CHUKA  **UNIVERSITY**

UNIVERSITY EXAMINATIONS

FOURTH YEAR EXAMINATIONS FOR THE AWARD OF BACHELOR OF SCENCE, BACHELOR OF SCIENCE (INDUSTRIAL CHEMISTRY) AND BACHELOR OF EDUCATION(SCIENCE)

CHEM 419: CHEMISTRY OF TRANSITION METAL ELEMENTS

STREAMS: BSC(Y4 S1), BSC IND CHEM (Y4S1)B.ED (Y4 S2)

TIME: 2 HOURS

DAY/DATE : WEDNESDAY 22 /09/ 2021 **11.30 AM – 1.30 PM**

INSTRUCTIONS TO CANDIDATES:

- Answer Question **ONE** and Any other **TWO** **Questions**
- DO NOT WRITE ANYTHING on the question paper.

QUESTION ONE [30 marks]

(a). Define transition element and give reasons why they are called transition Elements **[3marks]**

b). Discuss transition elements under the following headings **[4marks]**

(i) Position and classification in the periodic table.

(ii) General electronic configuration

(iii) Tendency to form complexes

c). (i) Enumerate the characteristics of transition elements and indicate by giving reasons which of the d block elements may not be regarded as transition elements **[5marks]**

(ii). Write the expected electronic configuration and the observed electronic configuration of the following elements belonging to the first transition series.

Give reasons for any irregularities from the expected electronic configuration. **[4marks]**

Element	***Expected E.C***	***Observed E.C***
Cr [Z = 24],		
Cu [Z=29]		
Ni [Z= 28}		

d). Discuss the trends in the following properties of first row transition metals **[6marks]**

i). Melting and Boiling points

ii). Atomic and Ionic sizes (for a given oxidation state)

e). Transition metals compounds are usually coloured. Explain how the colour of a substance arises and why transition metal compounds are coloured **[4 marks]**

f). Give explanations to any **TWO** of the following observations **[4marks]**

i. Most d –block elements show variable oxidation states and the metal in the middle of the series from both ends exhibit the highest number of oxidation states.
ii. Although Cr^{6+} complexes do exist, they are usually powerful oxidizing agents, whereas Mo^{6+} and W^{6+} are quite stable
iii. Cr, Mo and W are hard metals while Zn, Cd and Hg are not very hard.
iv. 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**.**

QUESTION TWO [20marks]

(a). (i). Define the term ionization enthalpy
[1.5marks]

(ii). Explain the trends observed in the ionization enthalpies of the d-block elements. **[4 marks]**

(iii). How would your account for the irregular variation of the first and second

ionization enthalpies in the first series of d-block metals?
[1.5marks]

(b) (i). Define the following: diamagnetic, paramagnetic and ferromagnetic compounds**.** **[3 marks]**

(ii) Explain the origin of the magnetic moments for transition metal compounds and derive spin only formula for calculating magnetic moments and the unpaired electrons in a transition metal compound**.** **[3marks]**

(iii) Calculate the spin only magnetic moment of M^{2+} (Z= 28)
[2marks]

.c.(i). Using probable oxidation states for the elements Ti, Mn and Zn as

examples show the extent to which the electronic configuration decides the stability of oxidation states in transition elements **[1.5 marks]**

(ii) By giving an example, suggest reasons for the following features of the

transition elements 'The lowest oxides of transition metal are basic, the

highest are amphoteric/acidic' **[1.5 marks]**

(iii). Which element of the 3d series of transition elements exhibits the largest

number of oxidation states and why **[2marks]**

QUESTION THREE [20marks]

a) (i). Distinguish between interstitial compounds and alloy. Why are such

compounds well known for transition metals? **[3marks]**

(ii). Give two examples of interstitial compounds **[2marks]**

(iii). Give characteristics of interstitial compounds **[4 marks]**

c). (i) What is meant by the term disproportionation? [Hint: Use the following

two reactions as examples to illustrate your explanation] **[2marks]**

(i). $3CrO_4^{3-} + 8H^+ \longrightarrow 2CrO_4^{2-} + Cr^{3+} + 4H_2O$

(ii) $3MnO_4^{2-} + 4H^+ \longrightarrow 2MnO_4^- + MnO_2 + 2H_2O$

d). (i). Distinguish between standard reduction potential and standard oxidation

potential. Explain how they are measured and comment on their relationship**.** **[3marks]**

(ii). Discuss briefly the reducing and oxidizing ability of chemical species in

aqueous solution on the basis of reduction potential **[3 marks]**

(iii). For M^{2+} /M and M^{3+} /M^{2+} systems the E^o values for some metals are as

Follows

M^{2+} /M	E^o	M^{3+} /M^{2+}	E^o
Cr^{2+}/Cr	-0.9V	Cr^{3+} /Cr^{2+} =	-0.4V
Mn^{2+} / Mn	-1.2V	Mn^{3+}/ Mn^{2+} =	+1.5V
Fe^{2+} /Fe	-0.4V	Fe^{3+} /Fe^{2+} =	+0.8V

Use the above data to comment on

(i) The relative stability of the Cr^{3+} , $Fe^{3+,}$ and Mn^{3+}
[1.5marks]

(ii) The ease with which Fe can be oxidized as compared to a similar process for either Cr or Mn **[1.5 marks]**

QUESTION FOUR [20marks]

(a). Give reasons why the following Comment is correct ***'' The elements of first transition series are more important than their heavier congeners hence their chemistry is best studied separately''***
[4marks]

b). By giving special emphasis on **ANY THREE** of the following properties, Compare the general characteristics of the first series of transition metal with those of the second and third transition series metals in the respective vertical columns. **[5marks]**

(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.

c). (i) What are inner transition elements?
[2marks]

(ii). Describe properties which demonstrate that f block elements are different from d-block elements **[5marks]**

d) Give reasons why many of the transition metals and their compounds act as catalysts **[4marks]**

QUESTION FIVE [20marks]

(a). Explain by comparing and contrasting the oxidation states of actinides and lanthanides and explain why actinide elements show larger number of oxidation states than lanthanides? **[2.5marks]**

(b). Explain why lanthanum, gadolinium and lutetium show different electronic configuration from the other lanthanides. Give the common oxidation state exhibited by these three elements**.** **[3marks]**

(c). Distinguish between lanthanide and actinide contractions. Explain why actinide contraction is more than lanthanide contraction**.** **[2marks]**

(d). Explain the cause and consequences of lanthanide contraction **[3.5marks]**

(e). Compare and contrast the chemistry of the lanthanides with that of actinides with special reference to (i) Electronic configuration (ii). Oxidation state (iii) chemical reactivities. **[9marks]**

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