
NATIONAL EXAMS MAY 2015

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 of water and is fed by a river with a flow rate of $10^6 \text{ m}^3/\text{yr}$ (Q_u). Evaporation across the lake is $5 \times 10^4 \text{ m}^3/\text{yr}$ (Q_e). Assume that the outflow stream from the lake is flowing at $3 \times 10^4 \text{ m}^3/\text{yr}$ (Q_o), that the river feeding the lake has a TN concentration of 15 mg/L (C_u) and that steady-state conditions apply. Calculate the concentration of the TN in the lake and outflow stream assuming a TN decay rate of $0.1/\text{yr}$ in the lake.
- (6) (ii) Use the partition coefficient (K_d) concept to explain the fate of a contaminant present in the liquid phase in contact with suspended solids during surface flow.
- (7) (iii) Briefly explain how a disinfectant like ultraviolet light or chlorine works to inactivate bacteria, cysts or viruses commonly present in surface waters. In your explanation, discuss how dose (D) and reaction time (T) are used in engineered systems to ensure proper inactivation of potential pathogens.

Problem 2

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

- (10) (i) An engineer on contract hired by the supplier of the disinfectant was to assess the effectiveness of the disinfection system and report back to the supplier and the municipality. The engineer finds that the disinfection system meets all the bacteriological requirements but notices what appears to be improper mixing causing overdosing of the disinfectant. He thinks that the overdosing may lead to potentially high THMs (known carcinogens at elevated concentrations) in the treated water. Briefly explain the actions that should be taken by the engineer under contract, considering the following two (2) ethical principles:
- (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 design principles for a drinking water or wastewater treatment facility (**select only one**). In your discussion, consider both technical and non-technical environmental principles.

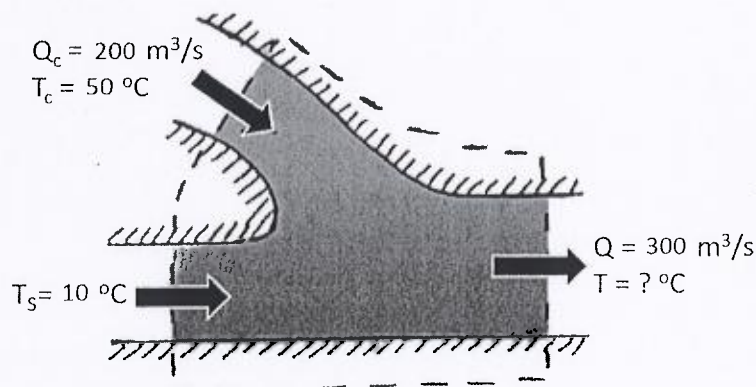
Problem 3

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

- (8) (i) It becomes obvious that the removal of particles from surface water or wastewater is crucial for effective treatment. Briefly explain the combined role of physical-chemical and biological treatment in the effective removal of particles. As part of your explanation provide a labelled schematic of a typical engineering process that combines a physical-chemical and biological system for either a drinking water or wastewater system (**select only one**).
- (7) (ii) The average analysis in terms of Ca, Mg and Fe results of Lake Superior waters near a salt 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; H=1; C=12, O=16, Mg =24, Fe = 56 and indicate how you would classify this water (i.e., soft, moderately hard or hard):

$$\begin{aligned}\text{Ca}^{2+} &= 150 \text{ mg/L} \\ \text{Mg}^{2+} &= 800 \text{ mg/L} \\ \text{Fe}^{2+} &= 60 \text{ mg/L}\end{aligned}$$

- (5) (iii) Calculate the temperature of the downstream river (T) in degree Celsius ($^{\circ}\text{C}$) (see diagram below) and assume that this elevated temperature will impact a downstream cold water fishery. Give two (2) possible engineering solutions to further reduce the downstream water temperature or reduce the upstream temperature assumed to be discharged at 50°C from a cooling tower.



Problem 4

Provide answers to the following questions related to *population, economic growth* and *industrialization* 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) Urban growth;
- (7) (ii) Water use; and
- (6) (iii) Industrial expansion.

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

Problem 5

Provide answers to the following questions related to *environmental impact assessment, sustainable development* and *life cycle analysis*:

- (10) (i) Explain how an environmental impact assessment may be applied to reduce pollution in the development of a hydro-electric dam in northern Alberta. Use a table to identify three (3) key process steps, three (3) key issues and the actions necessary to address the issues in each of the processes.
- (10) (ii) Briefly discuss the key principle of sustainable development and to what degree the use of hydro-electric power, solar power or oil (**choose only one**) may achieve the principle of sustainability. In your discussion, consider the principles of life cycle analysis to help with answering the question.

Problem 6

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

- (8) (i) Briefly describe two (2) different methods that can be used to control air toxics (e.g., VOCs, PM_{2.5}) from industrial fixed sources or mobile sources. For each method, briefly provide one (1) advantage and one (1) limitation of the method and an example of where each method is most appropriate. Use a table to organize your answer.
- (6) (ii) The existing landfill site for the city's solid waste will reach capacity in five (5) years at the current rate of solid waste production. You have been hired to recommend an engineering plan for the next 25 years by the city to assist in managing their solid waste. Identify and briefly discuss three (3) strategies you would recommend in your solid waste management plan. Use a table to organize your answer.
- (6) (iii) Environmental controls are typically managed by the use of environmental guidelines or standards. Briefly explain a key difference between an environmental guideline and standard. As part of your explanation, indicate when each type of environmental control is better at controlling environmental impacts.

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 open surface water reservoir (similar to a natural fresh water lake) used as a drinking water supply for a town is vulnerable to runoff pollution associated with soil erosion. Discuss one (1) water resource management strategy to protect the long term viability of this valuable water source.
- (5) (ii) Briefly explain two (2) main causes for the greenhouse effect and one (1) technical solution to help reduce associated environmental impacts.
- (5) (iii) Briefly explain two (2) engineering methods to reduce noise pollution from a railway track close to a residential community and briefly explain the preferred method.
- (5) (iv) Give an example to compare the use of a technical and non-technical environmental principles in the control of air emissions from a mobile source.

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