



# THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

(A Constituent College of Jkuat)

*Faculty of Applied & Health Sciences*

DEPARTMENT OF PURE AND APPLIED SCIENCES

**DIPLOMA IN SCIENCE LABORATORY TECHNOLOGY (DSL09J)**

ACH 2309: CHEMICAL ANALYTICAL TECHNIQUES

**END OF SEMESTER EXAMINATION**

**SERIES: AUGUST/SEPTEMBER 2011**

**TIME: 2 HOURS**

**Instructions to Candidates:**

You should have the following for this examination

- *Answer booklet*

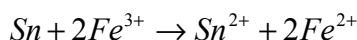
This paper consists of **FIVE** questions

Answer question **ONE (COMPULSORY)** and choose any other **TWO** questions

This paper consist of **FOUR** printed pages

### QUESTION ONE – (COMPULSORY)

- a) Electrolytic conductivity of an electrolyte can be determined experimentally by use of a wheatstone bridge circuit
- i) Draw a fully labeled diagram of the wheatstone bridge circuit (8 marks)
  - ii) State the function of each component in the circuit (6 marks)
  - iii) Give the name used to describe the type of water used in making a solution for conductivity measurements (1 mark)
  - iv) State the reason why direct current is unsuitable for this work (1 mark)



- b) Given the reaction
- i) Identify the type of reaction. Explain (3 marks)
  - ii) Write the half cell equation for the reductant (1 mark)
- c) Find the oxidation number of

- i) *Mn in Mn<sub>2</sub>O<sub>3</sub>*
  - ii) *Cl in HClO<sub>3</sub>*
  - iii) *N in HNO<sub>3</sub>*
  - iv) *Cr in Cr<sub>2</sub>O<sub>7</sub><sup>2-</sup>*
  - v) *V in VO<sub>2</sub><sup>+</sup>*
- (10 marks)

### QUESTION TWO

- a) (i) Define the term polarogram (1 mark)  
(ii) Draw a labeled diagram of the apparatus used to obtain a polarogram in chemical analysis (8 marks)  
(iii) Sketch and label the expected polarogram from the polarographic analysis of an aqueous

*Zn<sup>2+</sup>, Pb<sup>2+</sup>, Sn<sup>2+</sup>, Ag<sup>+</sup>* and *Cu<sup>2+</sup>*  
Solution containing \_\_\_\_\_ and \_\_\_\_\_ given their decomposition potentials as -0.76, -0.13, -0.14, +0.80 and 0.34 volts respectively. (7 marks)

- b) Silver nitrate is used as a testing reagent in the last stage in detection of elements in organic samples.
- i) Identify the target element (1 mark)
  - ii) Describe how the test is carried out (2 marks)
  - iii) State one observation made during such a test and the inference (1 mark)

### QUESTION THREE

- a) A crude organic (containing C H and O) sample is known to contain 4% by mass of uncombustible impurities. On being subjected to combustion analysis, 9.375 of the crude sample on complete combustion gave 8.8g at carbon dioxide and 1.8g of water. Calculate the percentage of each of the three elements in the sample. (8 marks)

$$C = 12, H = 1, O = 16.$$

- b) The Kjeldahi method is one of the methods commonly used in determination of elements in organic analysis. List the three basic steps of this method and for each state the reagents used and the role of each (12 marks)

#### QUESTION FOUR

- a) State Kohlrausch's Law (2 marks)
- b) A solution containing 6g of ethanoic acid per  $\text{dm}^3$  has an electrolytic conductivity of  $5.21 \times 10^{-2} \Omega^{-1} M^{-1}$  at  $25^\circ\text{C}$ . The molar conductivities at infinite dilution at this temperature for the  $H^+$  and  $CH_3COO^-$  ions are  $3.498 \times 10^{-2} \Omega^{-1} M^2 Mol^{-1}$  and  $0.412 \times 10^{-2} \Omega^{-1} M^2 Mol^{-1}$  respectively. Calculate the degree of dissociation of ethanoic acid (8 marks)

$$C = 12, O = 16, H = 1$$

- c) Given an organic sample to demonstrate presence of elements carbon and hydrogen
- Name THREE chemical substances you will require and the role of each giving chemical equations where applicable (8 marks)
  - State the observations made to confirm the presence of carbon and hydrogen (2 marks)

#### QUESTION FIVE

Use the following list of standard electrode potentials to answer the questions that follow.

Half cell reaction	$E^\circ$ (Volts)
$Mg^{2+} + 2e \rightarrow Mg_{(s)}$	-2.38
$Al^{3+} + 3e \rightarrow Al_{(s)}$	-1.68
$Cr_2O_7^{2-} + 14H^+ + 6e \rightarrow 2Cr^{3+} + 7H_2O$	+1.33
$Cl_2 + 2e \rightarrow 2Cl$	+1.36



a) Identify

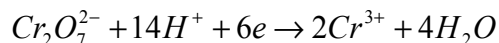
- |     |                               |          |
|-----|-------------------------------|----------|
| i)  | The strongest oxidizing agent | (1 mark) |
| ii) | The strongest reducing agent  | (1 mark) |



b) From half cells

- |      |   |           |
|------|---|-----------|
| i)   | Draw a labeled diagram of the cell made of the two electrodes and indicate on it the direction of electron flow | (5 marks) |
| ii)  | Write the cell representation stating what each of the symbols represents                                       | (4 marks) |
| iii) | Write the equation for the cell reaction taking place   | (1 mark)  |
| iv)  | Calculate the equilibrium constant  | (3 marks) |

c) For the half cell reaction



Calculate the electrode potential if hydrogen ion concentration was changed to 0.01 leaving the concentration of the others unchanged (5 marks)