**CHUKA**  **UNIVERSITY**



# UNIVERSITY EXAMINATIONS

## EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF EDUCATION SCIENCE

**CHEM 419: CHEMISTRY OF TRANSITION METAL ELEMENTS**

**STREAMS: BED (SCI) Y4S2** **TIME: 2 HOURS**

**DAY/DATE: TUESDAY 14/04/2020** **2.30 PM – 4.30 PM**

**INSTRUCTIONS:**

**Answer Question One and any other Two Questions**

**QUESTION ONE (30 MARKS)**

(a) (i) What are transition elements? Why are they called transition element? [2 marks]

(ii) Explain why transition elements show tendency to form large number of complexes. [3 marks]

(iii) Illustrating with an example where possible, show the extent to which electronic configuration decides the stability of oxidation state in the first series of transition metals. [2 marks]

(b) Account for the following observations

(i) Scandium $[Z = 21]$ is a transition element but Zinc $[Z = 30]$ is not? [1 marks]

(ii) Atomic radii of transition elements decrease in the order $Sc > Ti > V$ [1.5 marks]

(iii) Of the $d^4$ species, Cr(ii) is strong reducing while Mn(III) is strongly oxidizing [1.5 marks]

(iv) Transition metals and their many compounds act as good catalysts. [2 marks]

(v) Transition metals have high densities and high melting and boiling points. [3 marks]

(c) Explain briefly the following

(i) Although $Cr^{6+}$ complexes do exist, they are usually powerful oxidizing agents, whereas $Mo^{6+}$ and $W^{6+}$ are quite stable. [2 marks]

(ii) Lanthanum, gadolinium and lutetium show different electronic configuration and oxidation states.

(iii) Cr, Mo and W are hard metals while Zn, Cd, and Hg are not very hard. [1.5 marks]

(iv) In transition metals series, the metal which exhibit the greatest number of oxidation state, occurs in the middle of the series. [3 marks]

(v) Among the lanthanides, $Ce^{3+}$ is easily oxidized and forms tetra positive ion $Ce^{4+}$ in aqueous solution which is used as an oxidizing agent in volumetric analysis. [1.5 marks]

(d) (i) Explain the origin of the magnetic moments for transition metals and give the spin only formula for calculating magnetic moment. [2 marks]

(ii) Calculate the spin only magnetic moment of $M^{2+}$ (Z=26) [2 marks]

**QUESTION TWO (20 MARKS)**

(a) (i) Define the term ionization enthalpy. [2 marks]

(ii) Discuss the trends observed in the ionization enthalpies of the first row transition metals. [4 marks]

(b) The elements of the first transition series are much important than those of the second and third series. Their chemistry is best considered separately. Give reasons for this assertion. [3 marks]

(c) (i) Distinguish between interstitial compounds and alloy. Give an example of each and explain why such compounds are well known in transition metals. [3 marks]

(ii) Give any four characteristics of interstitial compounds. [2 marks]

(d) Distinguish between standard reduction potential and standard oxidation potential. Explain how they are measured and comment on their relationship. [3 marks]

(e) Discuss briefly the reducing and oxidizing ability of chemical species in aqueous solution on the basis of reduction potential. [3 marks]

**QUESTION THREE (20 MARKS)**

(a) Give brief explanation to the following

(i) Although the common oxidation state of lanthanide elements is +3, the +2 oxidation state of Eu and Yb is significant. [3 marks]

(ii) $Ce^{4+}$ and $Tb^{4+}$ are most stable with respect to reduction than other $Ln^{4+}$ cations while $Eu^{2+}$ and $Yb^{2+}$ are most stable with respect to oxidation than any other $Ln^{2+}$ cations. [3 marks]

(iii) Unlike the lanthanides whose oxidation states are dominated by +3 oxidation states, early actinides up to uranium exhibit positive oxidation state equal to the sum of their valence electrons. [2 marks]

(iv) In any given group of transition metals. Stability of higher oxidation state increases down the group. [2 marks]

(b) Describe properties which demonstrate that f block elements are different from d-block elements. [6 marks]

(c) The nitrate ion is a good example of an ambidentate ligand that can bond to a metal through more than one type of donor atoms. By giving explanation to your answer, indicate the preferred atom that coordinates to $Ce^{4+}$ ion and draw a plausible structure of the complex formed. [4 marks]

**QUESTION FOUR (20 MARKS)**

(a) Lanthanide ions give rise to very sharp electronic spectral bands in the visible or near uv regions and their magnetic moments do not obey the spin only formula: $\mu = \sqrt{n(n+2)}$. Explain [4 marks]

(b) Enumerate the main differences between the second and third series of transition elements on one hand and those of the first series of transition elements on the other hand with respect to. [8 marks]

(i) Atomic and ionic radii
(ii) Oxidation state
(iii) Formation of metal-metal bond
(iv) Magnetic properties
(v) Ligand-donor atoms preference and coordination number

(c) The most stable complexes of lanthanide elements are those which involve coordination to oxygen donor polydentate ligands. Explain [2 marks]

(d) (i) Distinguish between lanthanide and actinide contractions? Explain why actinide contraction is more than lanthanide contraction. [3 marks]

(ii) Explain the causes and consequences of lanthanide contraction. [3 marks]

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