



KENYATTA UNIVERSITY
UNIVERSITY EXAMINATIONS 2017/2018
DIGITAL SCHOOL OF VIRTUAL AND OPEN LEARNING
SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF
SCIENCE

SCH 400: COMPARATIVE STUDY OF TRANSIT ELEMENTS

DATE: SATURDAY 23RD JUNE 2018

TIME: 4.30 P.M. - 6.30 P.M.

INSTRUCTIONS: Attempt ALL Questions

Question 1

- a) Distinguish between transition and main group elements with reference to the following properties:
- (i) Electronic configuration (use the first transition series to illustrate)
 - (ii) Variable oxidation states
 - (iii) Complex compound formation
 - (iv) Electronegativities

(16 marks)

Question 1 Total marks = 16

Question 2

Give possible reasons for the following observations:

- (i) Atomic radii of the elements decrease gradually at the beginning of each transition series and then rise towards the end of each series. (4 marks)
- (ii) Across the first row of transition elements from left to right, the +2 oxidation state becomes more stable in comparison with the +3 state. (4 marks)
- (iii) At room temperature, TiF_4 is a white insoluble solid that melts at 284°C and does not hydrolyze in water while TiCl_4 is a colourless liquid that readily hydrolyzes in water. (6 marks)
- (iv) Titanium extraction is expensive but it is still extracted and used in the world today either as an alloy or in form of its compounds such as TiO_2 . (6 marks)
- (v) Zr and Hf are both useful in water cooled nuclear reactors, but they cannot be used together i.e. Zr and Hf must be separated. (2 marks)

Question 2 Total marks = 22

Question 3

(a) Write balanced net ionic equations for the following reactions:

(i) Reaction of KMnO_4 with Fe^{2+} in acidic medium

(2 marks)

(ii) FeCl_2 reacts with excess aqueous NaCN to give a deep blue solution of sodium hexacyanidoferrate(II).

(2 marks)

(iii) Dissolution of solid AgCl conc. HCl . When the clear solution is diluted with water the AgCl reappears.

(4 marks)

(iv) When the yellow solution of CuCl_2 in HCl is further diluted with water it changes colour to green then to blue.

(4 marks)

b) The Table below shows the standard oxidation potentials of the first transition series elements. Use it to respond to the questions that follow.

Standard Potentials for Oxidation of First-Series Transition Metals

Oxidation Half-Reaction	E° (V)	Oxidation Half-Reaction	E° (V)
$\text{Sc}(s) \rightarrow \text{Sc}^{3+}(aq) + 3e^-$	2.08	$\text{Fe}(s) \rightarrow \text{Fe}^{2+}(aq) + 2e^-$	0.45
$\text{Ti}(s) \rightarrow \text{Ti}^{2+}(aq) + 2e^-$	1.63	$\text{Co}(s) \rightarrow \text{Co}^{2+}(aq) + 2e^-$	0.28
$\text{V}(s) \rightarrow \text{V}^{2+}(aq) + 2e^-$	1.18	$\text{Ni}(s) \rightarrow \text{Ni}^{2+}(aq) + 2e^-$	0.26
$\text{Cr}(s) \rightarrow \text{Cr}^{2+}(aq) + 2e^-$	0.91	$\text{Cu}(s) \rightarrow \text{Cu}^{2+}(aq) + 2e^-$	-0.34
$\text{Mn}(s) \rightarrow \text{Mn}^{2+}(aq) + 2e^-$	1.18	$\text{Zn}(s) \rightarrow \text{Zn}^{2+}(aq) + 2e^-$	0.76

(i) Using your knowledge that the standard potential for the oxidation of a metal is a composite property that depends on ΔG° for the sublimation of the metal, the ionization energies of the metal atom, and ΔG° for the hydration of the metal ion, explain the general trend in the variation in standard potentials for oxidation observed across the first transition series (from Sc to Zn).

(3 marks)

(ii) Based on the variation in standard potentials for oxidation, identify the metal that should be the strongest reducing agent and the metal that should be the weakest reducing agent.

(2 marks)

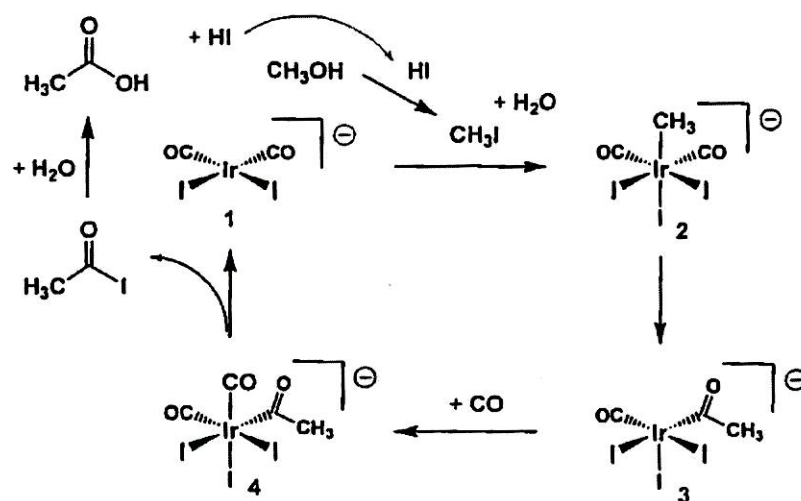
(iii) Arrange the oxoanions VO_4^{3-} , CrO_4^{2-} , MnO_4^{2-} and FeO_4^{2-} in order of their oxidizing strength. Give your reasoning.

(3 marks)

Question 3 Total marks = 20

Question 4

The catalytic cycle below shows the industrial Cativa process used in the production of acetic acid. Study it carefully and answer the questions that follow:



- Identify two properties of the iridium metal that make it possible for it to perform the catalytic activity. How do these help in the catalysis according to the cycle? (4 marks)
- Identify the types of reactions that the metal is involved in within the cycle. (2 marks)
- Work out the effective atomic number of metal in compounds 1 and 2. (4 marks)
- Cite one reason why the reaction is considered catalytic and not stoichiometric. (2 marks)

Question 4 Total marks = 12
