above process (20 marks)

(b) Write an equation for the **positron** emission of sodium-22. (8 marks)

(c) Compare the properties of **alpha** and **beta** particles. (12 marks)

THE OPEN UNIVERSITY OF SRI LANKA

B. Sc. Degree Programme – 2007/2008

CHU 2123/CHE 4123– Inorganic Chemistry

Assignment Test II

M.C.Q. ANSWER SHEET: Mark a cross (X) over the most suitable answer.

Name: .....

Index. No.

FOR EXAMINERS USE		
Unanswered		
Correct Answers		
Wrong Answers		
Total		

1.	1	2	3	4	5	2.	1	2	3	4	5	3.	1	2	3	4	5
4.	1	2	3	4	5	5.	1	2	3	4	5	6.	1	2	3	4	5
7.	1	2	3	4	5	8.	1	2	3	4	5	9.	1	2	3	4	5
10.	1	2	3	4	5	11.	1	2	3	4	5	12.	1	2	3	4	5
13.	1	2	3	4	5	14.	1	2	3	4	5	15.	1	2	3	4	5

THE OPEN UNIVERSITY OF SRI LANKA
B. Sc. DEGREE PROGRAMME 2007/2008
CHU2123/CHE 4123 – INORGANIC CHEMISTRY
ASSIGNMENT TEST II **ANSWER GUIDE**

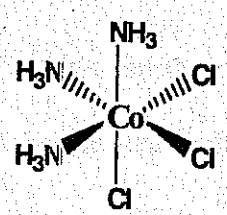
Part A – MCQ ANSWER GUIDE

1. (1)	2. (2)	3. (4)	4. (1)	5. (4)
6. (3)	7. (3)	8. (5)	9. (1)	10. (3)
11. (3)	12. (3)	13. (3)	14. (1)	15. (4)

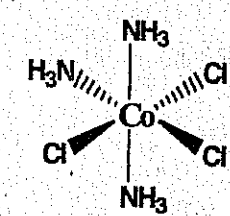
Part B

1. (a) i. (I) EAN = (A.N. – O.N.) + 2 x C.N. = (25 - 1) + 2 x 6 = 36
(II) EAN = (A.N. – O.N.) + 2 x C.N. = (26 - 3) + 2 x 6 = 35

ii. (I) $[CoCl_3(NH_3)_3]$
(II)

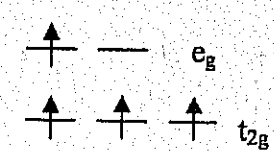


fac- iosomer



mer- iosomer

(b) $Cr^{2+} \rightarrow d^4$



(For octahedral complexes, H_2O is a weak field ligand)

(i) *d*-electron configuration = $t_{2g}^3.e_g^1$
(ii) CFSE = (-0.4 x 3 + 0.6 x 1) Δ_o = -0.6 x 213 kJ mol^{-1}
= -127.8 kJ mol^{-1}
Total Stabilization Energy = CFSE
(iii) $\mu = \{n(n+2)\}^{1/2} = (4 \times 6)^{1/2}$
= 4.9 BM

2. (a) (i) $t_{1/2} = 0.693/\lambda$
(ii) (α): λ = 0.693/100 years = 6.93 x 10^{-3} y^{-1} (0.2197 x 10^{-9} s^{-1})
(β): $^{16}_{7}N \rightarrow {}^{0}_{-1}\beta + {}^{16}_{8}O$

(b) $^{22}_{11}Na \rightarrow {}^{0}_{1}e + {}^{22}_{10}Ne$

(c) alpha = $^{4}_{2}\alpha$ (He^{2+}) - detected by electric/magnetic field
beta = $^{0}_{-1}\beta$ (electron) - detected by electric/magnetic field

Penetrating power : $\alpha < \beta$

THE OPEN UNIVERSITY OF SRI LANKA

B.Sc./B.Ed. DEGREE/STAND ALONE COURSES IN SCIENCE – LEVEL 4

FINAL EXAMINATION – 2007/2008

CHU2123/CHE4123 – INORGANIC CHEMISTRY

Date: 28th June 2008 (Saturday) 10.00 a.m. – 12.30 p.m.

Gas constant, R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
Planck's constant, h	=	$6.63 \times 10^{-34}\ J\ s$
Avogadro constant, L	=	$6.023 \times 10^{23}\ mol^{-1}$
Velocity of light, c	=	$3 \times 10^{8}\ m\ s^{-1}$
Charge on electron	=	$1.602 \times 10^{-19}\ C$
Mass of an electron	=	0.0005 a.m.u.
Mass of a proton	=	1.0073 a.m.u.
Mass of a neutron	=	1.0089 a.m.u.
1 a.m.u.	=	$1.661 \times 10^{-27}\ kg$
1 Mev	=	$1.6021 \times 10^{-13}\ J$

Answer any FOUR (04) questions.

If more than four questions are answered, **only the first four answers will be marked.**

1. (a) (i) Give the IUPAC name of $[FeBr_2(acac)(H_2O)_2]$. (acac = acetylacetonate ion)

(ii) What is the coordination number of Fe in (i)?

(iii) Calculate the Effective Atomic Number (EAN) of Fe in (i).

(Atomic number of Fe is 26)

(iv) Does it obey the EAN rule? (20 marks)

(b) Draw the **structures** of all five **geometrical** isomers of $[FeBr_2(NH_3)_2(CO)_2]$. (20 marks)

(c) (i) According to the Crystal Field Theory, what is the d-electron configuration of cobalt in $[CoBr_4]^{2-}$? (Atomic number of Co is 27).

(ii) Calculate the Crystal Field Stabilisation Energy in kJ mol^{-1} of $[CoBr_4]^{2-}$ if $\Delta_t = 150$ kJ mol^{-1}.

(iii) Calculate the spin only magnetic moment (μ_s) of $[CoBr_4]^{2-}$. (25 marks)

(d) Using Valence Bond Theory predict the hybridization of cobalt in $[Co(NH_3)_6]^{3+}$ if the magnetic moment of the complex is zero B.M. (15 marks)

(e) How would you prepare *cis*-$[PtCl_2(Py)(CO)]$from $[PtCl_4]^{2-}$ if the order of ***trans*-effect** is CO > Cl > Py (pyridine). (20 marks)

2. (a) An octahedral complex (**B**) with the empirical formula $CoBr_3 \cdot 4NH_3 \cdot 2H_2O$ shows a molar conductivity typical for a 1:1 electrolyte (100 $m^2\ \Omega^{-1}\ mol^{-1}$). What is the molecular formula of (**B**)? Draw the structures of the two isomers of (**B**) and identify the type of isomerism involved. (20 marks)

(b) $PtCl_2$ reacts with two moles of ethylenediamine to give a square -planar Pt(II) complex **X**. When a solution of **X** (1 mole) reacts with an excess of $AgNO_3$, AgCl (2 moles) is precipitated. Draw the structure of **X**. (15 marks)

(c) (i) State the Jahn Teller Theorem.

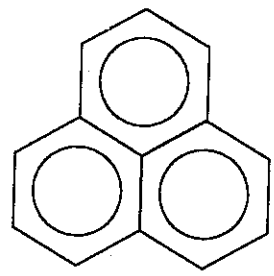
(ii) $[Cu(NH_3)_6]^{2+}$ has four Cu-N bonds with a bond length of 207 pm and two Cu-N bonds with a bond length of 262 pm. How many d-electrons are there in the d_z^2 and $d_x2_{-y}2$ orbitals ? (15 marks)

(d) Define the following as applied in the study of molecular symmetry.

(i) Axis of rotation

(ii) Order of an axis of rotation (10 marks)

(e) Consider the planar aromatic molecule with three benzene rings as shown below.



(i) Copy the above structural formula on to your answer sheet and indicate all the axes of rotation of the molecule in standard notation (clearly indicating the order of axis) on it.

(ii) What is the symmetry point group of this molecule? Briefly explain your answer.

(24 marks)

(f) A non-planar molecule has an improper rotation axis of order seven, i.e. S_7.

(i) In standard notation list all possible distinct improper rotational symmetry operations of the molecule that can be performed about this axis.

(ii) Which operation/s listed above is/are equivalent to the identity operation?

(16 marks)

3. (a) Write complete nuclear equations for each of the following notations:

(i) $^{59}_{27}Co$ (n, α) (ii) $^{31}_{15}P$ (n,) $^{32}_{15}P$ (iii) $^{7}_{3}Li$ (p,) $^{4}_{2}He$ (15 marks)

(b) Write balanced equations for the following nuclear reactions.

(i) positron mission by $^{11}_{6}C$

(ii) β emission by carbon-14

(iii) electron capture by $^{40}_{19}K$

(15 marks)

(c) $^{225}_{88}Ra$ decays with a half-life of 15 days to produce $^{225}_{89}Ac$.

Answer the following questions:

(i) Identify the type of decay involved in the above process.

(ii) Calculate the decay constant (λ)

(iii) Calculate the percentage of Radium-225 that will remain after 5 days.

(iv) Calculate the time taken to decay 75% of the original sample. (30 marks)

(d) Below is a part of the (4n+2) decay series

$$^{238}_{92}U \xrightarrow{-\alpha} X \xrightarrow{?} {}^{234}_{91}Pa \xrightarrow{-\beta} Y \xrightarrow{?} {}^{230}_{90}Th \xrightarrow{-\alpha} Z$$

Complete the portion of the series by adding missing particles, and mass numbers and atomic numbers of X, Y, Z.

(15 marks)

(e) (i) Acetic acid is not an acid in H_2SO_4. Explain

(ii) What is meant by an "amphoteric solvent". Give two examples.

(iii) Give two examples for an ammonolytic reaction. (25 marks)

4. (a) Amorphous silica has a density of about 2.2 g cm^{-3}, whereas the density of crystalline quartz is 2.65 g cm^{-3}. Relate the differences in densities to the structures of the substances. (20 marks)

(b) A substance melts with some decomposition at 720 °C. As a solid it does not conduct electricity; but dissolves in water to form a conducting solution. Predict the type of bonding in the solid. (15 marks)

(c) For each of the following pairs of substances, predict which will have the higher melting point and give a reason for your choice.
(i) Ar, Xe (ii) SiO_2, CO_2 (20 marks)

(d) Use appropriate diagrams to explain why diborane molecule is called
(i) an electron deficient compound
(ii) a molecule with unusual bonding. (30 marks)

(e) What is more effectively diffracted by crystals: X-rays or visible light? Give reasons for your answer. (15 marks)

5. (a)(i) Sketch the unit cell of CsCl.
(ii)Calculate the number of Cs^+ ions and Cl^- ions in the unit cell.
(iii) How many formula units are there in a unit cell? (30 marks)

(b) An ammonium halide, NH_4X has the CsCl structure at room temperature, with unit cell length of 4.059 Å. It is transformed to the NaCl structure at 138 °C. If the density of the polymorph is 2.431 g cm^{-3} at room temperature, identify the substance. Give reasons for your answer. (35 marks)

(c) Explain why the conductivity of NaCl at 800 °C just below its melting point is about 10^{-3} $ohm^{-1}cm^{-1}$, whereas at room temperature, pure NaCl is an insulator with a conductivity much less than 10^{-12} $ohm^{-1}cm^{-1}$. (10 marks)

(d) Sketch a sodium chloride lattice with a Schottky defect.
Will such a crystal preserve electroneutrality? Give reasons for your answer.
How do you compare the behaviour of the above lattice with that of a lattice with " F-centres" in a magnetic field? (25 marks)

6. (a) (i) Write a balanced chemical equation for the decomposition of $CaCO_3$. What will be the expression for K_p?

(ii) Use the trends in the properties of ions of Group 2 to explain how the numerical value of K_p for the above reaction would change if $BaCO_3$ is used instead of $CaCO_3$.

(iii) What property of barium makes it possible to be used in the "barium meal" in medical diagnosis? (25 marks)

(b) An acidic solution of **potassium permanganate** liberates chlorine gas when reacted with a sodium chloride solution but an acidic solution of **potassium dichromate** does not show any effect.

Explain the above observation using the data below.

$$MnO_4^-(aq) + 8H^+(aq) + 5e \longrightarrow Mn^{2+}(aq) + 4H_2O \quad E^\circ = +1.52\ V$$

$$Cl_2(g) + 2e \longrightarrow 2Cl^- \quad E^\circ = +1.36\ V$$

$$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 7e \longrightarrow Cr^{3+}(aq) + 7H_2O \quad E^\circ = +1.33\ V$$

(30 marks)

(c) A 0.204 g sample of steel was made to react completely with excess dilute sulphuric acid. The resulting solution required 27.40 cm^3 of 0.022 mol dm^{-3} potassium dichromate solution for complete reaction. Calculate the percentage of iron in the sample of steel.
(Relative atomic mass: K = 39; Cr = 52; O = 16) (25 marks)

(d) With appropriate equations explain how the oxidative properties of dichromate ion can be used to detect alcohol in the breath. (20 marks)
