NATIONAL EXAMS MAY 2017

04-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.

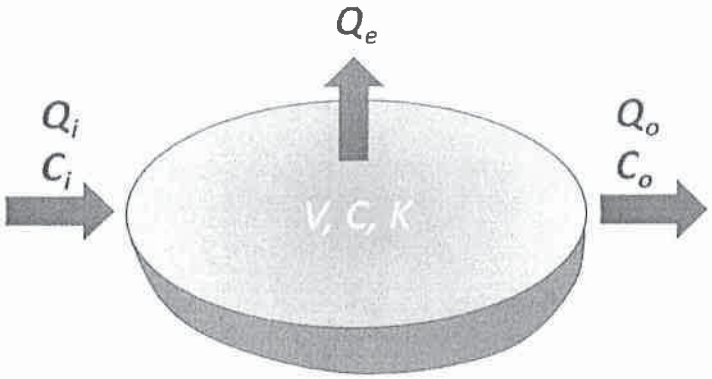
4. Any five (5) questions constitute a complete paper. Only the first five (5) answers as they appear in your work book(s), will be marked.

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

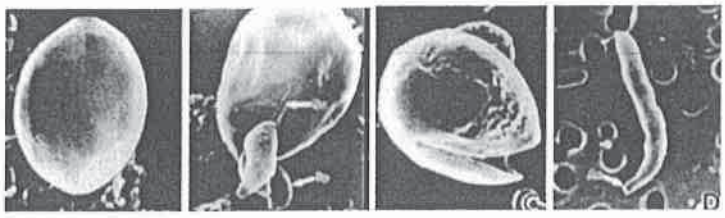
Provide answers to the following questions related to *mass and energy balance*, *contaminant partitioning* and *microbiology* as related to environmental engineering:

(7) (i) A lake has a volume of 10^5 m^3 (V) of water and is fed by an upstream river with a flow rate of 10^4 m^3/yr (Q_i). The net evaporation across the lake is 1 x 10^4 m^3/yr (Q_e). Assume that the outflow stream from the lake is flowing at Q_o m^3/yr, that the upstream river has a PO_4 concentration (C_i) of 10 mg/L from a local sewage treatment plant discharge 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 $K = 0.10$/yr.



(6) (ii) The equilibrium partitioning of a chemical between water and air is generally predicted by the use of Henry's Law constant (K_H). Select two (2) environmental factors (e.g., water pH, water salinity, soil carbon content) and explain how these factors may affect partitioning of polar chemicals (e.g., propanol) between phases.

(7) (iii) Disinfection of water is typically modelled according to the Chick-Watson law. Give a statement of the Chick-Watson law, define the terms and explain one (1) underlying assumption of this disinfection law.



Problem 2

Provide answers to the following questions related to *environmental ethics* and *water and wastewater treatment*.

(10) (i) Reynold, an engineer, is hired to confirm the structural integrity of an apartment building that Reynold's client, Johnson, is going to sell. According to an agreement with Johnson, Reynold will keep the report confidential. Johnson makes it clear to Reynold that the building is being sold in its present condition without any further repairs or renovations. Reynold determines that the building is structurally sound, but Johnson confides to Reynold that violations of the mechanical engineering code do exist. While Reynold is not a mechanical engineer, he realizes that the problems could result in injury and informs Johnson of this fact. In his report, Reynold briefly mentions the conversation with Johnson about these deficiencies, but he does not report the violations to a third party. Were Reynold's obligations to Johnson fulfilled? What about Reynold's professional responsibility for public safety? Is there any information not supplied that would make an important difference in your judgment about Reynold'd professional responsibility? In answering these questions consider an engineer's obligations below:

(a) Engineers shall hold paramount the health, safety and welfare of the public in the practice of their profession; and

(c) Engineers shall appropriately report any public works, engineering decisions, or practices that endanger the health, safety and welfare of the public. When, in an engineer's judgment, a significant risk to the public remains unresolved, that engineer may ethically make the concerns known publicly.

(10) (ii) Briefly identify and discuss four (4) key operational, maintenance or monitoring practices, for a water or wastewater treatment facility (**select only one**), to ensure that the treated water or final effluent will consistently comply with typical health and environmental requirements.

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 colloidal 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 colloidal and particulates from the final effluent of a wastewater treatment facility. Clearly explain how each treatment approach works.

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

Ca^{2+} = 100 mg/L
Mg^{2+} = 600 mg/L
Cu^{2+} = 200 mg/L

(5) (iii) A municipal wastewater treatment plant discharges effluent with a seasonal temperature range of 12 to 25 ^oC to a local cold-water fishery with an ideal temperature of 5 to 10 ^oC. The local regulators have required that the effluent be maintained at $<$ 10 ^oC year-round. Compare two (2) engineering solutions to ensure that the effluent temperature criterion is met.

Problem 4

Provide answers to the following questions related to *population*, *economic growth* and *urbanization* 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) Industrial expansion

(7) (ii) Economic growth; and

(6) (iii) Urban expansion.

2-Impacts & 2-Solutions	Industrial Expansion	Economic Growth	Urban Expansion
Air Emissions			
Water Demand			
Wastewater Treatment			

Problem 5

Provide answers to the following questions related to *sustainable development* and *life cycle analysis*:

(10) (i) Briefly discuss three (3) key principles of sustainable development and how they may be appplied to achieve a sustainble energy recovery plan. In your discussion, consider both short-term and long-term strategies along with the use of existing fossil fuel energy resources (e.g., coal, crude oil, natural gas) and the integration of new renewable energy sources (e.g., solar, wind, biogas, hydro-electric).

(10) (ii) Briefly discuss three (3) key process steps within the life cycle analysis (LCA) and how the LCA steps can be implemented to improve the sustainability in the production of newsprint paper from wood harvested from natural forests.

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 benzene (found in gasoline) and methylene chloride (paint solvent) from mobile or fixed sources. 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. Describe one (1) key difference between these two different approaches and briefly explain under what conditions each approach may be superior to the other.

(6) (iii) The existing city landfill site for solid waste will reach capacity in ten (10) years at the current rate of solid waste production. Your engineering firm has been hired to recommend a solid waste-resource management strategy to extend the life of the existing landfill site to a projected 20-year life. Identify and briefly discuss three (3) strategies you would recommend in your solid waste management plan and briefly explain the implementation of each strategy.

Problem 7

Provide answers to the following questions related to *water resource management*, *greenhouse effect*, *noise pollution* and *technical and non-technical environmental principles*:

(5) (i) A large subsurface water reservoir that is used as the primary drinking water supply for a town is vulnerable due to surface water infiltration. Discuss two (2) water resource management strategies to protect both the short term and long term viability of this valuable water source.

(5) (ii) Briefly explain three (3) main causes that aggravate the greenhouse effect within large municipalities.

(5) (iii) Briefly explain two (2) engineering methods to reduce noise pollution from highway traffic close to a residential community. Identify the preferred method providing reasons.

(5) (iv) Briefly explain two (2) advantages and two (2) disadvantages in using **technical** versus **non-technical** environmental principles for the reduction of air emissions from an industrial source.

Marking Scheme
04-Env-A1 Principles of Environmental Engineering
May 2017

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) 5, (ii) 5, (iii) 5, (iv) 5 marks, 20 marks total