TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Applied and Health Sciences

DEPARTMENT OF PURE AND APPLIED SCIENCES

UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF TECHNOLOGY IN APPLIED CHEMISTRY

ACH 4209 : COMPARATIVE STUDY OF TRANSITION ELEMENTS

SPECIAL/SUPPLEMENTARY EXAMINATION

FEBRUARY 2013 SERIES 2 HOURS

Instructions to candidates:

This paper consist of **FIVE** questions
Answer question **ONE** (compulsory) and any other **TWO** questions

Question ONE

a) (i) Define the term "transition element". **(1mark)**

(ii) Explain why transition elements exhibit variable oxidation states. **(2marks)**

(iii) Explain why chromium exhibits a number of oxidation states upto a maximum of +6, while for nickel the only common oxidation state is +2. **(5marks)**

b) (i) Explain the meaning of the term " catalytic hydrogenation". **(1mark)**

(ii) Differentiate between "heterogenous" and "homogenous" hydrogenation. **(2marks)**

(iii) State TWO applications of hydrogenation. **(2marks)**

c) (i) Write the electronic configurations of the following ion-pairs: Mn^{3+}/Mn^{2+} and Fe^{3+}/Fe^{2+} **(2marks)**

(ii) Explain why the standard electrode potential value for the reaction Mn^{3+} /Mn^{2+} (E° = + 1.60V) is higher than that for FE^{3+}/Fe^{2+}(E = + 0.80V). **(7marks)**

(iii) State THREE applications of manganese and its compounds. **(3marks)**

d) Explain the following:

(i) Most transition metals react very slowly with dilute mineral acids despite being electropositive **(2marks)**

(ii) Aqueous solution of cobalt (II) nitrate is acidic. **(3marks)**

Question TWO

a) (i) Define the "Ligand field theory". **(2marks)**

(ii) Explain the splitting of d-orbitals in an actahedral ligand field. **(8marks)**

b) (i) Briefly explain the TWO mechanisms of catalysis by transition metals and their compounds. **(4marks)**

(ii) Give FOUR industrial catalytic processes and state the transition metal or compound used as catalyst in each case. **(4marks)**

(iii) State TWO advantages of Ziegler-Natla catalysts over free-radical polymerization. **(2marks)**

Question THREE

a) Write the molecular structures of the following coordination compounds.

(i) Pentaamminecarbonatocobalt(III) chloride. **(1mark)**

(ii) Bis(ethylenediamine) dinitrocobalt(III) bromide **(1mark)**

(iii) Potassium tetracyanonickelate(O) **(1mark)**

(iv) Calcium bis[ethylenediaminetetraacetatoferrate (III)] **(1mark)**

(v) Sodium pentachloroammineplatinate(IV). **(1mark)**

b) Explain the following :

(i) Transition metals have higher densities than s-block elements in the same period.

(2marks)

(ii) $CoCl_2$ is less thermally stable than $CaCl_2$ **(4marks)**

(iii) Low-spin octahedral Co^{3+} compounds have no magnetic properties. **(4marks)**

c) Discuss the relative stabilities of the +2 and +3 oxidation states in Mn and Fe in terms of electronic configurations. **(5marks)**

Question FOUR

a) (i) Explain the origin of paramagnetic moments in transition metal compounds.

(3marks)

(ii) Calculate the "Spin-only" magnetic moment of a high-spin octahedral Cobalt(II) complex. **(7marks)**

$\{Ms = 2\sqrt{S(S+1)}\}$

b) (i) Differentiate between "normal covalence" and coordinate covalence**. (2marks)**

(ii) Explain why transition metal compounds are often referred to as "coordination" compounds **(2marks)**

c) Give ONE application for each of the following transition metals and their oxides.

(i) Cr and CrO_2 **(2marks)**

(ii) Co and CoO **(2marks)**

(iii) Ti and TiO_2 **(2marks)**

Question FIVE

a) Give systematic names of the following transition metal complex compounds.

(i) $[Cr(H_2O)_4\,Cl_2]\,Cl$ **(1mark)**

(ii) $[Fe(CN)_6]^{3-}$ **(1mark)**

(iii) $[Co\,en_2Cl_2]^{+}$ **(1mark)**

(iv) $[Ni(NH_3)_4Br_2]$ **(1mark)**

(v) $Na[PtCl_3NH_3]$ **(1mark)**

b) Explain the mechanism of colour formation in transition metal compounds. **(4marks)**

c) Explain the following

(i) Scandium is not considered a transition element. **(3marks)**

(ii) CaO is soluble in water , while CoO is only sparingly soluble. **(4marks)**

d) Discuss the relative stabilities of the Cr^{3+} /Cr^{2+} and Co^{3+}/Co^{2+} ion pairs, the standard electrode potential values being -0.40V and + 1.91V, respectively. **(4marks)**