KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2019/2020 ACADEMIC YEAR

FOUR YEAR SECOND SEMESTER
SUPPLEMENTARY EXAMINATIONS

FOR THE DEGREE (SCIENCE)

COURSE CODE: SCH 420

COURSE TITLE: SCIENTIFIC INSTRUMENTATION
DURATION: **2 HOURS**

DATE: 5/02/21 **TIME:** 2-4Pm

INSTRUCTIONS TO CANDIDATES
- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.
- Indicate **answered questions** on the front cover.
- Start every question on a new page and make sure question's number is written on each page.

This paper consists of 3 printed pages. Please Turn Over

QUESTION ONE (30 marks)

i. Name any instrumental method of analysis based on the following characteristic properties; (4 marks)
   I. Emission of radiation
   II. Absorption of radiation
   III. Mass-to-charge ratio
   IV. Diffraction of radiation

ii. The wavelength of a sodium 'D' line is 589 nm. What are the frequency and wave number of this line? ($C = 3.0 \times 10^8$ m/s) (4 marks)

iii. State three properties of ion-selective membrane electrodes used as indicator electrodes in Potentiometric methods of analysis. (3 marks)

iv. State three applications of Potentiometric methods of analysis. (3 marks)

v. A solution contained 1 mg of $KMnO_4$ per litre in a 1 cm cell. At 525 nm, the transmittance (T) was 0.3 while at 5000 nm the transmittance was 0.35. Calculate; (molar mass of $KMnO_4$ is 158)
   I. Absorbance at each wavelength (4 marks)
   II. Molar absorptivity at each wavelength (4 marks)

vi. A spectrophotometric method for determination of lead ions (Pb^{2+}) levels in blood uses Cu^{2+} ions as an internal standard. A standard containing 1.75ppb Pb^{2+} and 2.25 ppb Cu^{2+} yield a ratio for analyte signal to internal standard signal as 2.37. A sample of blood is spiked with the same concentration of Cu^{2+} and gives a signal ration of 1.8.
   I. What is an internal standard? (1 mark)
   II. Determine the concentration of Pb^{2+} in the blood sample. (3 marks)

vii. Describe how a Photomultiplier tube works. (4 marks)

QUESTION TWO (20 marks)

i. State the principle on which coulometry is based. (3 marks)

ii. Briefly explain what the following coulometric methods involve;
   I. Potentiostatic coulometry (4 marks)
   II. Amperostatic coulometry (4 marks)

iii. A constant current of 0.8A was used to deposit copper at the cathode and oxygen at the anode of an electrolytic cell. Calculate the mass in grams of each product that was formed in 15.2 minutes. Assume there was no other redox reaction. (6 marks)

iv. State three advantages of coulometric methods of analysis. (3 marks)

QUESTION THREE (20 marks)

i. What do you understand by the term data domain? (2 marks)

ii. Data domains can be broadly classified into electrical and non-electrical domains.
   I. Give any three measurements that entirely involve non-electrical domains. (3 marks)

II. Electrical domains are further divided into analog, time and digital domains. Briefly discuss what analog and time domains involve. Give an example in each case. (10 marks)

III. The measured analytical signal is normally related to the concentration of the analyte by a process called calibration or standardization. Briefly explain how standard addition method is used to relate the measured signal and the concentration of the analyte. (5 marks)

QUESTION FOUR (20 marks)

i. With regard to spectroscopic methods of analysis, explain what wavelength selection involves. (3 marks)

ii. State two properties of an ideal wavelength selector. (2 marks)

iii. Filters and monochromators are used as wavelength selectors.

I. Name the two types of filters and briefly explain how they are used. (6 marks)

II. What is the advantage of using a Monochromator over a filter as a wavelength selector? (2 marks)

iv. Interferometers provide an alternative approach for wavelength selection. Explain the advantages of interferometers over monochromators. (4 marks)

v. Define the following: (3 marks)

I. Resolution

II. Polychromatic

III. Effective bandwidth