NATIONAL EXAMS MAY 2015

98-CIV-A3, 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.

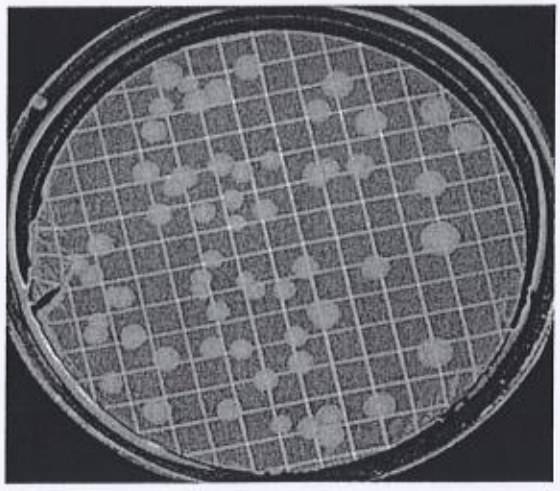
Problem 1

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

(6) (i) A 50 m^3 storage tank is half filled with water and the rest filled with air at 25 ^oC. After 38 kg (500 mol) of liquid dipropylene glycol ($C_3H_8O_2$) is added, the storage tank is sealed. Determine the equilibrium concentration of dipropylene glycol in water and the equilibrium partial pressure of dipropylene glycol in the air space. Henry's Law Constant (K_H) for dipropylene glycol at 25 ^oC is 15^6 mol/(L·atm).

(7) (ii) A nitrogen analysis of a contaminated ground water sample gave the following results for ammonia, nitrite, nitrate and organic-N: 10 mg/L as NH_3, 3 mg/L as NO_2^-, 15 mg/L as NO_3^- and 5 mg/L as organic-N, respectively. Calculate the total nitrogen concentration as N in the water sample. Use the chemical atomic weights: H=1, N=14 and O=16.

(7) (iii) Two different methods, the most probable number (MPN) and colony-forming unit (CFU), are commonly used to enumerate fecal indicator bacteria in water samples for environmental compliance. Briefly explain each method and two (2) important issues that need to be considered when interpreting reported data from a microbiology lab. The image below shows bacterial colonies growing on a selective agar after membrane filtration.



Problem 2

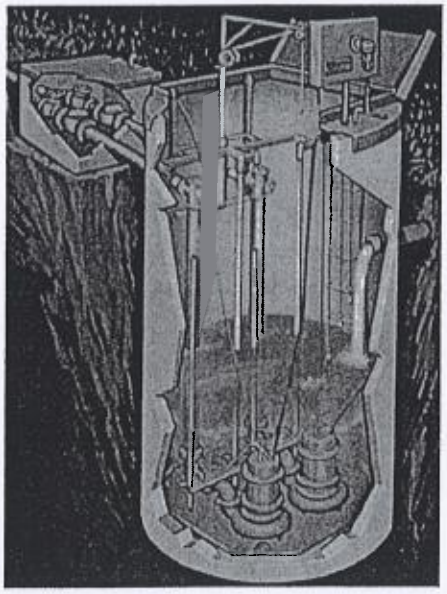
Provide answers to the following questions related to *particle characteristics*, *chemistry of solutions* and *gases*:

(9) (i) The removal of particles from water is crucial for safe potable water production. Briefly outline two (2) key engineering principles to explain how two (2) different particle types are effectively removed in a drinking water treatment plant. Also give one (1) important reason why particle counters may be an improvement over turbidity measurements.

(6) (ii) The average concentrations of Ca^{2+}, Mg^{2+} and Fe^{2+} of Lake Ontario waters near a rock quarry 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 and Fe=56 and indicate how you would classify this water (i.e., soft, moderately hard or hard).

Ca^{2+}	=	160 mg/L
Mg^{2+}	=	50 mg/L
Fe^{2+}	=	40 mg/L

(5) (iii) Identity two (2) different toxic gasses and two (2) different technologies that can be used to reduce the effect of toxic atmospheric pollutants common under anaerobic conditions similar to what you may find in confined spaces such as sewage pumping stations and underground storage reservoirs. The image below shows a typical sewage pumping station section detail.



Problem 3

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

(i) Briefly explain two (2) major environmental impacts and two (2) corresponding potential engineering solutions associated with the Atmospheric Emissions, Water and Wastewater Infrastructure and Solid Waste Management (see picture below) with respect to:

(7) (a) Urban growth;

(7) (b) Increased water demands; and

(6) (c) Higher energy use

(Use a 3x3 matrix as provided below to organize your answer)

2-Impacts & 2-Solutions	Urban Growth	Increased Water Demands	Higher Energy Use
Atmospheric Emissions			
Water and Wastewater Infrastructure			
Solid Waste Management			

Problem 4

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

(10) (i) A junior site environmental engineer, was assigned the responsibility to conduct daily checks of the effeciveness of the water filtration system by calculating the median of on-line particle counts and to compare this to a daily maximum value of 1000. Exceeding the daily maximum particle count may compromise the water disinfection downstream of the filter. Because of other duties imposed by her superior, the junior engineer was told by her supervisor, that she could conduct the analysis every other day instead of daily and things should still be fine. Explain what the junior engineer should do considering the following three principles:

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

(b) Engineers shall act as faithful agents for their employers or clients and maintain confidentiality; 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) Population increases, in developing countries have caused a direct increase in wastewater generation and pollution due to nutrient (N and P) loadings to surface and groundwater receivers. Identify and briefly discuss two (2) different ways of addressing both these issues by considereing a 'soft' and a 'hard' engineering solution. Use a matrix like the one below to organize your answer.

Engineering Solutions	'Soft' Engineering	'Hard' Engineering
Wastewater Generation		
Nutrient Pollution		

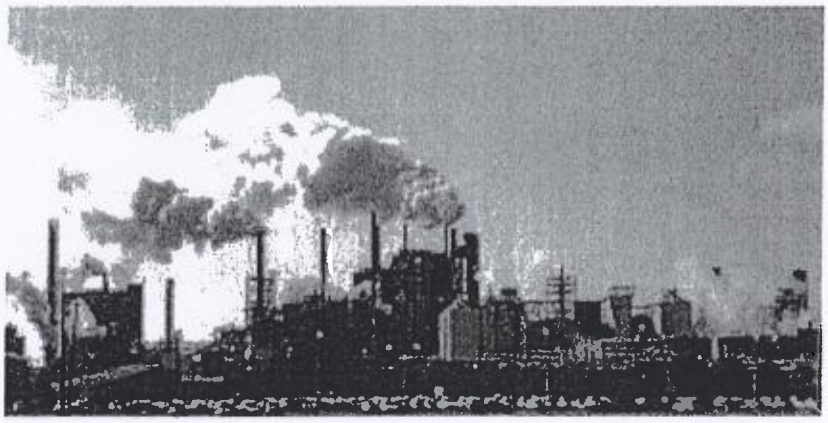
Problem 5

Provide answers to the following questions associated with *air pollution control* and *solid waste management* :

(10) (i) Briefly describe three (3) different engineering methods that can be used to control three (3) different air toxics (3 in total) associated with stationary industrial emissions (see picture below). For each method, briefly provide one (1) advantage and one (1) limitation and an example of where it is most appropriate to use that particular method. You may use a matrix to organize your answer.

(10) (ii) Give and prioritize three (3) engineering strategies to minimize the solid waste production rate and ways to increase the recycling or reuse potential of solid waste needs in a large municipality that is restricted in land availability. Prioritize the 3-strategies according to environmental benefits and cost recovery over a 20 year period. You may use a matrix to organize your answer as below.

Solid Waste	Engineering Strategies		
	Strategy 1	Strategy 2	Strategy 3
Production Rate			
Recycle and Reuse			



Problem 6

Provide answers to the following questions related to *environmental impact assessment* and *sustainable development*:

(10) (i) Explain how an environmental impact assessment may be applied to reduce the pollution associated with the operation of a new logging operation located in northern Ontario. You may use a matrix to organize your explanation and to identify the key process steps, the main issues and actions necessary to address the potential environmental impacts.

(10) (ii) Briefly discuss the key principle of sustainable development associated with ensuring a sustainable cold-water fish farm on a large lake susceptible to contamination from point and non-point sources coming from an adjacent large municipality. In your discussion, consider the link between environmental and economic sustainability.

Problem 7

Provide answers to the following questions related to *water resource management*, *water treatment* and *wastewater treatment*:

(5) (i) A large underground shallow aquifer has been identified as the main water supply source for a large town. It has been clearly shown that a discharge from a mine tailings pond is a major source of contamination due to the shallow aquifer being under the influence of surface water. Explain how you would use water resource management principles to address the contamination of this aquifer.

(6) (ii) Give an example of how disinfection is used in drinking water treatment and briefly explain why secondary disinfection (disinfection of the distribution system) is typically a requirement for a large municipality.

(iii) With respect to drinking water or wastewater treatment, briefly explain two (2) main similarities or differences between the following terms:

(3) (a) Coagulation and flocculation;

(3) (b) Osmosis and filtration; and

(3) (c) Aerobic and anoxic treatment.

Marking Scheme
98-CIV-A3 Environmental Engineering
May 2015

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

2. (i) 9, (ii) 6, (iii) 5 marks, 20 marks total

3. (i) (a) 7, (b) 7, (c) 6 marks, 20 marks total

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

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

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

7. (i) 5, (ii) 6, (iii) (a) 3 (b) 3 (c) 3 marks, 20 marks total