TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF APPLIED AND HEALTH SCIENCES

DEPARTMENT OF PURE & APPLIED SCIENCES

UNIVERSITY EXAMINATION FOR:

BACHELOR OF TECHNOLOGY IN APPLIED CHEMISTRY:

BTAC/SEP2014/J-FT Y2S2; BTAC/SEP 2015/S-PT Y2S2

ACH4209: COMPARATIVE STUDY OF TRANSITION ELEMENTS

PAPER 1

SERIES: APRIL 2016

TIME: 2 HOURS

DATE: Pick DateSelect MonthPick Year

Instructions to Candidates
You should have the following for this examination
-Answer Booklet, examination pass and student ID
This paper consists of **FIVE** questions. Attempt question ONE (Compulsory) and any other TWO questions.
Do not write on the question paper.

Question ONE

(a) i) Explain what you understand by the phrase "transition element" and state with
reasons which of the d-block elements may not be supported by your definition.

(4 marks)

ii) The pHs of 0.1 M aqueous solutions of $FeCl_3$, $AlCl_3$ and $Cu(NO_3)_2$ are 2.0, 3.0 and

4.0, respectively. Give reason(s) to explain this acidity. (4 marks)

(b) i) Write down electronic configuration of:

I) Cr^{3+} ($_{24}Cr$) II) Pm^{3+} ($_{60}Pm$) (2 marks)

ii) Enumerate any THREE common uses of MnO_4^- (3 marks)

(c) The highest oxidation state for the early transition metal elements Sc, Ti, V, Cr, and Mn is the group number. On the other hand the highest oxidation state for the later elements of the same period (Fe, Co, Ni, and Cu) is less than the group number. (5 marks)

(d) Explain giving reasons:
   i) Transition metals and many of their compounds form colored compounds.
   (3 marks)

   ii) The atomic/ionic radii of transition metals first *decreases* till the middle, becomes *almost constant* and then *increases* towards the end of the period. (3 marks)

(e) Use chemical equation to describe the reaction of acidified potassium permanganate solution with SO_2 and oxalic acid. (6 marks)

Question TWO

(a) Explain why Cr^{2+} is reducing and Mn^{3+} is oxidizing when both have d^4 configuration? (2 marks)

(b) i) Write half-equations for the oxidation of Fe^{2+} and for the reduction of $Cr_2O_4^{2-}$ in acidic solution, and use these to construct an overall equation for the reaction between these two ions. (5 marks)

(c) Briefly describe the mechanism polymerization of ethylene using Zieglar-Natta. What is the meant by the terms high density polyethylene (HDPE) and low density polyethylene (LDPE)? Use a diagram to show the difference between an atactic or syndiotactic polymer. (9 marks)

(d) i) Write down the formula and charge of the complex ion made from one titanium (III) ion and six water molecules. (2 marks)

   ii) Calculate the 'spin only' magnetic moment of M^{2+} (aq) ion ($Z = 25$). (2 marks)

Question THREE

(a) Determine the charge on the transition metal ion in the following complexes.
   i. $Na_2Co(SCN)_4$
   ii. $Ni(NH_3)_6(NO3)_2$
   iii. K_2PtCl_6 (6 marks)

(b) Describe the Chloride Process for the manufacture of titanium dioxide from rutile. (14 marks)

Question FOUR

(a) Draw the chemical structure of each of the following species.
   (i) The bipyramidal complex, $[Ni(CN)_5]^{3-}$
   (ii) The tetrahedral complex, $Ni(CO)_4$

(iii) The trigonal bipyramidal, VF_5

(iv) The octahedral complex, $[Co(NH_3)_6]^{3+}$

(v) The trigonal/or pyramidal, $FeCI_3$ (15 marks)
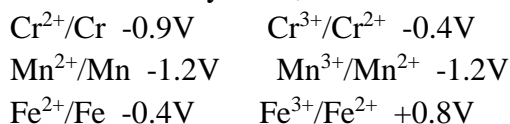
(b) Account for the fact that Cobalt (II) is stable in aqueous solution but in the presence of complexing reagents it is easily oxidized. (5 marks)

Question FIVE

(a) A solution of iron salt reacts with aqueous sodium hydroxide to form a red-brown precipitate:

  I. Identify the iron ion present. (1 marks)

  II. Determine its oxidation number. (1 marks)

  III. Write ionic equation for the reaction taking place (3 marks)

(b) For M^{2+}/M and M^{3+}/M^{2+} systems, $E^{\ominus}$ values for some metals are as follows:

   Cr^{2+}/Cr -0.9V Cr^{3+}/Cr^{2+} -0.4V

   Mn^{2+}/Mn -1.2V Mn^{3+}/Mn^{2+} -1.2V

   Fe^{2+}/Fe -0.4V Fe^{3+}/Fe^{2+} +0.8V

Use this data to answer the following questions:

i) Compare the stability of the metal ion Fe^{3+} in acid solution relative to that of Cr^{3+} and Mn^{3+}, respectively. (3 marks)

ii) Arrange the given pairs of metals in increasing order of reduction potential and comment on the ease with which iron can be oxidized compared to chromium and manganese. (3 marks)

(b) The scheme below shows some reactions of chromium compounds in aqueous solution. Study it to answer the questions that follow.

 i) (i) Identify a reagent for Reaction **2**. (1marks)

  (ii) Deduce the oxidation state of chromium in CrO_4^{2-}. (1 marks)

  (iii) Identify a reagent needed for Reaction **3**. Write a half-equation for the conversion of $[Cr(OH)_6]^{3-}$ into CrO_4^{2-}. (3 marks)

 ii) Identify the chromium-containing species present in the blue solution **D** formed in Reaction **6** and state the role of zinc in its formation. (2 marks)
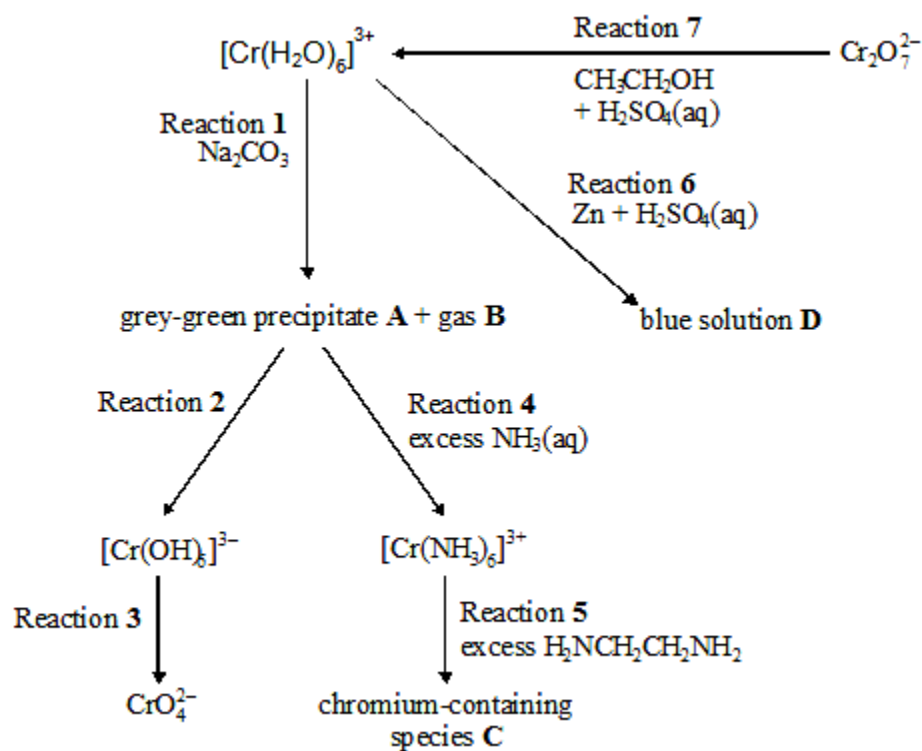
ii) Two organic compounds are formed in Reaction **7**. One of these compounds has a low boiling point and can be distilled readily from the reaction mixture. The other compound has a higher boiling point and is the main organic product formed when the reaction mixture is refluxed.

  (i) Identify the organic product which has a low boiling point.

  (1 marks)

  (ii) Identify the main organic product formed when the mixture is refluxed.

  (1 marks)

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