



MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FOURTH YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF EDUCATION SCIENCE

SCH 400: COMPARATIVE STUDY OF TRANSITION ELEMENTS

DATE: 7/5/2019

TIME: 2.00-4.00 PM

INSTRUCTIONS TO CANDIDATES

Answer Question One [Compulsory] and Any Other Two Questions.

QUESTION ONE (30 MARKS)

- The compounds VOCl and VOBr where V is in oxidation state +3 are known but not NbOCl and TaOCl . Explain why this could be so. (2 marks)
- A transition metal ion catalyses the original reaction by providing an alternative route between reactants and products that has a lower activation enthalpy. Draw reaction coordinate diagrams that clearly show the difference between a catalysed and a non-catalysed reaction. (3 marks)
- State any 3 uses of titanium (3 marks)
- Draw the idealized structure of Re_3Cl_9 (2 marks)
- Describe with equations only, the extraction of Zr from ZrSiO_4 ore (3 marks)
- List any three stages involved in metallurgy (3 marks)
- Show that the manganate and permanganate equilibrium is interrelated and pH dependent. (3 marks)
- Given that $[\text{Co}(\text{1-norbornyl})_4]$ has a d^5 configuration and a room temperature magnetic moment of 1.89 BM determine whether it is low spin or High spin. Draw the structure of norbornyl and indicate the donor atoms (3 marks)

- i) Compare the structure of CuCl_2 with that of $\alpha\text{-PdCl}_2$ (2 marks)
- j) How can one tell that a solution contains Fe^{3+} ? Give two methods. (2 marks)
- k) Arguably, coinage metals, copper (Cu), silver (Ag) and gold (Au) should not be classified as transition elements. Their resistance to chemical attack increases from Cu to Au. In particular, Au is only attacked by aqua regia giving bright yellow tetrachloroaurate(III) complex ion, AuCl_4^- .
 - i. Explain why coinage metals shouldn't be classified as typical transition metals (2 marks)
 - ii. Write down the ionic equation for the formation of AuCl_4^- . (2 marks)

QUESTION TWO (20 MARKS)

- a) Pd^{II} and Pt^{II} complexes with ammonia and amines, especially those of the types $[\text{ML}_4]^{2+}$ and $[\text{ML}_2\text{X}_2]$, are numerous. Chernyaev, a Russian Chemist, noticed that with alternative positions of an incoming ligand might affect a substitution and has considerable influence on the synthetic coordination chemistry of Pt^{II} .
 - i. In this context, outline the consequences of trans-effect (3 marks)
 - ii. Describe how the 'trans effect' is applied in the preparation of three isomers of $[\text{PtCl}(\text{NH}_3)(\text{NH}_2\text{Me})(\text{NO}_2)]$. (6 marks)
- b) Bis(dimethylglyoximate)nickel(II), $[\text{Ni}(\text{dmg})_2]$ is Ni^{II} complex that is used in Ni^{2+} qualitative analysis. Describe in detail how it is formed. (5 marks)
- c) With relevant equations, discuss the pyrometallurgy process in the context of extractive metallurgy of Nickel from its ores. (6 marks)

QUESTION THREE (20 MARKS)

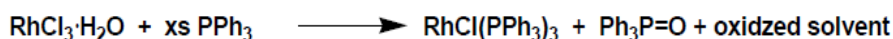
- a) Discuss rusting of iron
 - i. as an electrochemical reaction
 - ii. as a chemical reaction and its prevention (8 marks)
- b) Discuss the uses of **group 7 elements** and the properties that make them suited for the uses (6 marks)

- c) Cr_2O_3 is obtained by air oxidation of chromite in molten alkali to give sodium chromate, Na_2CrO_4 , which is leached out with water, precipitated and then reduced to the Cr(III) oxide by carbon. Write relevant equations to illustrate these processes (6 marks)

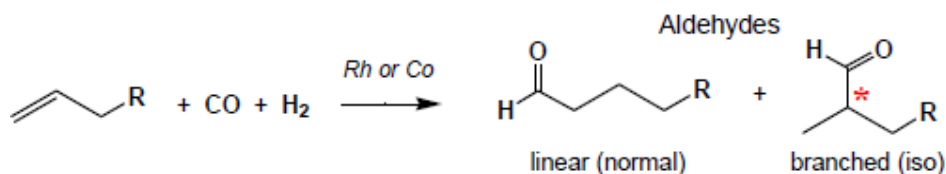
QUESTION FOUR (20 MARKS)

- a) Write down the proposed mechanism for each of the following reactions; (15 marks)

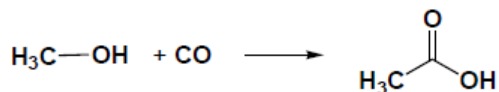
- i. Production of the Wilkinson's Catalyst ($\text{RhCl}(\text{PPh}_3)_3$), a highly active homogeneous hydrogenation catalyst



- ii. Hydroformylation using Co/Rh catalyst



- iii. The Monsanto (BP) Acetic Acid Processes



- b) Briefly describe the mechanism involved in the polymerization of an alkene over the Ziegler-Natta catalyst $\text{TiCl}_4/\text{AlEt}_3$. Would you expect a regular or an irregular polymer? Explain your answer. (Describe the main stages involved). (5 marks)

QUESTION FIVE (20 MARKS)

- a) The poly acids of Mo and W are classified into two main groups, isopolyacids and heteropolyacids. Discuss each of these bearing in mind that their chemistry is not well understood. (6 marks)
- b) MoO_3 and WO_3 differ from CrO_3 in several ways. Describe THREE of them. (6 marks)
- c) Given a supply of potassium dichromate and any other reagent you may require, how would you prepare:
- a solution of K_2CrO_4 ;
 - Crystals of Cr_2O_3 ;
 - Crystals of chrome alum;
 - Crystals of chromium (II) acetate
- (8 marks)