# SOUTH EASTERN KENYA UNIVERSITY

## UNIVERSITY EXAMINATIONS 2016/2017

### SECOND SEMESTER EXAMINATION FOR THE DEGREES OF

### BACHELOR OF EDUCATION (SCIENCE) AND BACHELOR OF

### SCIENCE (CHEMISTRY)

**SCH 401: CHEMISTRY OF TRANSITION ELEMENTS**

**DATE: 19 TH APRIL, 2017** **TIME: 10.30-12.30 P.M**

## INSTRUCTIONS TO CANDIDATES

**(a) Answer question One and any other Two questions**
**(b) Question 1 carries 30 marks while the other questions carry 20 marks each**
**(c) Illustrate your answers with well labeled diagrams where appropriate**

**QUESTION 1 (30 MARKS)**

(a) How do the following properties vary in the transition elements:

(i) Ionic character (2 marks)

(ii) Basic properties (2 marks)

(iii) Stability of the various oxidation states (2 marks)

(b) Give examples of, and suggest reasons for, the following features of transition metal chemistry;

(i) The lowest oxide of a transition metal is basic whereas the highest oxide is usually acidic. (3 marks)

(ii) A transition metal usually exhibits higher oxidation states in its fluorides than in its iodides. (3 marks)

(c) Explain the features of cations which form complex ions. (3 marks)

(d) Describe the origin of color in transition elements. ( 4 marks)

(e) Explain **four** factors determining the magnitude of crystal field splitting with respect to nature of the ligand. (4 marks)

(f) Show the *d* electrons configuration in the following complexes:

(i) $[Co(NCS)_4]^{2-}$ tetrahedral (4 marks)

(ii) $[Fe(CN)_6]^{3-}$ octahedral (4 marks)

**QUESTION 2 (20 MARKS)**

(a) Describe the features of Crystal Field Theory (5 marks)

(b) Calculate crystal field stabilization energies for the following;

(i) $d^6$ tetrahedral (4 marks)

(ii) $d^7$strong field octahedral (4 marks)

(c) Explain why $NH_3$ readily form complexes but $NH_4^+$ does not. (3 marks)

(d) Explain why the tetrahedral complexes of Mn (II) are more intensely coloured than the octahedral complexes of Mn (II). (5 marks)

**QUESTION 3 (20 MARKS)**

(a) Calculate the number of microstates for;

(i) $d^1$ configuration (4 marks)

(ii) $p^3$ configuration (4 marks)

(b) Determine the term symbol for ground state of nitrogen (5 marks)

(c) With the aid of an example, describe the phenomena of vibronic coupling (5 marks)

(d) Explain two limitations of Orgel Energy Level diagrams. (2 marks)

**QUESTION 4 (20 MARKS)**

(a) Explain why $Cu^{2+}$ ions are colored and paramagnetic while $Zn^{2+}$ ions are colorless and diamagnetic. (3 marks)

(b) Explain why Cu (I) is diamagnetic whereas Cu (II) is paramagnetic. (3 marks)

(c) Calculate the expected magnetic moment for the following ions;

(i) $Fe^{2+}$ (3 marks)

(ii) $Ni^{2+}$ (3 marks)

(d) On the basis of crystal field theory, account for the following: While $[Fe(H_2O)_6]^{3+}$ is thoroughly paramagnetic, $[Fe(CN)_6]^{3-}$ is less paramagnetic. (5 marks)

(e) Between $Mn^{2+}$ and $V^{2+}$, state and explain which ion would exhibit a larger magnetic moment. (3 marks)

**QUESTION 5 (20 MARKS)**

(a) The log β value for $[FeF]^{2+}$ is 6 and that for $[FeCl]^{2+}$ is 1.3. What do these values indicate about these species. (4 marks)

(b) Explain the catalytic properties of the following transition metals and their compounds;

(i) $TiCl_3$ (1 mark)

(ii) $V_2O_5$ (1 mark)

(iii) Fe (1 mark)

(c) Explain ways in which the electron creates magnetic moment. (4 marks)

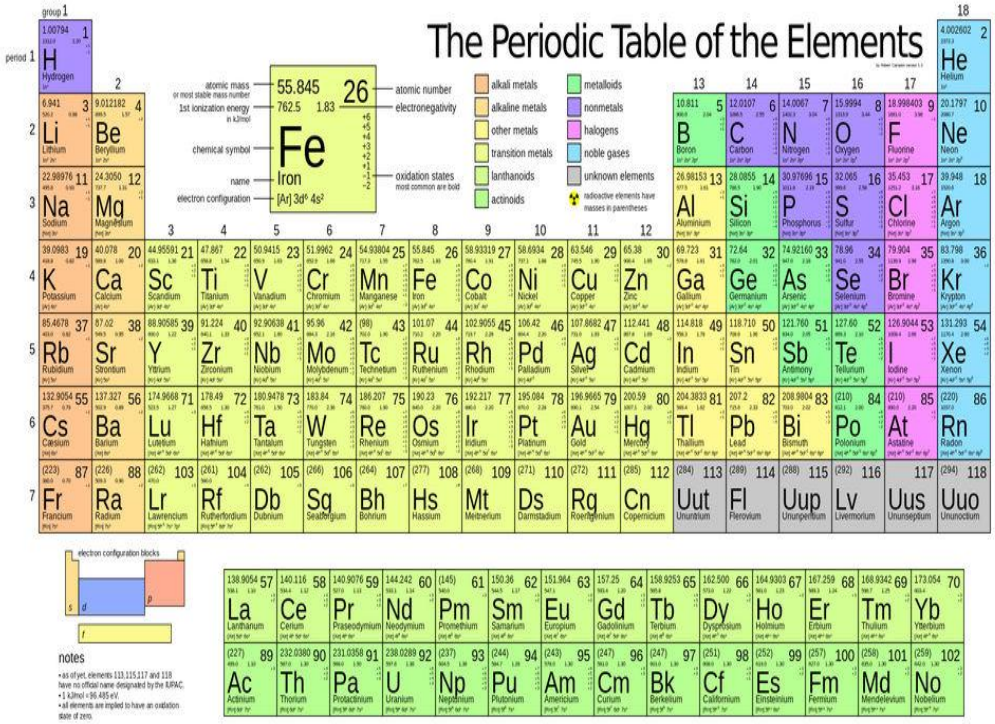
(d) Explain the meaning of the following;

(i) Magnetic susceptibility (2 marks)

(ii) Paramagnetic substances (2 marks)

(e) Write the formula for magnetic susceptibility obtained after correction and define all the parameters contained therein (3 marks)

(f) Explain the criteria that must be satisfied if an ion is to be coloured. (2 marks)


The Periodic Table of the Elements
group 1
18
period 1
2
13
14
15
16
17
atomic mass
or most stable mass number
1st ionization energy
in kJ/mol
chemical symbol
name
electron configuration
55.845
762.5
1.83
26
Fe
Iron
[Ar] 3d⁶ 4s²
atomic number
electronegativity
oxidation states
most common are bold
alkali metals
alkaline metals
other metals
transition metals
lanthanoids
actinoids
metalloids
nonmetals
halogens
noble gases
unknown elements
radioactive elements have masses in parentheses
3
4
5
6
7
8
9
10
11
12
H Hydrogen
He Helium
Li Lithium
Be Beryllium
B Boron
C Carbon
N Nitrogen
O Oxygen
F Fluorine
Ne Neon
Na Sodium
Mg Magnesium
Al Aluminium
Si Silicon
P Phosphorus
S Sulfur
Cl Chlorine
Ar Argon
K Potassium
Ca Calcium
Sc Scandium
Ti Titanium
V Vanadium
Cr Chromium
Mn Manganese
Fe Iron
Co Cobalt
Ni Nickel
Cu Copper
Zn Zinc
Ga Gallium
Ge Germanium
As Arsenic
Se Selenium
Br Bromine
Kr Krypton
Rb Rubidium
Sr Strontium
Y Yttrium
Zr Zirconium
Nb Niobium
Mo Molybdenum
Tc Technetium
Ru Ruthenium
Rh Rhodium
Pd Palladium
Ag Silver
Cd Cadmium
In Indium
Sn Tin
Sb Antimony
Te Tellurium
I Iodine
Xe Xenon
Cs Caesium
Ba Barium
Lu Lutetium
Hf Hafnium
Ta Tantalum
W Tungsten
Re Rhenium
Os Osmium
Ir Iridium
Pt Platinum
Au Gold
Hg Mercury
Tl Thallium
Pb Lead
Bi Bismuth
Po Polonium
At Astatine
Rn Radon
Fr Francium
Ra Radium
Lr Lawrencium
Rf Rutherfordium
Db Dubnium
Sg Seaborgium
Bh Bohrium
Hs Hassium
Mt Meitnerium
Ds Darmstadium
Rg Roentgenium
Cn Copernicium
Uut Ununtrium
Fl Flerovium
Uup Ununpentium
Lv Livermorium
Uus Ununseptium
Uuo Ununoctium
La Lanthanum
Ce Cerium
Pr Praseodymium
Nd Neodymium
Pm Promethium
Sm Samarium
Eu Europium
Gd Gadolinium
Tb Terbium
Dy Dysprosium
Ho Holmium
Er Erbium
Tm Thulium
Yb Ytterbium
Ac Actinium
Th Thorium
Pa Protactinium
U Uranium
Np Neptunium
Pu Plutonium
Am Americium
Cm Curium
Bk Berkelium
Cf Californium
Es Einsteinium
Fm Fermium
Md Mendelevium
No Nobelium
electron configuration blocks
s
d
p
f
notes
• as of yet, elements 113,115,117 and 118 have no official name designated by the IUPAC.
• 1 kJ/mol = 96.485 eV.
• all elements are implied to have an oxidation state of zero.