



NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF ENGINEERING

DEPARTMENT OF CHEMICAL ENGINEERING

Environmental Process Engineering 1A

TCE 5104

First Sitting- Examination Paper

July 2024

This examination paper consists of **three** pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: Graph Paper

Examiner's Name: Dr. Fortune Nkomo

INSTRUCTIONS

1. Answer **ALL** questions in **SECTION A**
2. Answer **ANY TWO** questions in **SECTION B**
3. Each question carries 25 marks

MARK ALLOCATION

QUESTION	MARKS
1	25
2	25
3	25
4	25
5	25
TOTAL ATTAINABLE MARK	100

Copyright: National University of Science and Technology, 2024

SECTION A: Answer ALL questions in this section.

QUESTION A1

- i. Discuss the following terms as applied to environmental process engineering:
- a) Environmental aspect [3]
 - b) Environmental impact [3]
 - c) Environmental Management system [3]
 - d) Chemical Oxygen Demand [3]
 - e) Biological Oxygen Demand [3]
- ii. As a consulting engineer, you have been contracted to modify an existing control device used in fly ash removal. The federal standards for emissions have been changed to a total numbers' basis. Determine if the unit will meet an effluent standard of 105.7 particles/m³. Data for the unit are given below. Average particle size, $d_p = 10 \mu\text{m}$; assume constant Particle specific gravity = 2.3 Inlet loading = 3.0 gr/m³ Efficiency (mass basis), $E = 99\%$ [10]

QUESTION A2

- i. With the aid of a well-labelled diagram, explain the waste hierarchy [7]
- ii. Explain how wastes or pollutants can be identified in a production line. [6]
- iii. A proposed incineration facility design requires that a packed column and a spray tower be used in series for the removal of HCl from the flue gas. The spray tower is to operate at an efficiency of 65% and the packed column at an efficiency of 98%. Calculate the mass flowrate of HCl leaving the spray tower, the mass flowrate of HCl entering the packed tower, and the overall efficiency of the removal system if 76.0 kg of HCl enters the system every hour. [10]

SECTION B: Answer any TWO (2) questions in this section.

QUESTION B1

Discuss the functions and powers of the Environmental Management Agency as outlined by the Environmental Management Act [Chapter 20:27] [25]

QUESTION B2

A cyclone on a cement plant suddenly malfunctions. By the time the plant shuts down, some dust has accumulated on parked cars and other buildings in the plant complex. The nearest affected area is 700m from the cyclone location, and the furthest affected area measurable on plant grounds is 2500m from the cyclone. What is the particle size range of the dust that has landed on plant grounds? On this day, the cyclone was discharging into a 6km/h wind. The specific gravity of the cement is 1.96. The cyclone is located 175m above the ground. Neglect effects of turbulence [25]

QUESTION B3

- i. Exhaust gases from petroleum processing plant contain hydrogen sulphide (H_2S) which is an air pollutant. It is desired to clean the gas by absorbing 95% of hydrogen sulphide by a solvent in a counter-current tray tower before the exhaust gases are released into the atmosphere. The gas to be cleaned is a mixture of hydrogen sulphide and nitrogen containing 1.5% hydrogen sulphide. Total gas input is 30 kmol/hr and the solvent enters the tower at a rate of 90 kmol/hr. The tower operates at $27^\circ C$ and 1 atm. The equilibrium relation is $Y=2.53X$. Determine the number of stages required for this operation. [20]
- ii. You are required to choose a suitable solvent for the operation in (i) what factors would you consider [5]

END OF QUESTION PAPER