

CHUKA



UNIVERSITY

**UNIVERSITY EXAMINATIONS**

**EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF  
SCIENCE IN INDUSTRIAL CHEMISTRY**

**CHIN 451: AIR POLLUTION AND CONTROL**

**STREAMS: CHIN**

**TIME: 2 HOURS**

**DAY/DATE: TUESDAY 21/09/2021**

**2.30 P.M. – 4.30 P.M.**

**INSTRUCTIONS:**

- **Answer all questions in section A and any two in section B**

**SECTION A (30 MARKS)**

- a) i) Name and describe the four segments of environment. (4 marks)
- ii) Enumerate the role of the atmosphere in the environment. (3 marks)
- iii) What is the primary basis for the division of the atmosphere into different regions?  
(2 marks)
- b) i) Name the regions of the atmosphere. (2 marks)
- ii) sketch the temperature profile showing how the atmospheric temperature varies with altitude and indicate the major regions of the atmosphere and the boundaries between them. (4 marks)
- iii) State the respective altitudes and temperature ranges of the major regions of the atmosphere. What are the characteristics and important chemical species in each region? (4 marks)
- c) i) Briefly explain what you understand by the terms lapse rate. (2 marks)

- ii) Give reasons why temperature decreases with altitude in the troposphere, but increases with altitude in the stratosphere. (4 marks)
- d) i) Briefly discuss why the environmentalists are greatly concerned about pollution of the stratosphere. (2 marks)
- ii) Why do environmental scientists call tropopause thermal layer or cloud trap? Explain its importance in the atmosphere. (3 marks)

**Question two (20 marks)**

- a) i) Describe the phenomenon 'Temperature inversion' and explain its significance in air pollution. (2 marks)
- ii) Using any three examples explain how temperature inversion occurs. (3 marks)
- b) i) with the help of chemical equations, explain the Chapman's cycle for formation and destruction of ozone destruction? (2 marks)
- ii) The dissociation energy of carbon-bromine bond is typically about 210kJ/mol. What is the maximum wavelength of photons that can cause C- Br bond [Planck's Constant  $h=6.26 \times 10^{-34}$ J.SEC, Avogadro's number  $N = 6.02 \times 10^{23}$ /mol, Velocity of light =  $3.0 \times 10^8$ m/s (3 marks)
- c) i) With the help of chemical equations, describe the mechanism for catalytic destruction of ozone and mention possible chain carriers responsible for this process. (3 marks)
- ii) Rank the following constituents of the troposphere in increasing order of concentration: O<sub>3</sub>, CO, CO<sub>2</sub>, N<sub>2</sub>, O<sub>2</sub> and CH<sub>4</sub>? (1 mark)

**Question Three (20 marks)**

- a) i) Give three examples each of natural and anthropogenic air pollutants. (3 marks)
- ii) What naturally occurring cleanser helps to remove pollutants from the atmosphere? (1 marks)
- iii) Show how the cleanser in (i) above is formed in the troposphere and give any three examples of pollutants destroyed by this cleanser and their end products. (3 marks)

- b) i). Distinguish between a pollutant and contaminant. (2 marks)
- ii) what are primary pollutants? List three major primary air pollutants and their sources present in the troposphere. (3 marks)
- iii) What are secondary pollutants and how are they formed. Give two examples of secondary of secondary pollutants. (3 marks)
- c) i) What impact does air pollution have on human health? Give the three categories of impact and distinguish among them. (3 marks)
- d) Name two basic approaches that are used for controlling air pollution and show how they can be achieved. (3 marks)

**Question four (20 marks)**

- a) i) Distinguish between industrial smog and photochemical smog. (2 marks)
- ii) With help of equations, give a detailed explanation on how photochemical smog is formed. (3 marks)
- iii) What are the environmental conditions required to form photochemical smog? (2 marks)
- iv) What are harmful effects of photochemical smog and how can they be controlled. (2 marks)
- b) i) What is acid rain? (2 marks)
- ii) Name and give source of the pollutants responsible for causing acid rain. (3 marks)
- iii) Acid rain is known to contain some acids. Name these acids and by writing chemical equations show where they come from in rain? (3 marks)
- iv) How is acid rain harmful to the environment? Explain three practical ways that can mitigate the problem of acid rain. (3 marks)

**Question five (20 marks)**

- a) i) Explain in details what greenhouse effect is and how it affects the global climate. (4 marks)
- ii) With respect to absorption of radiant energy, what distinguishes a greenhouse gas from a non-greenhouse gas? (2 marks)
- iii) Explain using molecular structure of  $\text{CO}_2$  why it is a greenhouse gas but Ar is not. Name any other two greenhouse gases. (3 marks)
- b) i) What properties of CFCs make them ideal for various commercial applications but also make them a long term problem in the stratosphere? (4 marks)
- ii) Using  $\text{CF}_2\text{Cl}_2$  as an example, show how CFCs reactions are involved in ozone depletion in the atmosphere. (2 marks)
- c) i) What is a hydrofluorocarbon? Why are these compounds potentially less harmful to ozone layer than CFCs? (3 marks)
- ii) What are halons? What are their commercial applications? (2 marks)

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