

CHUKA



UNIVERSITY

UNIVERSITY EXAMINATIONS

FOURTH YEAR EXAMINATIONS FOR THE AWARD
OF BACHELOR OF SCIENCE

CHEM 419: CHEMISTRY OF TRANSITION METALS

STREAMS: BSC (Y4S1)

TIME: 2 HOURS

DAY/DATE: THURSDAY 05/12/2019

8.30 A.M. – 10.30 A.M.

INSTRUCTIONS: Answer Question ONE and Any other TWO Questions

QUESTION ONE [30MARKS]

- (a) Explain the position and classification of the d-block elements in the periodic table and give reasons why they are called transition elements. [3 marks]
- (b) 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. [5marks]
- i. Cr [Z = 24], ii. Cu [Z=29] iii. Mn [Z= 25}
- (c) Discuss the trends in the following properties of first row transition metals [10 marks]
- Melting and Boiling points
 - Atomic and Ionic sizes (for a given oxidation state)
 - Ionization enthalpies
- (d) Give explanation to the following facts [12 marks]
- Many of the transition metals and their compounds act as catalysts

CHEM 419

- (ii) In transition metal series, the metal which exhibit the greatest number of oxidation state, occurs in the middle of the series.
- (iii) Cr, Mo and W are hard metals while Zn, Cd and Hg are not very hard.
- (iv) The metallic radii of the second (4d) transition series are virtually the same as those of the corresponding members of the third (5d) transition series.
- (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.
- (vi) $\text{Fe}^{3+}/\text{Fe}^{2+}$ redox couple has less positive electrode potential than $\text{Mn}^{3+}/\text{Mn}^{2+}$ couple

QUESTION TWO [20 MARKS]

- (a) Most of the transition metals form coloured compounds
 - (i) Giving sufficient reasons explain why most of the transition metal compounds are remarkably coloured. [6 marks]
 - (ii) Identify the transition metals which are exceptional from the above statement and give reasons. [2 marks]
 - (iii). Explain why copper(II)sulphate is blue in colour when dissolved in water but turns yellow when treated with concentrated hydrochloric acid. [1.5 marks]
- (b) By qualifying your answer, comment on the statement that the metals of the first transition series possess many properties different from those of the heavier transition metals. [3marks]
- (c) Explain the extent to which the electronic configuration decide the stability of Oxidation states in the first series of transition element, Illustrate your answer with examples [2.5

marks] (d) For M^{2+}/M and $\text{M}^{3+}/\text{M}^{2+}$ couples the E^0 for some metals are as follows:

M^{2+}/M	E^0	$\text{M}^{3+}/\text{M}^{2+}$	E^0
Cr^{2+}/Cr	-0.9V	$\text{Cr}^{3+}/\text{Cr}^{2+}$	-0.4V
Mn^{2+}/Mn	-1.2V	$\text{Mn}^{3+}/\text{Mn}^{2+}$	+1.5V
Fe^{2+}/Fe	-0.4V	$\text{Fe}^{3+}/\text{Fe}^{2+}$	-0.4V

Use the above data to comment on

CHEM 419

(i). The stability of Fe^{3+} in acid solution as compared to that of Cr^{3+} or Mn^{3+} [2 marks]

(ii) The ease with which Fe can be oxidized as compared to a similar process for

either Cr or Mn

[3

marks]

QUESTION THREE [20 MARKS]

(a) What is meant by the term disproportionation? [Hint: Use the following two reactions as examples to illustrate your explanation] [3 marks]



(b) (i) Discuss why the highest oxidation states of transition metals are exhibited in their oxides or fluorides only? [2 marks]

(ii) By giving an example in each case, distinguish between a strong oxidizing and a strong

reducing agent

[2

marks]

(c) Transition metals and many of their compounds are paramagnetic and exhibit different magnitudes of paramagnetic character.

(i) Explain the origin of the magnetic moments for transition metals and give the spin only formula for calculating magnetic moment. [2.5 marks]

(ii) Calculate the spin only magnetic moment of M^{2+} ($Z=27$) [2.5 marks]

(d) (i) What are interstitial compounds? Why are such compounds well known for transition metals? [3 marks]

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

(iii) Give characteristics of interstitial compounds [3 marks]

QUESTION FOUR [20 MARKS]

(a) Briefly explain why electronic configuration of lanthanides are not known with certainty and give reasons why actinide elements show larger number of oxidation states than lanthanides? [2.5 marks]

(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. [3 marks]

CHEM 419

- (c) Distinguish between lanthanide and actinide contractions. Explain why actinide contraction is more than lanthanide contraction. [2 marks]
- (d) Explain the cause and consequences of lanthanide contraction [3.5 marks]
- (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.

[9

marks]
