NATIONAL EXAMS MAY 2018

16-Civ-A3 Elementary 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. This is a Closed Book Exam with a candidate prepared $8\frac{1}{2}''$ x $11''$ double sided Aid-Sheet allowed.

3. Candidates may use one of two calculators, the Casio or Sharp approved models. Write the name and model designation of the calculator on the first inside left hand sheet of the exam work book.

4. Any five (5) questions constitute a complete paper. Only the first five (5) answers as they appear in your work book(s), will be marked.

5. Each question is worth a total of 20 marks with the section marks indicated in brackets ( ) at the left margin of the question. The complete Marking Scheme is also provided on the final page. A completed exam consists of five (5) answered questions with a possible maximum score of 100 marks.

Problem 1

Provide answers to the following questions associated with *air pollution control* and *water treatment* while considering both technical and non-technical environmental principles:

(10) (i) Briefly describe two (2) different types of air pollution controls [one (1) technical and one (1) non-technical] that can be used to reduce the emission of VOCs and PM_{10} from industrial sources. For each type of control, briefly provide two (2) advantages and two (2) limitations of the control. Use a table to organize your answer.

(10) (ii) Provide a labelled schematic which includes three (3) main treatment processes of a drinking water treatment plant designed to reduce both dissolved solids and odours associated with the source water. In addition, briefly discuss two (2) non-technical principles to ensure that the final treated water maintains its potable quality throughout the distribution system to the consumer.

Problem 2

Provide answers to the following questions related to *water resource management* and *characteristics of gases* considering both technical and non-technical environmental principles:

(10) (i) Identify and discuss the application of three (3) water resource management strategies, either technical or non-technical, to protect both the short term and the long term designated uses of a large groundwater reservoir under the influence of surface water. The groundwater reservoir is actively used as the primary source of drinking water supply through private wells, and for irrigation water for the local farming community. Also note that decentralized septic systems, with subsurface discharge, are the primary source of residential wastewater treatment in the area.

(10) (ii) Chlorine gas [Cl_2 (g)] combined with ammonia [NH_3 (g)] is used to generate chloramines as a secondary disinfectant for a water distribution system located on-site at a large water treatment plant. Identify and discuss three (3) environmental issues, considering both technical and non-technical environmental principles related to the use of toxic gases.

Problem 3

Provide answers to the following questions related to the application of enviornmental principles pertaining to *environmental impact assessment*, *sustainable development* and *environmental ethics*:

(6) (i) Briefly explain how an *environmental impact assessment* may be applied to reduce the environmental damage and reduce the life cycle costs associated with the creation, operation and maintenance of a coal mine operation in Nova Scotia located within a watershed discharging into a highly priced crab fishing region.

(7) (ii) Consider a green energy production strategy with the objective of improving the overall quality of the environment. Identify and discuss three (3) key strategies in achieving two (2) important *sustainable development* goals. Use table(s) to organize your answer.

(7) (iii) An engineer on contract by the British, Australian and American Energy Services (BAAES), was to oversee and review the findings of an environmental impact assessment prepared by a subcontractor (NRC) as part of an application for a Federal government permit to build a privately owned uranium enrichment plant. An exaustive search, thoughout Canada, was undertaken by NRC to find the "best" site for a plant that would produce up to 20 % of Canada's enriched uranium. NRC supposedly used an objective scientific method in designing its site selection process. However a review by the engineer on contract found that racial bias played a role in the site selection process and that NRC also underestimated the hazards and costs imposed on the nearby low income, minority community and overestimated proposed benefits. In addition, alternative sites to the selected location were not adequately analyzed as required by standard procedures. Briefly explain the actions that should be taken by the engineer, considering the following principles of professional duty:

(a) Act for each employer or client as faithful agents or trustees;

(b) Hold paramount the safety, health, and welfare of the public; and

(c) Issue public statements only in an objective and truthful manner.

Problem 4

Provide answers to the following questions as related to *material balances*, *reaction kinetics* and *microbiology and ecology* of environmental engineering :

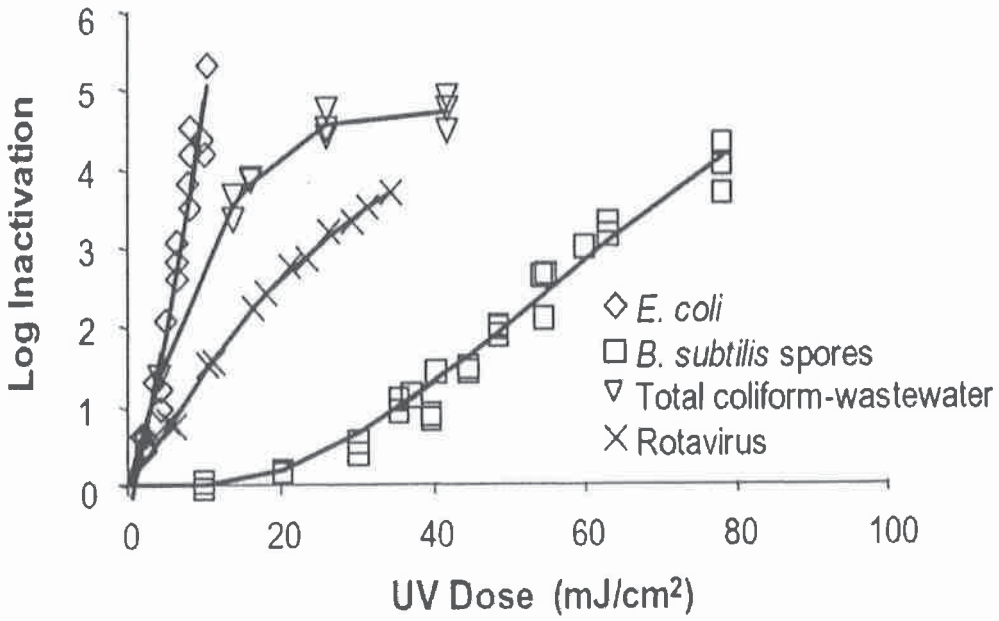
(6) (i) Use mass balances to estimate the lead (Pb) emission in kg/yr from a 2000 MW coal-fired power plant. Assume that the higher heating value of coal (HHV) is 30 x 10^6 J/kg; the concentration of Pb in coal is 0.1 μg/g and the overall efficiency of the power plant is 50%.

(6) (ii) Consider the fundamental gas phase reaction and the corresponding rate law below:

$$2A + B \Longrightarrow C$$
$$-r_A = k_A C_A^2 C_B$$

Assuming that the reaction is carried out at constant T (500 K) and P (15 atm) with k_{Pb} = 20 dm^6/mol^2, determine the completely stirred tank reactor (CSTR) volume that is necessary to achieve a 99% conversion when the feed is 60% mole A and 40% mole B.

(8) (iii) Consider the figure (below) and give the order of resistance, from highest to lowest, to UV disinfection by each microorganism. In addition give the approximate UV dose required to achieve 99.9% inactivation for each microorganism.



Problem 5

Provide answers to the following questions related to *population*, *economic growth*, *industrialization*, *urbanization* and *energy use* as causes of environmental pollution:

Briefly explain two (2) major environmental impacts and two (2) corresponding potential environmental engineering solutions to reduce impacts from increase in water demands and increase in solid waste production associated with the following growth areas (**use a 2 x 3 table as provided below**). Assume that strict environmental requirements are to be met following further economic growth, industrialization and energy use:

(6) (i) Economic Growth;

(7) (ii) Industrial Expansion; and

(7) (iii) Energy Use.

2-Impacts & 2-Solutions	Economic Growth	Industrial Expansion	Energy Use
Water Demands			
Solid Waste Production			

Problem 6

Provide answers to the following questions pertaining to the application of environmental principles (technical and non-technical) as related to *wastewater treatment* and *solid waste management*:

(10) (i) A municipality projects that its population will double over the next 20-years. However the wastewater treatment plant capacity is limited to the current capacity due to land constraints. You as the lead process engineer in the firm have been tasked with developing strategies to upgrade or retrofit the existing wastewater treatment system so that the future treatment capacity needs can be met within the current treatment system. Through the application of environmental principles, propose two (2) technical and two (2) non-technical strategies to ensure that the existing treatment capacity will be adequate over the next 20-years while at the same time the quality of the final effluent complies with the environmental limits.

(10) (ii) It is generally recognized that solid waste should be considered a resource that if managed environmentally responsibly can result in a sustainable and healthy environment. Through the application of environmental principles, propose two (2) technical and two (2) non-technical strategies to ensure that a target of 50% waste diversion can be reached within a 10-year period. Assume that the current landfill capacity is at 80% and only a 5-year life remaining at the current solid waste generation rate.

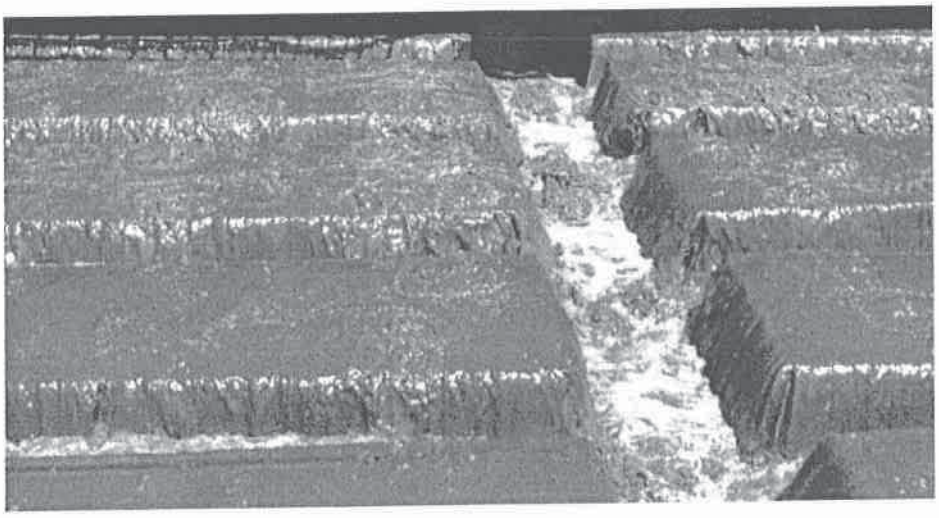
Problem 7

Provide answers to the following questions related to *particle characteristics* and *chemistry of solutions* as it pertains to environmental engineering:

(10) (i) The removal of particles from source waters during water treatment is critical to ensure a potable treated water supply that can be effectively disinfected. Briefly explain the combined role of coagulation/flocculation and filtration in the effective removal of colloidal and suspended particles. As part of your explanation, provide a simplified labelled schematic of a typical engineering process that combines the use of coagulation/flocculation and filtration in a water treatment system.

(10) (ii) The average analysis in terms of Ca, Mg and Cu results of groundwater near a copper mine is given below. Calculate the hardness of the lake water in mg/L as $CaCO_3$, assuming that the atomic weights are: Ca = 40; Mg = 24; Cu = 64; H=1; C=12 and O=16 and indicate how you would classify this water (i.e., soft, moderately hard or hard):

Ca^{2+} = 20 mg/L
Mg^{2+} = 30 mg/L
Cu^{2+} = 45 mg/L



Marking Scheme
16-CIV-A3 Elementary Environmental Engineering
May 2018

1. (i) 10, (ii) 10 marks, 20 marks total

2. (i) 10, (ii) 10 marks, 20 marks total

3. (i) 6, (ii) 7, (iii) 7 marks, 20 marks total

4. (i) 6, (ii) 6, (iii) 8 marks, 20 marks total

5. (i) 6, (ii) 7, (iii) 7 marks, 20 marks total

6. (i) 10, (ii) 10 marks, 20 marks total

7. (i) 10, (ii) 10 marks, 20 marks total