

National Exams May 2004

98-BS-16, Environmental Engineering

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. Candidates may use one of two calculators, the Casio or Sharp approved models. This is a Closed Book examination.
3. Any five questions constitute a complete paper. Only the first five questions as they appear in your answer book will be marked.
4. All questions are of equal value.

1. (i) What are the major constituents (or the surrogate parameters) of concern in municipal wastewater discharges into natural waterbodies?

Briefly discuss the reasons for the concern for each listed constituent.

- (ii) A stream with a flow rate of $5 \text{ m}^3/\text{s}$ and a certain pollutant "X" concentration of $80 \text{ } \mu\text{g/L}$ feeds into a lake having a volume of $10 \times 10^6 \text{ m}^3$. A wastewater treatment plant also discharges its treated effluent at the rate of $0.5 \text{ m}^3/\text{s}$ into the same lake. The concentration of X in the wastewater effluent is 1 mg/L and the reaction rate coefficient is $0.2/\text{d}$.

- (a) Find the steady-state concentration of X in the lake, and
- (b) If the wastewater effluent discharge is eliminated to improve the quality of water in the lake, what will be the new steady-state concentration of X in the lake?

State the basic assumptions that you made.

2. (i) List and discuss three different type of temperature inversions and their effects in the dispersion of air pollutants.

- (ii) Assuming that the total mass of air is $5.1 \times 10^{18} \text{ kg}$ and the density of air at standard temperature ($0 \text{ }^\circ\text{C}$) and pressure (1 atm) is 1.29 kg/m^3 , determine the following:

- (a) the amount of carbon (in metric tonnes) in the atmosphere corresponding to a concentration of 350 ppm of CO_2 , and
- (b) the amount of carbon emission (in metric tonnes) into the atmosphere that would raise CO_2 concentration by 1 ppm. [C = 12; O = 16]
- (iii) Explain why the relationship derived in (ii)(b) cannot be used directly to estimate any future increases in atmospheric CO_2 concentrations due to carbon emissions.

3. (i) Discuss the following terms with respect to drinking water treatment using a typical process schematic:
- (a) Coagulation and Flocculation
 - (b) Filtration
 - (c) Disinfection
- (ii) Explain why “alkalinity” of water is an important characteristic.
- (iii) The total alkalinity of a wastewater sample is 80 mg/L as CaCO₃. If the temperature and pH of the sample are 25 °C and 10.2 respectively, calculate the carbonate, bicarbonate and hydroxide alkalinities in mg/L as CaCO₃.

Assume that the dissociation constant $K_a = 4.8 \times 10^{-11}$ mole/L at 25 °C.

[Ca = 40; C = 12; O = 16]

4. (i) Explain eutrophication of water bodies by discussing the causes, effects and control strategies.
- (ii) (a) Ammonia in wastewater discharges exist in two forms: free/unionized ammonia and ammonium/ionized ammonia. Find the fraction of the free/unionized form of ammonia as a function of pH at a temperature of 25 °C, assuming that the equilibrium constant at 25 °C is 1.82×10^{-5} .
- (b) Illustrate this relationship by using an appropriate sketch for the pH range of 7 to 12.
- (c) Which form of ammonia is more toxic to aquatic organisms? Why?
- (iii) What are the other forms of nitrogen present in wastewater besides total ammonia nitrogen?

5. Write short notes on the following:

- (i) Facultative lagoons
- (ii) Population pyramid
- (iii) Trihalomethanes
- (iv) Greenhouse effect
- (v) Bioassay

6. (i) Describe the limitations or difficulties associated with common economic evaluation methods in quantifying environmental impacts.

(ii) Briefly outline the intent of any three important Acts or Regulations in your Province used to protect the environment.

7. (i) Describe the various types of environmental conflict resolution.

(ii) Discuss the ecological effects of thermal discharges into aquatic ecosystems. Group these effects into physical, chemical and biological categories in a tabular form to facilitate your discussion.

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Marking Scheme

1.	(i)	10
	(ii)	10
2.	(i)	9
	(ii)	7
	(iii)	4
3.	(i)	10
	(ii)	2
	(iii)	8
4.	(i)	9
	(ii)	8
	(iii)	3
5.	(i)	4
	(ii)	4
	(iii)	4
	(iv)	4
	(v)	4
6.	(i)	14
	(ii)	6
7.	(i)	10
	(ii)	10