

CHUKA



UNIVERSITY

UNIVERSITY EXAMINATIONS

FOURTH YEAR EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF EDUCATION (SCIENCE)

CHEM 416: COMPARATIVE STUDY OF D AND F BLOCK ELEMENTS

STREAMS:

TIME: 2 HOURS

DAY/DATE: FRIDAY 15/7/2016

11.30 A.M. – 1.30 P.M.

INSTRUCTIONS:

- **Answer question one and any other two questions (Total marks 70)**

1. (a) Transition elements comprise those in the D and F – blocks
 - (i) Explain why the D- block elements show variable oxidation states. (2marks)
 - (ii) Although the most stable and common oxidation state in the F block is $+3$ but also $+2$ and $+4$ exist. Give an explanation for the occurrence of these two additional oxidation states. (2marks)
- (b) The major characteristics which distinguish both D and F blocks from other elements is the formation of coloured compounds and generation of magnetic moments in the compounds.
 - (i) Explain how magnetic moments are generated in these two blocks of elements. (2marks)
 - (ii) The first series of the D-block elements has magnetic moments from orbital contribution Quenched . Explain the term quenching and account for it in these elements of the first row of the D-block. (2marks)

- (iii) Using symbols and appropriate equations, derive the appropriate equations for the magnetic moments in the D and F –block elements. (4marks)
- (iv) Show clearly the differences which exist in the equations for the magnetic moments of the two blocks D and F. (3marks)
- (c) Another characteristic associated with the D and F block elements is formation of coloured compounds by the elements.
- (i) Name four transition which contribute to colour of the transition elements. (2marks)
- (ii) Explain briefly how electronic d-d transitions occur in the transition metal compounds. Use the appropriate symbols and diagrams to illustrate your answers. (9marks)
2. (a) The main copper ore for traditional (conventional) mining is chalcopyrite.
- (i) Give the chemical formula of chalcopyrite. (1mark)
- (ii) Explain the steps involved in the extraction of copper from chalcopyrite with the help of balanced chemical equations. (4marks)
- (iii) Explain why this method of extraction is of environmental concern. (2marks)
- (b) A more friendly method of copper extraction known as leach solvent extraction electro-winning (SX/EW) is from other copper ores such as azurite and malachite.
- (i) Give the chemical formulae of the two ores mentioned in b above. (2marks)
- (ii) Outline the steps involved in this method of extraction without chemical equations. (4marks)
- (c) Explain in details how a lanthanide metal, say cerium , is extracted from the major mineral deposit monazite, which is a lanthanide orthophosphate, including the following steps in your discussion:
- (i) Initial separation of the target element from other elements. (2marks)
- (ii) Separation of the target element from other lanthanide elements. (2marks)
- (iii) Generation of the pure metal. (2marks)
3. (a) The CO molecule is said to be inert with negligible Lewis basicity (donor ability) yet it is capable of forming stable complexes with transition metals in low or zero oxidation states.

- (i) What is $\pi\pi$ acceptor ligand? (2marks)
- (ii) Describe in details the bonding which occurs between the transition metals at their low oxidation states and the $\pi\pi$ acceptor ligands like CO. Use suitable diagrams to illustrate your answer. (4marks)
- (iii) Describe the effect of back donation on the structure of CO bond. (3marks)
- (b) How do the following affect the bond strength of CO molecule?
- (i) Replacement of some of the CO ligand groups by the non $\pi\pi$ acceptor ligands in an octahedral complex. (1mark)
- (ii) When $\text{Cr}(\text{CO})_6$ is converted to $\text{Cr}(\text{CO})_6^-$ (1mark)
- (iii) When $\text{Mn}(\text{CO})_6$ is converted to $\text{Mn}(\text{CO})_6^+$ (1mark)
- (c) Briefly explain how the following compounds are prepared;
- (i) $\text{H}_2\text{Fe}(\text{CO})_4$ from $\text{Fe}(\text{CO})_5$ (2marks)
- (ii) $[\text{Mn}(\text{CO})_4\text{Br}_2]_2$ from $\text{Mn}_2(\text{CO})_{10}$ (2marks)
- (iii) $\text{Co}_2(\text{CO})_8$ from CoCO_3 (2marks)
4. (a) Another feature of transition elements is their catalytic activities. Discuss the detailed mechanisms involved in the following catalytic reactions.
- (i) The homogenous reduction of alkenes to alkanes using $\text{RhCl}(\text{PPh}_3)_3$ as the catalyst. (7marks)
- (ii) The hydroformylation reaction (addition of H_2 and CO to an alkene to form an aldehyde) using $\text{RhH}(\text{CO})(\text{PPh}_3)_3$ as the catalyst. (7marks)
- (b) Using Fe (III) as an example in the catalysis of the reaction between I^- ions (iodide) and $\text{S}_2\text{O}_8^{2-}$ (thiosulphate), Explain with balanced equations how Fe (III) acts as a catalyst. (6marks)
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