National Exams December 2002

98-Civ-A3, 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 wastewater treatment plant discharges its treated effluent with a phosphorus concentration of 2 mg/L into a lake at a rate of 0.4 m^3/s. A stream with an average flow of 30 m^3/s and an average phosphorus concentration of 0.03 mg/L also flows into the same lake. Assuming that the settling rate for phosphorus in the lake is 7 m/yr and the surface area of the lake is 60 square kilometres, determine

(a) the average phosphorus concentration in the lake, and

(b) the maximum allowable phosphorus concentration in the wastewater treatment plant effluent, if the phosphorus concentration in the lake is not to exceed 0.025 mg/L.

State the basic assumptions that you made.

2. (i) Explain the different types of temperature inversions and their effects in the dispersion of air pollutants.

(ii) Assuming that the total mass of air is 5.1×10^{18} kg and the density of air at standard temperature (0°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 briefly the basic unit processes used in the treatment of drinking water, using a typical process schematic.

(ii) Explain the significance of the "carbonate system" in natural waters in the protection of aquatic species from acid precipitations.

The analytical results of a water sample are as follows:

CO_3^{2-} 45 mg/L
HCO_3^- 61 mg/L
pH 10

Calculate the alkalinity of this water in mg/L as $CaCO_3$, assuming that the atomic weights are:

Ca = 40; H = 1; C = 12; O = 16.

4. (i) Explain eutrophication of water bodies by discussing the causes, effects and control strategies.

(ii) Briefly discuss the processes "nitrification" and "denitrification" as used in the treatment of municipal wastewater, explaining the relative importance of these two processes depending on whether the effluent is discharged to a surface waterbody or into the groundwater.

Nitrogen analysis of a wastewater sample gave the following results:

Ammonia	17.0 mg/L
Ammonium	18.0 mg/L
Nitrite	0.46 mg/L
Nitrate	1.24 mg/L
Organic Nitrogen	10.0 mg/L

Calculate the total concentration of nitrogen in the sample, assuming that the atomic weights of N, O and H are 14, 16 and 1 respectively.

5. Write short notes on the following:

(i) Activated sludge process
(ii) Photochemical smog
(iii) Trihalomethanes
(iv) Facultative ponds
(v) Population momentum

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 techniques available for quantitative environmental impacts identification.

(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.