CHEM 419: CHEMISTRY OF TRANSITION ELEMENTS EXAM APRIL 2023

CHUKA UNIVERISTY

UNIVERSITY EXAMINATIONS

FOURTH YEAR EXAMINATIONS FOR THE AWARD OF BACHELOR

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

STREAMS: B.ED (Y4S2) TIME: 2 HOUR

INSTRUCTIONS: Question ONE and any other TWO Questions

QUESTION ONE [30maarks]

(a). (i). Explain the position and classification of the transition elements in the periodic table and give reasons why they are called transition elements **[3marks]**

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

(iii). Enumerate **ANY FOUR** the characteristics of transition elements. Which of the d block elements may not be regarded as transition elements. Give reasons for your answer. **[2marks]**

(b) Explain giving reasons and examples where necessary the following

(i). Transition metals and their compounds generally exhibit a paramagnetic Behavior **[2marks]**

(ii) Transition metals generally form coloured compounds**[3marks]**

(iii) Transition metals and many of their compounds show catalytic properties.**[3marks]**

iv).The lowest oxides of transition metals basic, the highest are amphoteric/acidic.**[3marks]**

(c) (i). Explain the metallic character of the d-block elements. Why are Cr, Mo and W hard metals with high melting and boiling points while Zn, Cd and Hg are soft with low melting and boiling points **[3marks]**

(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? **[3marks]**

d) List the first row transition metals in the ascending order of atomic numbers and hence answer the following questions. Give reasons for your answers **[5marks]**

(i) Write the element which shows maximum number of oxidation states
(ii) Which element has the highest melting point?
(iii) Which element shows only +3 oxidation state?
(iv) Which element is a strong oxidising agent in +3 oxidation state
(v) There is hardly any increase in atomic size with increasing atomic numbers in the above series of transition metals

QUESTION TWO [20marks]

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

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

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

(b). Explain the thermodynamic stability of transition metal compounds on the basis of ionization enthalpy**.** Use the following reactions as examples.

[3marks]

$Ni \longrightarrow Ni^{2+} + 2e$ IE = 2.49×10^3 kJ/mol

$Pt \longrightarrow Pt^{2+} + 2e$ IE = 2.66×10^3kJ/mol

$Ni \longrightarrow Ni^{4+} + 4e$ IE = 11.29×10^3 kJ/mol

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

(c) (i). Define the following: diamagnetic, paramagnetic and ferromagnetic compounds**. [1.5 marks]**

(ii) Explain the origin of the magnetic moments for transition metal Compounds.Why does Mn(II) ion show maximum paramagnetic character Amongst bivalent ions of the elements of the 3d series **[2.5marks]**

(iii). Derive spin only formula for calculating magnetic moments and the unpaired electrons in a transition metal compound**. [2.5marks]**

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

QUESTION THREE [20marks]

a) (i). Distinguish between interstitial compounds and alloy. Why are such compounds well known for transition metals? **[2.marks]**

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

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

b). (i) Define a disproportionation reaction (use any one of the reactions given below to explain **[2marks]**

(ii) Which of the following disproportionation reactions are spontaneous at

standard states. Give reasons for your answer **[3marks]**

(i) $Cu^{+}(aq) \longrightarrow Cu^{2+}(aq) + Cu(s)$

(ii) $2Sn^{2+}(aq) \longrightarrow Sn^{4+}(aq) + Sn(s)$

(iii) $3Fe^{2+}(aq) \longrightarrow 2Fe^{3+}(aq) + Fe(s)$

Given : $E^{o}\ Cu^{+} \mid Cu(s) = 0.52V$ $\quad E^{o}\ Cu^{+} \mid Cu^{2+} = -0.16V$

$E^{o}\ Sn^{2+} \mid Sn(s) = -0.14V$ $\quad E^{o}\ Sn^{4+} \mid Sn(s) = 0.15V$

$E^{o}\ Fe^{2+} \mid Fe(s) = -0.44V$ $\quad E^{o}\ Fe^{3+} \mid Fe^{2+} = 0.77V$

c) (i). Distinguish between standard reduction potential and standard oxidation potential. Explain how they are measured and comment on their relationship. **[2marks]**

(ii).Discuss briefly the reducing and oxidizing ability of chemical species in aqueous solution on the basis of reduction potential **[2.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^{0}	M^{3+}/M^{2+}	M^{0}
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 **[1.5marks]**

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) Explain giving a suitable reason for each of the following
(i) Metal-metal bonding is more frequent for the 4*d* and the 5*d* series of transition metal than that for the 3*d* series.**[2 marks]**

i) The atomic radii of the metals of the third (5*d*) series of transition elements are virtually the same as those of the corresponding members of the second (4*d*) series.**[2 marks]**

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 **[9marks]**

(i) Electronic configuration

(ii). Oxidation states

(iii) chemical reactivities.

(iv) Atomic and ionic radii

(v) Tendency to form complexes