NATIONAL EXAMS
DECEMBER 2018

18-Env-A1 Principles of 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.

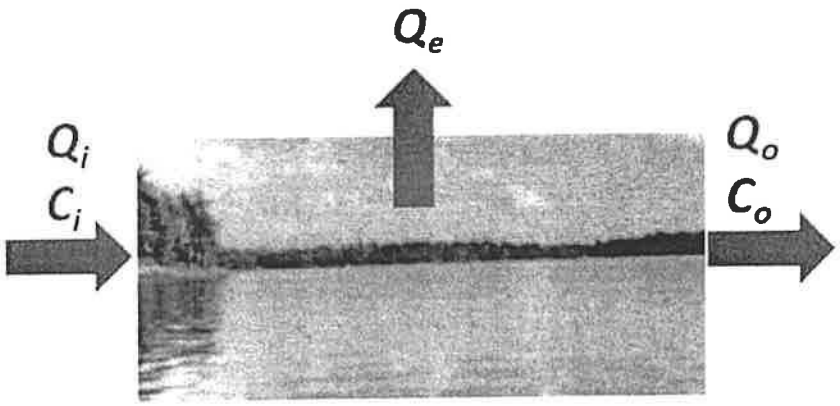
4. Any five (5) questions constitute a complete paper. Only the first five (5) answers as they appear in your work book(s), will be marked.

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

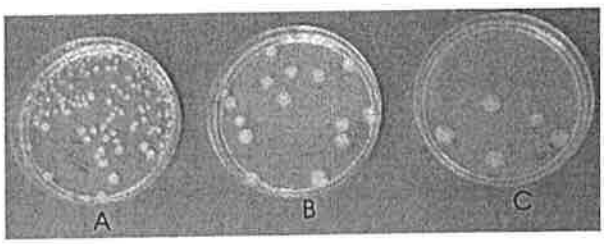
Provide answers to the following questions related to *mass and energy balance*, *contaminant partitioning* and *microbiology* as related to environmental engineering:

(7) (i) A lake has a volume of 10^6 m^3 (V) of water and is fed by an upstream river with a flow rate of 10^5 m^3/yr (Q_i). Evaporation across the lake is 2 x 10^4 m^3/yr (Q_e). Assume that the outflow stream from the lake is flowing at 5 x 10^4 m^3/yr (Q_o), that the upstream river has a PO_4 concentration (C_i) of 15 mg/L and that steady-state conditions apply. Calculate the concentration of the PO_4 in the outflow stream (C_o) assuming a PO_4 decays at a rate of $K = 0.07$/yr.



(6) (ii) The equilibrium partitioning of a chemical between water and solid phases in the environment may be predicted by the organic carbon adsorption coefficient (K_{OC}). Explain what the K_{OC} is and then select two (2) environmental factors that may affect the partitioning of an organic chemical present in the water to the soil. Briefly discuss how these two factors influence partitioning between the two phases.

(7) (iii) Briefly explain how to design of an efficient disinfection system to eliminate microbial pathogens in water using chlorine. In your explanation, consider the form of chlorine, dose, contact time, pathogen indicators and the type of microbial pathogens you are targeting to disinfect. You may use figures and equations in your explanation.



Problem 2

Provide answers to the following questions related to *environmental ethics*, *sustainable development* and *water and wastewater treatment*:

(10) (i) Engineers Canada defines sustainability as: "Ability to meet the needs of the present without compromising the ability of future generations to meet their own needs, through the balanced application of integrated planning and the combination of environmental, social, and economic decision-making processes." As a professional engineer in charge of a sustainable development plan to build a dam to generate electricty over a 50-year period while minimizing the potential social and environmental impacts, briefly discuss five (5) key engineering actions you need to take to meet the obligations to your client while at the same time meeting the principles of the code of ethics below to ensure sustainability:

(1) Fairness and loyalty to the practitioner's associates, employers, clients, subordinates and employees;

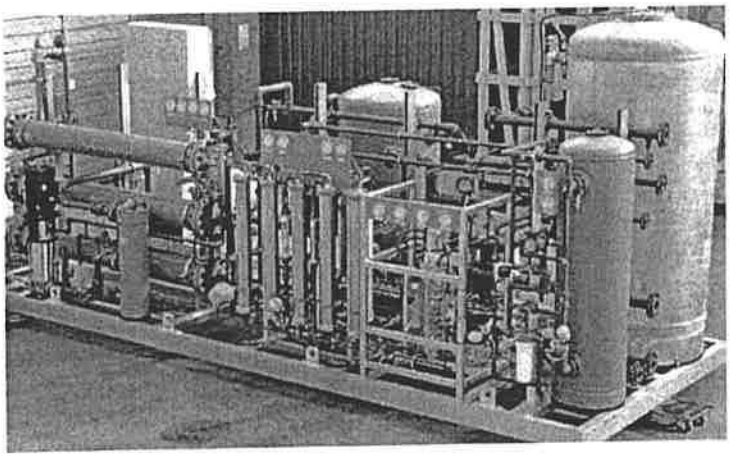
(2) Fidelity to public needs;

(3) Devotion to high ideals of personal honour and professional integrity;

(4) Knowledge of developments in the area of professional engineering relevant to any services that are undertaken; and

(5) Competence in the performance of any professional engineering services that are undertaken.

(10) (ii) Provide a clearly labelled schematic of a water or wastewater treatment facility (**select only one**), that includes pretreatment, the main-treatment units and includes disinfection. Briefly discuss the engineering function of any three (3) treatment units that work to ensure that final potable water or the final effluent discharged complies with environmental regulations.



Problem 3

Provide answers to the following questions related to *particle characteristics*, *chemistry of solutions* and *thermal pollution*:

(8) (i) Briefly explain two (2) key differences between suspended particles and particulate (settleable) particles typically found in municipal wastewater. In addition, provide a labelled schematic of a treatment approach (**one** for each type of particle) to significantly reduce suspended and settleable particulates from the final effluent of a wastewater treatment facility. Briefly explain how the treatment approach works for each type of particle.

(7) (ii) The average analysis results of Ca, Mg and Cu of a groundwater supply near an abandoned quarry in southern Ontario are given below. Calculate the hardness of the ground 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. Also indicate how you would classify this water (i.e., soft or hard):

Ca^{2+} = 80 mg/L
Mg^{2+} = 60 mg/L
Cu^{2+} = 30 mg/L

(5) (iii) A cooling tower for a nuclear plant discharges cooling water year round at a temperature of 30 ^oC to a local cold-water fishery with an ideal temperature of 5 to 10 ^oC. The local regulators have required that the mixing zone water, upstream of the main fishery habitat, be maintained at $< 10\ ^oC$ year-round. Provide two (2) potential engineering solutions to ensure that the fishery habitat is protected from thermal pollution.

Problem 4

Provide answers to the following questions related to *population*, *economic growth*, *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 in air emissions, water demands and wastewater treatment associated with the following growth areas (**use a 3 x 3 table as provided below**). Assume that strict environmental requirements are to be met following further growth and industrialization:

(7) (i) Population growth

(7) (ii) Intense urbanization; and

(6) (iii) Increased energy use.

2-Impacts & 2-Solutions	Population Growth	Intense Urbanization	Increased Energy Use
Air Emissions			
Water Demands			
Wastewater Treatment			

Problem 5

Provide answers to the following questions related to *life cycle analysis*, *ground-level ozone and fine particulates (photochemical smog)* and *the application of environmental principles (technical or non-technical)*:

(10) (i) Briefly discuss three (3) key process steps within the life cycle analysis (LCA) and show how the LCA steps can be implemented to minimize liquid or solid waste generation during the production of plastics from petroleum products.

(10) (ii) Briefly explain the production of ground-level ozone and fine particulates (photochemical smog) in highly industrialized centres and discuss three (3) key engineering approaches, using technical or non-technical environmental principles, to eliminate or reduce the environmental impacts of phochemical smog.

Problem 6

Provide answers to the following questions associated with *air pollution control of air toxics*, *environmental quality objectives, standards and guidelines* and *solid waste management*:

(8) (i) Briefly describe two (2) different control methods that can be used to control the emission of lead (found in gasoline) from mobile and fugitive emissions from refineries (one control method for each case needs to be answered). For each control method, briefly provide one (1) advantage and one (1) limitation of the control method. Use a table to organize your answer and you may consider both engineered control methods or legislated measures.

(6) (ii) Many jurisdictions use both environmental quality **standards** and **guidelines** to promote environmental protection. Give an example where each type of approach is used (2-examples) and briefly explain under what conditions each approach is superior to the other. Use a table to organize your answer.

(6) (iii) The existing municipal landfill site handling solid waste will reach its capacity within five (5) years (currently at 80 % of the capacity) at the current rate of solid waste production. Provide three (3) engineering recommendations to extend the life of the existing landfill site by an additional 10-years. Prioritize the recommendations by considering the implementation costs to the municipality and the environmental impacts in the event recommendations are not fully implemented.

Problem 7

Provide answers to the following questions related to *water resource management*, *greenhouse effect* and *noise pollution*:

(6) (i) A large surface water reservoir that is used as the primary drinking water supply for a town is vulnerable due to stormwater runoff and sewage overflows from a combined sewer system during large storm events. Discuss two (2) water resource management strategies to protect both the short term and long term viability of this valuable water source.

(6) (ii) Briefly explain three (3) main causes of greenhouse gases and two (2) engineering strategies to reduce the effect within large municipalities.

(8) (iii) Briefly explain three (3) engineering or environmental strategies to convince the authorities (provincial or federal) to implement effective measures to reduce noise pollution from either train or air traffic (**select only one case**) close to a residential community and briefly explain the preferred method from an environmental perspective.

Marking Scheme
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1. (i) 7, (ii) 6, (iii) 7 marks, 20 marks total

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

3. (i) 8, (ii) 7, (iii) 5 marks, 20 marks total

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

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

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

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