

CHUKA



UNIVERSITY

UNIVERSITY EXAMINATIONS

**FOURTH YEAR EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR
OF SCIENCE**

CHEM 448: ENVIRONMENTAL CHEMISTRY II**STREAMS: BSC (Y4S1)****TIME: 2 HOURS****DAY/DATE: TUESDAY 30/03/2021****2.30 P.M – 4.30 P.M****INSTRUCTIONS:****Answer question one and any other two questions****QUESTION ONE (30 MARKS)**

(a) Briefly explain the following:

(i) Limit of detection (LOD) (ii) Limit of quantitation (LOQ) [2 marks]

(b) A chemistry student made a series of absorbance measurements in a spectrophotometric method for determining the concentration of lead in an environmental sample using a blank solution. The absorbance reading obtained were: 0.003, 0.000, 0.006, 0.008 and 0.003 absorbance units. A standard 1ppm of lead solution gave an absorbance reading of 0.062 absorbance units.

(i) Determine the limit of detection (LOD) [4 marks]

(ii) What would be the total absorbance reading at the detection limit level? [2 marks]

(iii) Determine limit of quantitation (LOQ) [2 marks]

(c) (i) Distinguish between accuracy and precision. [3 marks]

(ii) Accuracy is important in an analytical methods used for environmental sample analysis. List any three ways that the accuracy of an analytical method can be measured. [1.5 marks]

- (d) Replicate water samples are analyzed for cadmium in an environmental sample. The following results are obtained: 102.2, 102.8, 103.1, 102.3 ppm Cd. Calculate:
- (i) The standard deviation [2 marks]
 - (ii) The coefficient of variation [1.5 marks]
 - (iii) The standard deviation of the mean [1.5 marks]
 - (iv) The variance [1.5 marks]
- (e) (i) Describe the term method validation and mention two aspects of the validation process. Why is it necessary to validate an analytical method? [2.5 marks]
- (ii) A spike recovery for analysis of cyanide in waste water sample was found to contain 3.8 ppm cyanide. A 100 ml aliquot of this sample was spiked with 10 ml of 50 ppm cyanide standard solution. The concentration of this spiked solution was measured to be 8.1 ppm. Calculate the percent spike recovery. [3.5 marks]
- (iii) By giving one example each distinguish between determinate and indeterminate errors. How can the common determinate errors be minimized? [3 marks]

QUESTION TWO (20 MARKS)

- (a) (i) Explain the meaning of environmental pollutant and name the types of environmental pollution. [3 marks]
- (ii) With the use of relevant examples, explain the point and non point sources of pollution. Illustrate with an example. [2 marks]
- (iii) Distinguish between primary and secondary pollutants. Discuss any three major primary pollutants provided by human activity in the light of source and relative contributions to air pollution. [4 marks]
- (b) (i) Differentiate between Bioremediation and Biodegradation. [2 marks]
- (ii) Why is Bioremediation considered important and safe? When can this process be considered unsafe? [2 marks]

- (iii) What are the factors that affect microbial degradation process? [2 marks]
- (iv) Although many bacteria are able to metabolize organic pollutants, a single bacterium does not. Explain. [2 marks]
- (v) Explain why heavy metals are not biodegradable, yet bacteria are efficient in heavy metal biomediation. [2 marks]
- (c) Distinguish between Biochemical Oxygen Demand (BOD) and chemical Oxygen demand. What is the value of BOD in contaminated and uncontaminated water? [3 marks]

QUESTION THREE (20 MARKS)

- (a) Define chromatography and explain how gas chromatography differs from other forms of chromatography. [2 marks]
- (b) (i) Draw a schematic diagram of the components of typical gas chromatograph and explain the basic principle of gas chromatography. [5 marks]
- (ii) What are the commonly used carrier gas in GC analysis when using FID detector? [2 marks]
- (c) (i) Name and describe the commonly used types of capillary column. Explain capillary column the usually preferred over packed columns in GC analysis? [3 marks]
- (ii) What do you understand by column efficiency and how is it expressed? [2 marks]
- (iii) What measures would you adopt to extend useful life of a column? [2 marks]
- (iv) What are the advantages and limitations of gas chromatography? [4 marks]

QUESTION FOUR (20 MARKS)

- (a)(i) Using a schematic diagram show all the components of an Atomic absorption spectrophotometer (AAS). State the functions of each of the following component. [3 marks]

(i) Hollow cathode lamp

(ii) The nebulizer

(iii) The flame

(iv) The monochromator

(v) The photomultiplier tube

(b) (i) Outline the steps involved in introducing a sample for an AAS measurement.

[2 marks]

(ii) State the disadvantages of flame atomization in AAS? [1.5 marks]

(iii) Atomic absorption or emission spectroscopy is a method of choice for analysis of metals that are considered to be major environmental pollutants. Justify this assertion. [2 marks]

(c) (i) What are the main advantages of the graphite furnace technique over the conventional flame methods? What are the disadvantages of the graphite furnace and how can they be reduced or eliminated? [2 marks]

(ii) Name the types of interferences that are commonly associated with AAS. [1.5 marks]

(iii) Give an overview of the principles behind graphite furnace atomic absorption spectrometry. [2 marks]

(d) Hydride generation is a sample introduction specific to a few elements:

(i) Briefly explain how hydride generation sample introduction works and give an example of one element that you can use this sample introduction method for. [1.5 marks]

(ii) Explain why you get better sensitivity when this sample introduction method is used. [1.5 marks]

(iii) Explain the basic principles of ICP-MS technique. What are the advantages of ICP-MS technique over AAS? [3 marks]

QUESTION FIVE (20 MARKS)

(a) Briefly discuss each of the following categories of water pollutants and the problems they cause. [6 marks]

(i) Pathogens

(ii) Organic wastes

(iii) Chemical pollutants

(b) (i) Explain the difference between oligotrophic and eutrophic waters. [12 marks]

(ii) Explain the term eutrophication and by means of a flow diagram show the sequential process of eutrophication give details of each stage. [4 marks]

(c) List categories of pollutants present in raw waste sewage and state their sources? [2 marks]

(d) Name and describe any two methods of treating raw sludge and give the end products that may be produced from each step and its use. [4 marks]

(e) Why is the secondary treatment of waste water called biological treatment? Outline the principle involved. [2 marks]