NATIONAL EXAMS MAY 2014

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 an upstream river with a discharge rate of $9 \cdot 10^5$ m^3/yr (Q_u). Evaporation across the lake is $1 \cdot 10^4$ m^3/yr (Q_e). Assume that the outflow stream from the lake is flowing at $8 \cdot 10^4$ m^3/yr (Q_o), that the upstream river has a TP concentration of 10 mg/L (C_u) and that steady-state conditions apply. Calculate the concentration of the TP in the outflow stream assuming a TP decay rate of 0.12/yr in the lake.

(6) (ii) Briefly explain the significance of the octanol-water partition coefficient (K_{OW}) with respect to the partitioning of organic substances into biological components (e.g., PCBs found in fish lipid layer).

(7) (iii) Briefly explain how a chemical disinfectant like chlorine works to inactivate bacteria, cysts and viruses commonly present in surface waters used as potable sources. In your explanation, discuss how reaction time (T) and disinfectant concentration (C) are used in engineered systems to ensure proper disinfection.

Problem 2

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 gold mine in northern Ontario. You may use a matrix to identify the key process steps, the issues, considerations and actions necessary to address the issues.

(10) (ii) Briefly discuss the key principle of sustainable development and to what degree the use of nuclear energy, wind power, coal or natural gas (**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 3

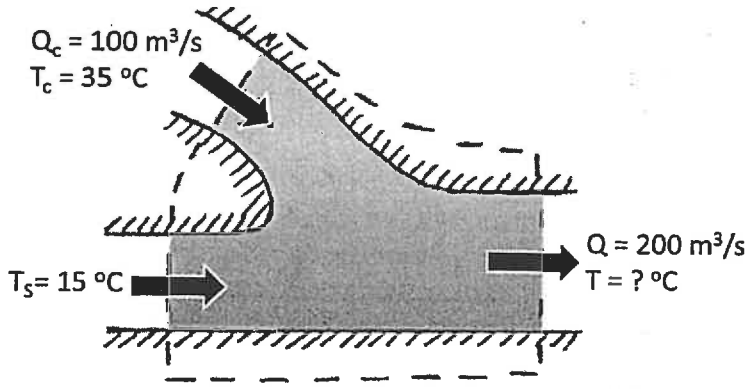
Provide answers to the following questions related to *particle characteristics*, *chemistry of solutions* and *thermal pollution*:

(8) (i) The removal of particles from water is crucial for safe potable water production. Briefly explain the combined role of sedimentation and filtration in effective removal of particles. As part of your explanation, provide a labelled schematic of a typical engineering process that combines sedimentation and filtration.

(7) (ii) The analysis of Lake Superior waters near a salt mine for Ca, Mg and Cu gave concentrations 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 and O=16. Indicate how you would classify this water (i.e., soft, moderately hard or hard):

Ca^{2+} = 90 mg/L
Mg^{2+} = 100 mg/L
Cu^{2+} = 50 mg/L

(5) (iii) Calculate the temperature of the downstream river (T) in degree Celsius (^oC) (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.



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 associated with the following (**use a 3 x 3 table as provided below**):

(6) (i) Industrial growth;

(7) (ii) Population increases in sub-urban areas; and

(7) (iii) Increased energy use.

2-Impacts & 2-Solutions	Industrial Growth	Suburban Sprawl	Energy Use
Air Shed			
Water Resources			
Solid Waste Impacts			

Problem 5

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

(10) (i) Briefly describe three (3) different methods that can be used to control air toxics (e.g., Benzene, Acetone, $PM_{2.5}$) 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 the method is most appropriate. You may use a matrix to organize your answer.

(10) (iii) 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 four (4) strategies you would recommend in your solid waste management plan and briefly explain how your strategies relate to environmental quality standards or guidelines set by the local regulators. You may use a matrix to organize your answer.

Problem 6

Provide answers to the following questions related to *environmental ethics*, *water and wastewater treatment* and *technical and non-technical environmental principles*.

(10) (i) A chemical engineer on contract to the municipality is supervising the commissioning of a new sewage treatment plant disinfection system. The supervising engineer notices what appears to be improper sampling from the most turbulent point of the conctact tank where the disinfection is most effective. A very low *E. coli* is required in the summer months due to a busy beach area downstream of the effluent discharge. Briefly explain the actions that should be taken by the supervising engineer, 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 water or wastewater treatment facility (**select only one**). In your discussion, consider both technical and non-technial environmental principles.

Problem 7

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

(6) (i) A large open surface water reservoir (similar to a natural fresh water lake) used as a drinking water supply for a local town is vulnerable to runoff pollution associated with intensive farming. Provide two (2) water resource management strategies that can be used to protect the long term viability of this valuable water source.

(7) (ii) Briefly explain two (2) main causes for the greenhouse effect and two (2) technical solutions to help reduce associated environmental impacts.

(7) (iii) Briefly explain two (2) engineering methods to reduce noise pollution from a busy highway next to a residential community and briefly explain the preferred method and compare the advantages and limitations of each method.

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) 10, (ii) 10 marks, 20 marks total

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