MACHAKOS UNIVERSITY

University Examinations 2021/2022

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

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DEPARTMENT OF PHYSICAL SCIENCES

FOURT YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (ANALYTICAL CHEMISTRY)

BACHELOR OF EDUCATION (SCIENCE)

BACHELOR OF EDUCATION (SPECIAL NEEEDS)

SCH 400: COMPARATIVE STUDY OF TRANSITION ELEMENTS

DATE: **TIME:**

INSTRUCTIONS

- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks)
- Answer any **two** questions from section **B** (each 20 marks)
- Check for useful Tables behind the Question paper

SECTION A

QUESTION ONE (30 MARKS)

(a) Briefly explain the following observations:

(i) $Ni(CO)_4$ is known while $Ca(CO)_4$ is unknown **(**2 marks)

(ii) Transition metals form compounds in which they show variable oxidation states (2 marks)

(iii) VF_5 is viscous liquid while VCl_5 is either very unstable or does not form (2 marks)

(iv) 3rd ionization energy of manganese is unexpectedly high (2 marks)

(b) Account for the following:

(i) The existence of OsO_4 in terms of trends in oxidation states (2 marks)

(ii) Zinc and cadmium are soft metals (2 marks)

(iii) The sufficiently higher second ionization of Cu and Cr compared to those of their neighbouring elements (2 marks)

(c) (i) Use Hund's rule to derive the electronic configuration of Ce^{3+} ion and calculate its magnetic moment. (3 marks)

(iv) State and explain two factors that will affect the colour of transition metal complexes (4 marks)

(v) Explain why $Ti(H_2O)_6]^{3+}$ is coloured while $[Sc(H_2O)_6]^{3+}$ is colourless (2 marks)

(d) (i) Write the general electronic configuration of *f*- block elements (1 mark)

(ii) Explain why actinides contraction is more than lanthanides (2 marks)

(iii) Explain Actinides show larger number of oxidation states than lanthanides (2 marls)

(e) Explain the oxidising action of acidified potassium dichromate on (iron(II) salts and write the ionic equation for the reaction (2 marks)

SECTION B

QUESTION TWO (20 MARKS)

(a) Briefly explain why group (IIB) elements (zinc and group of elements) are not classified among transition elements (5 marks)

(b) State four industrial uses of titanium (4 marks)

(c) With an example, briefly explain disproportionation of an oxidation state (2 marks)

(d) (i) Briefly explain why transition metal compounds or transition metals are mostly used as industrial catalysts (2 marks)

(ii) Explain the preparation of potassium dichromate from its ore (4 marks)

(iii) State three uses of potassium dichromate (3 marks)

QUESTION THREE (20 MARKS)

(a) (i) Define metallurgy (2 marks)

(ii) Using the sulphate process explain how you will prepare TiO_2 pigment grade from illemite (8 marks)

(iii) List the two qualities that make titanium oxide to be used in paints (2 marks)

(b) State three factors that gives d-block elements the tendency to form complexes

(c) State any four differences between lanthanides and actinides (4 marks)

(d) State any four properties of interstitial compounds. (4 marks)

QUESTION FOUR (20 MARKS)

(a) State why transition metals have high enthalpy of hydration (2 marks)

(b) (i) Name three ores of lead (3 marks)

(ii) Using any one of the ores listed above; briefly outline how you will extract lead metal. (Use reaction equations where necessary) (8 marks)

(c) With an example define pyrometallurgy (3 marks)

(d) Explain why Copper can be extracted by hydrometallurgy but not zinc (2 marks)

(e) Explain why the reduction of a metal oxide is easier if the metal formed is in liquid state at the temperature of reduction than when in solid state (2 marks)

QUESTION FIVE (20 MARKS)

(a) Name three natural processes that utilize transition metals (3 marks)

(b) Using chemical reactions explain how pure copper is obtained from its principle ore

(4 marks)

(c) Using Ziegler Natta catalyst show a catalytic cycle of production of $C_6H_{12}R$ (5 marks)

(d) Explain how the presence of double bonds in rubber influence their structure and reactivity (3 marks)

(e) Complete and balance the following equations:

(i) $MnO_4^{2-} + H^+ \rightarrow$ (1 mark)

(ii) $KMnO_4 \xrightarrow{\text{heat}}$ (2 marks)

(iii) $MnO_4^- + FeC_2O_4 + H^+ \rightarrow$ (2 marks)