CHUKA  **UNIVERSITY**

UNIVERSITY EXAMINATIONS

THIRD YEAR EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF SCIENCE

CHEM 419: CHEMISTRY OF TRANSITION ELEMENTS

STREAMS: BSC (Y4S1)

TIME: 2 HOURS

DAY/DATE: WEDNESDAY 24/3/2021 **2.30 PM – 4.30 PM**

INSTRUCTIONS:

- Answer question ONE (Compulsory) and any other Two questions.
- Do not write on the paper.

QUESTION ONE (30 MARKS)

(a).(i) Explain the position and classification of the transition elements in the Periodic Table and give reasons why they are called transition elements. [3 Marks]

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

(iii) Enumerate the characteristics of transition elements. Which of the d-block elements may not be regarded as transition elements. Give reasons for your answer. [3 Marks]

(b) Discuss the trends in the following properties of first row transition metals. Give reasons for the observed trends.

i) Melting and Boiling points [3 Marks]

ii) Atomic and ionic sizes (for a given oxidation state) [3 Marks]

(c) Comment on the following observations:

(i) Scandium [Z=21] is a transition element but zinc [Z=30] is not. [2 Marks]

(ii) Transition metals and their many compounds act as good catalysts. [3 Marks]

(iii) Of the d^4 species, Cr (II) is strongly reducing while Mn (III) is strongly oxidizing. [2 Marks]

(iv) Transition metals have high density and high melting points and boiling points. [2 Marks]

(d) (i). Explain the metallic character of the d-block elements. Why are Cr, Mo and W hard

metals while Zn, Cd and Hg are soft. [3 Marks]

(ii) Discuss the oxidation states of the first row transition elements and give reasons why the highest oxidation state of a transition metal is exhibited in its oxide or fluoride.[3 Marks]

QUESTION TWO (20 MARKS)

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

(ii). Explain the trends observed in the ionization enthalpies of the d-block elements. [5 Marks]

(iii). How would your account for the irregular variation of the first and second ionization energies in the first series of d-block metals. [2 Marks]

(b).(i) Explain the thermodynamic stability of transition metal compounds on the basis of ionization enthalpy. Use the following reactions as examples. [3 Marks]

$Ni \rightarrow Ni^{2+} + 2e$ IE = 2.49 X 10^3 KJ/mol

$Pt \rightarrow Pt^{2+} + 2e$ IE =2.66 X 10^3KJ/mol

$Ni \longrightarrow Ni^{4+} + 4e$ IE = 11.29 X10^3 KJ/mol

$Pt \longrightarrow Pt^{4+} + 4e$ IE =9.36 x 10^3KJ/mol

(ii) illustrating with examples where possible, show te extent to which the electronic configuration decide the stability of oxidation states in transition elements. [3 Marks]

c). (i) By giving a suitable an example, suggest reasons for the following features of the transition elements ' The lowest oxides of transition metal are basic, the highest is amphoteric /acidic' [3 Marks]

(ii) Which element of the 3d series of transition elements exhibits the largest number of oxidation states and why. [2 Marks]

QUESTION THREE (20 MARKS]

a).(i) 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 any TWO of the following. [4 Marks]

(i). Electronic configuration
(ii) Atomic and ionic radii sizes
(iii) Oxidation states
(iv) Formation of metal-metal bonds
(v). Magnetic properties
(vi) Ligand-donor prevalence and coordination number.

(b).(i) Explain the origin of the magnetic moments of transition metals. Why does Mn (II) ion show maximum paramagnetic character amongst bivalent ions of the elements of the 3d series.

[3 Marks]

(ii) Give the spin only formula for calculating magnetic moments. Hence calculate the spin only magnetic moment of M^{2+} (aq) ion (Z=27). [3 Marks]

(c)(i) Distinguish between standard reduction potential and standard oxidation potential. Explain briefly how they are measured and comment on their relationship. [4 Marks]

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

(d). Given the standard electrode potentials,
K^+ /K=-2.93V,
Ag^+ /Ag = 0.080V,
Hg^{2+} /Hg =0.79v
Mg^{2+} / Mg = -2.37v.
Cr^{3+} /Cr= -0.74V

Arrange these metals in their increasing order of reducing power. Elaborate the principle on which you based your answer. [3 Marks]

QUESTION FOUR (20 MARKS]

a). Compare the chemistry of lanthanides with that of actinides with special reference to . [5 Marks]

i. Electronic configuration
ii. Atomic and ionic sizes
iii. Oxidation state
iv. Chemical reactivity
v. Tendency to form complexes

b) (i) Distinguish between lanthanide constration and actinide contraction. What are the causes and consequences of lanthanide contraction? [4 Marks]

(ii) Explain why actinide contraction is more than lanthnide contraction. [2 Marks]

c).(i). Write the general electronic configuration of 4f and 5f series of elements. [2 Marks]

(ii). Explain why lanthanum, gadolinium and lutetium show different electronic configurations and oxidation states. [3 Marks]

(iii) By giving examples where possible give three uses of lanthanides and three uses of actinides. [4 Marks]

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