



Technical University of Mombasa

Faculty of Applied and Health Sciences

DEPARTMENT OF PURE AND APPLIED SCIENCES

DIPLOMA IN SCIENCE LABORATORY TECHNOLOGY

(DSL T 09J)

ACH 2309: CHEMICAL ANALYTICAL TECHNIQUES

SPECIAL/SUPPLEMENTARY: EXAMINATIONS

SERIES: JULY 2013

TIME: 2 HOURS

INSTRUCTIONS:

You should have the following for this paper

- *Answer booklet*

This paper consists of **FIVE** questions.

Answer Question **ONE (compulsory)** and any other **TWO** questions

This paper consists of 4 PRINTED pages

Question ONE

- (a) Electrical conductivity of an electrolyte can be determined experimentally by use of a wheatstone bridge circuit
- (i) Draw a fully labelled diagram of the wheatstone bridge circuit **(8marks)**
 - (ii) State the function of each component in the circuit. **(6marks)**
 - (iii) Give the name used to describe the type of water used in making the solution for conductivity measurements. **(1mark)**
 - (iv) State the reason why direct current is unsuitable for this work. **(1mark)**
- (b) Given the reaction $\text{Sn} + 2\text{Fe}^{3+} \rightarrow \text{Sn}^{2+} + 2\text{Fe}^{2+}$
- (i) Identify the type of reaction. Explain **(3marks)**
 - (ii) Write the half cell reaction equation for the reluctant **(1mark)**
- (c) Find the Oxidation number of
- (i) Mn in Mn_2O_3
 - (ii) Cl in HClO_3
 - (iii) N in HNO_3
 - (iv) Cr in $\text{Cr}_2\text{O}_7^{2-}$
 - (v) V in VO_2^+
- (10marks)**

Question TWO

- (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, 9.375g of the crude sample on complete combustion gave 8.8g of carbon dioxide and 1.8g of water. Calculate the percentage of each of the three elements in the sample. C = 12, H = 1, O = 16 **(8marks)**
- (b) The Kjeldahl 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 the reagents used and role of each. **(12marks)**

Question THREE

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

<i>Half cell reaction</i>	<i>E°(volts)</i>
$\text{Mg}^{2+} + 2\text{e} \longrightarrow \text{Mg(s)}$	-2.38
$\text{Al}^{3+} + 3\text{e} \longrightarrow \text{Al(s)}$	-1.68
$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e} \longrightarrow 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	+1.33
$\text{Cl}_2 + 2\text{e} \longrightarrow 2\text{Cl}^-$	+1.36
$\text{Fe}^{3+} + \text{e} \longrightarrow \text{Fe}^{2+}$	+0.77
$\text{Zn}^{2+} + 2\text{e} \longrightarrow \text{Zn}$	-0.76
$\text{Br}_2 + 2\text{e} \longrightarrow 2\text{Br}^-$	+1.09

- (a) Identify
- (i) The strongest oxidizing agent
 - (ii) The strongest reducing agent
- (2marks)**
- (b) From Fe^{3+} , Fe^{2+} and Zn/Zn^{2+} half cells.
- (i) Draw a labelled diagram of the cell mode of the two electrodes and indicate on it the direction of electron flow **(5marks)**
 - (ii) Write the cell representation stating what each of symbols represents **(4marks)**
 - (iii) Write the equation for the cell reaction taking place **(1mark)**
 - (iv) Calculate the equilibrium constant **(4marks)**
- (c) For the half reaction
- $$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e} \longrightarrow 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$$
- Calculate the electrode potential if hydrogen ion concentration was changed to 0.01M leaving the concentration of the others unchanged. **(5marks)**

Question FOUR

- (a) State Kohlrausch's law **(2marks)**
- (b) A solution containing 6g of ethanoic acid per dm^3 has an electrolytic conductivity of $5.21 \times 10^{-2} \Omega^{-1} \text{m}^{-1}$ at 25°C . The molar conductivities at infinite dilution at this temperature for the ions H^+ and CH_3COO^- are 3.498×10^{-2} and $0.412 \times 10^{-2} \Omega^{-1} \text{m}^2 \text{mol}^{-1}$ respectively. Calculate the degree of dissociation of ethanoic acid **(8marks)**
(C = 12, H = 1, O = 16)
- (c) Given an organic sample to demonstrate presence of elements carbon and hydrogen
- (i) Name THREE chemical substances you will require and role of each giving chemical equations where applicable **(8marks)**
 - (ii) State the observations made to confirm presence of carbon and hydrogen **(2marks)**

Question FIVE

- (a) (i) Define the term **(1mark)**
- (ii) Draw a labelled diagram of the apparatus used to obtain a polarogram in chemical analysis. **(8marks)**

- (iii) Sketch and label the expected polarogram from the polarographic analysis of an aqueous solution containing Zn^{2+} , Pb^{2+} , Ag^{2+} and Cu^{2+} given their decomposition potentials as -0.76, -0.13, -0.14, + 0.80 and + 0.34volts respectively. **(7marks)**
- (b) Silver nitrate is used as a testing reagent in the cast stage in detection of elements in organic samples.
- (i) Identify the target element **(1mark)**
- (ii) Described how the test is carried out **(2marks)**
- (iii) State ONE observation made during such a test and the inference **(1mark)**