



MACHAKOS UNIVERSITY

University Examinations for 2021/2022 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FOURTH YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF EDUCATION (SCIENCE)

BACHELOR OF EDUCATION (SPECIAL NEEDS EDUCATION)

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).

SECTION A (COMPULSORY)

QUESTION ONE (30 MARKS)

- a) Write the ground state electronic configuration of the transition element Mn ($z=25$) in Group 7 in:
- i) Long form, i.e. $1s^2, 2s^2$, etc. (2 marks)
 - ii) Noble gas format (1 marks)
 - iii) Terms of energy level format, i.e. 2:8..... (1 marks)
 - iv) Explain how the configuration in (iii) is related to the configurations in (i). (2 marks)
- b) State and explain the general trends for each of the following properties across the first transition series elements.
- i). Density
 - ii). Ionic radii
 - iii). Electronegativity
 - iv). Metallic character
- (12 marks)
- c) Explain why the basic character of the oxides of transition elements decrease with increase in the oxidation state of the metal. For example the basic character of manganese oxides varies as follows: $\text{MnO} > \text{Mn}_2\text{O}_3 > \text{MnO}_2 > \text{Mn}_2\text{O}_7$. (4 marks)
- d) Give possible reasons for the following observations:
- i) All transition elements are hard metals with high electrical and thermal conductivities, high melting points and boiling points (4 marks)
 - ii) Transition metals display numerous oxidation states in their compounds. (2 marks)
 - iii) Transition metals have to be alloyed with other transition or main group elements before they are used. provide a relevant example (2 marks)

SECTION B (ANSWER ANY TWO QUESTIONS)

QUESTION TWO (20 MARKS)

- a) Give possible reasons for the following observations:
- (i) Transition elements have higher tendency to form coordination complexes with electron donors known as Lewis bases than their main group counterparts (2 marks)
 - (ii) Transition metal compounds containing metal-metal bonds are most common among the second and third series elements of groups 5 and 6 of the periodic table. (3 marks)

- b) Describe three types of alloys formed by transition elements explaining clearly how they differ. (6 marks)
- c) At room temperature, TiF_4 is a white insoluble solid that melts at 284°C while TiCl_4 is a colorless liquid that readily hydrolyzes in water. Explain the differences in properties of the two halides (4 marks)
- d) Transition elements occur in four main types of ores. Identify the ores citing a relevant representative example of an element mineral. (3 marks)
- e) Give two reasons why Ti alloys with tin or aluminium are preferred to steel in structural engineering (2 marks)

QUESTION THREE (20 MARKS)

- a) Describe the chemistry involved in the extraction of titanium from ilmenite FeTiO_3 . (4 marks)
- b) Identify four uses of TiO_2 Explain what makes it suitable for each of the uses (6 marks)
- c) Rusting/corrosion of iron and iron-based materials is highly undesirable yet it presents business and research opportunities for entrepreneurs and corrosion scientists, respectively. Explain briefly on this paradox (6 marks)
- d) Consider the following reduction potentials: $\text{Fe}^{2+}_{(\text{aq})} + 2\text{e}^- \rightarrow \text{Fe}_{(\text{s})}$ $E^\circ = -0.45$
 $\text{Zn}^{2+}_{(\text{aq})} + 2\text{e}^- \rightarrow \text{Zn}_{(\text{s})}$ $E^\circ = -0.76$
 On the basis of the reduction potentials, explain why Zn acts as the sacrificial electrode when coupled with iron (4 marks)

QUESTION FOUR (20 MARKS)

- a) Describe any four types of mining used by the mining industry stating clearly the main factor that determines the type of mining used. (8 marks)
- b) Use electronic structure to
 - i) Distinguish between transition and main group elements (2 marks)
 - ii) Distinguish between 2nd and 3rd transition series elements (2 marks)
- c) Discuss four reasons for carrying out mineral concentration after mining (4 marks)
- d) Explain the lanthanide contraction and how does it manifest in the chemistry of the elements affected (4 marks)

QUESTION FIVE (20 MARKS)

- a) Describe the chemistry of conversion of FeTiO_3 to TiO_2 through the sulphate process (6 marks)
- b) The halides of titanium TiX_4 ($\text{X} = \text{F}, \text{Cl}, \text{Br}$ or I) act as Lewis acids forming adducts of the type TiX_4L_2 ($\text{L} =$ monodentate ligand) with Lewis bases such as NH_3 .
 - i) Explain why they act as Lewis acids (2 marks)
 - ii) Explain why all the adducts formed between the titanium halides, TiX_4 ($\text{X} = \text{F}, \text{Cl}, \text{Br}$ or I), and Lewis bases are likely to be diamagnetic. (2 marks)

- c) Provide a reason why elemental chromium is not widely used except as an alloying agent in manufacture of steels. (1 mark)
- d) Describe three reasons for alloying transition metals before use (3 marks)
- e) Discuss the variation in oxidation states of the first row of metals (6 marks)