



MACHAKOS UNIVERSITY

University Examinations 2023/2024

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FOURTH YEAR SECOND SEMESTER EXAMINATIONS FOR

BACHELOR OF EDUCATION (SCIENCE)

SCH 407: ENVIRONMENTAL CHEMISTRY

DATE:

TIME:

INSTRUCTIONS:

- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks).
- Answer any **two** questions from section **B** (each 20 marks).

QUESTION ONE COMPULSORY (30 MARKS)

- a) The atmosphere is stratified into different layers which can be represented graphically through Altitude –Temperature profile. With the help of a diagram with the vertical axis being the Altitude (km) and the horizontal axis being temperature (Kelvin);
- i. Show the profile of these layers. (5 marks)
 - ii. Explain adequately the variation of temperature with altitude at each layer (stratum). (5 marks)
 - iii. Explain briefly how pollutants are handled naturally in the troposphere. (2 marks)
- b) The stratosphere consists of an important constituent, the ozone layer;
- i. Explain clearly with the help of chemical equations how ozone is made and maintained naturally at steady state for the protection of mankind. (4 marks)
 - ii. Explain briefly how ozone is naturally controlled in the stratosphere by NO_x . (2 marks)
 - iii. Explain how the NO_x catalytic chain depletes ozone layer thus exposing mankind to the UV radiation. (3 marks)
- c) CFCs is a short form of organic compounds known to persist in the environment and ultimately play a role in the depletion of ozone in the stratosphere.

- i. Write the full name of CFCs. (1 mark)
- ii. What were the initial uses of these compounds which were introduced in the 1930s? (2 marks)
- iii. Why do they persist in the environment? (3 marks)
- iv. Explain briefly how they deplete ozone layer. (3 marks)

QUESTION TWO (20 MARKS)

- a) Combustion of gasoline in internal combustion engines and power plants contributes to the emission of NO, volatile organic compounds (VOCs) and CO.
 - i. Explain conditions under which NO, CO and VOC can be emitted to the atmosphere. (6 marks)
 - ii. Explain one strategy by industrial plants to control these three types of emissions mentioned in 2a (i) above. (2 marks)
 - iii. Explain in details with the help of equations how these three emissions are combated in the internal combustion engine using the three- way catalytic converter. (4 marks)
 - iv. Name the three metals used as catalysts which make up this three-way catalytic converter. (3 marks)
- b) In relation to the internal combustion engine, explain the following;
 - i. The octane rating of gasoline. (1 mark)
 - ii. The engine knock in relation to octane rating. (1 mark)
 - iii. The role of tetra-ethyl lead $\text{Pb}(\text{CH}_2\text{CH}_3)_4$ in the internal combustion engine. (1 mark)
 - iv. At least two ways by which the octane rating of gasoline is improved. (2 marks)

QUESTION THREE (20 MARKS)

- a) Acid rain plays a big role in environmental pollution both in the aquatic and terrestrial environments,
 - i. Explain briefly with the help of chemical equations how both natural and anthropogenic activities lead to formation of acid rain. (4 marks)
 - ii. Explain how acid rain is buffered by different buffering agents in the soil depending on the underlying rock. (3 marks)

- iii. Explain the term Cation Exchange Capacity of the soil cation exchange sites. (2 marks)
- iv. List three consequences of acid rain in the environment. (3 marks)
- b) Oxygen is regarded as the universal oxidant in most of the redox processes in aerobic conditions.
 - i. Explain with the help of a diagram showing different redox couples for the different oxidants used by anaerobic bacteria to effect redox processes under anaerobic conditions. (6 marks)
 - ii. Explain how the Eutrophication process in an aquatic environment (fresh water lake) can lead to the creation of anaerobic conditions thus necessitating the condition described in 3b(i) above. (4 marks)

QUESTION FOUR (20 MARKS)

- a) Both natural recycling of materials and anthropogenic activities can result both in contamination and pollution of the atmosphere, hydrosphere and lithosphere.
 - i. Differentiate between the terms contamination and pollution. (2 marks)
 - ii. Briefly explain how the natural processes/recycling of materials can lead to both contamination and pollution of environment. (4 marks)
 - iii. State briefly how anthropogenic activities lead to pollution. (4 marks)
 - iv. Differentiate with the help of examples point and non-point sources of pollution. (3 marks)
- b) (i). Explain the term of biochemical (biological) oxygen demand (BOD). (3 marks)
- (ii). Explain how the value of BOD varies among the following types of wastes domestic sewage, paper, food and metals. (4 marks)

QUESTION FIVE (20 MARKS)

- a) Agricultural chemicals are applied to the soil for both improved fertility and prevention of pests to boost food production.
 - i. differentiate between organic fertilizer and inorganic fertilizer. (2 marks)
 - ii. State advantages of organic fertilizer over inorganic fertilizer. (4 marks)
 - iii. Discuss briefly the differences between the organochlorines and organophosphates. (4 marks)

- b) Waste water (sewage waste) undergo several levels of treatment before being
- i. Discharged into the water systems.
 - ii. Outline briefly these steps stating clearly what happens at each of these steps and
 - iii. clearly what is achieved at each step. (10 marks)