NATIONAL EXAMS MAY 2012

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 ½ *in* x 11 *in* double sided Aid-Sheet allowed.

3. A Casio or Sharp approved calculator is permitted. Note that you must indicate the type of calculator being used. Write the name and model designation of the calculator on the first inside left hand sheet of the exam work book.

4. Any five questions constitute a complete exam. Only the first five questions as they appear in your answer book(s) will be marked.

5. Each question is equally weighted at twenty (20) marks with the mark indicated in square brackets [ ] beside 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.

1. Provide answers to the following questions related to *population*, *economic growth* and *urbanization* as causes of environmental pollution:

   i. Briefly explain the main difference between an expansive and constrictive population age pyramid structure. Briefly explain one (1) environmental implication, for a community over the next 50-years, associated with an expansive population pyramid. **[6]**

   ii. Identify three (3) specific environmental impacts of increased economic growth on the atmosphere. For each impact provide one (1) well established technology that has been used to minimize the impact and explain the key engineering principle of each technology. **[8]**

   iii. Identify three (3) major environmental impacts associated with urbanization. For each impact give a different non-technical solution to help reduce each impact. **[6]**

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

   i. Briefly describe two (2) methods that can be used to control air toxic emissions (e.g., PM10, NOx, SOx) emissions. For each method, provide one (1) advantage and one (1) limitation of the method and an example of where it is most appropriate to use that particular method. **[7]**

   ii. Briefly describe three (3) solid waste management (SWM) practices normally adopted in industrialized countries as part of an SWM hierarchy. In your description, prioritize each practice from the most to the least preferred practice and indicate why you have selected this ranking. **[7]**

   iii. In an effort to curb air pollution, regulators use standards and process guidelines. Explain one (1) advantage and one (1) disadvantage in the use of ambient air quality standards and process guidelines. **[6]**

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

   i. Briefly explain why primary settlers are inefficient at removing colloidal particulates and suggest a possible treatment that may be applied in water or wastewater treatment process to improve the removal of colloidal particles. In your explanation, provide the main treatment process involved. **[7]**

   ii. Analytical results of Lake Ontario waters near an industrial discharger shows the following characteristics:

   $$CO_3^{2-} = \quad 20 \text{ mg/L}, \quad HCO_3^- = 50 \text{ mg/L at a pH} = 10.0$$

   Calculate the *alkalinity* 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. **[7]**

   iii. Three (3) priority pollutants of importance as atmospheric pollutants include: volatile organic compounds (VOCs), mercury (Hg) and argon (Ar). Briefly describe one (1) environmental impact and one (1) appropriate engineering strategy or control measure to reduce the environmental impact of each of the three (3) priority pollutants. You need to provide a total of three (3) <u>different</u> appropriate engineering strategies or control measures. **[6]**

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

   i. A 1000 L barrel is half filled with water and half filled with air at 20 °C. After 920 g of liquid benzene (C_6H_6) is added, the jar is sealed. Determine the equilibrium concentration of benzene in water and the equilibrium partial pressure of benzene in the air space. Henry's Law Constant K_H for benzene at 20 °C is 0.18 (dimensionless). **[6]**

   ii. A nitrogen analysis of a nitrifying sewage treatment plant effluent gave the following results for ammonia, nitrite, nitrate and organic-nitrogen: 3 mg/L as NH_3, 0.5 mg/L as NO^-_2, 15 mg/L as NO^-_3 and 1.0 mg/L as organic-N respectively. Calculate the total nitrogen concentration in the effluent sample. Assume the following chemical atomic weights: H=1, N=14 and O=16. **[7]**

   iii. Briefly explain why ammonia and chlorine are added together to a water distribution system. In your explanation, you should consider travel time to the first consumer, dosage, initial concentration and final residual as important issues. **[7]**

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

   i. Give two (2) *water resource management* strategies or principles that may be applied for the protection of groundwater supplies. Briefly explain how the strategies may also foster long term sustainability. **[5]**

   ii. Explain the key processes associated with disinfection as applied in drinking water treatment. In your answer, include a brief discussion of associated operation and maintenance issues important to ensure a potable water supply. **[6]**

   iii. Briefly explain two (2) important differences between the following:

      a) Aerobic and anoxic reactors in wastewater treatment; **[3]**
      b) Primary and secondary disinfectants in drinking water treatment; and **[3]**
      c) Pathogens and pathogen indicators as related to monitoring final wastewater effluents or treated water **[3]**

6. Provide answers to the following questions related to *environmental impact assessment (EIA)* and *sustainable development*:

   i. Consider the expansion of a large gold mine operation in Northern Ontario or take an example of your choosing and provide an outline of four (4) key issues you would deal with in developing an environmental impact assessment (EIA). The EIA is to be submitted to the Ontario Ministry of the Environment and would need to satisfy their environmental requirements. **[10]**

   ii. Identify and discuss four (4) common limitations or difficulties associated with ensuring sustainable development when extracting natural resources. **[10]**

7. Provide an answer to the following questions related to *environmental ethics* and *energy-use*:

i. A chemical engineer on contract by the city is supervising the construction of a fugitive emissions collection system at a chemical refinery. The collection system shows leaks upon closer examination by the engineer. The construction is currently behind schedule, is incurring cost overruns and the chemical refinery is scheduled to be commissioned in the next few weeks. Briefly explain the actions that should be taken by the engineer, considering the following ethical principles: **[10]**

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.

ii. Population increases and the improvements in the quality of life in developing countries have resulted in increased energy consumption and associated pollution. The increase in energy-use has been attributed to the global increase in green-house gases due to the burning of fossil fuels. Provide a brief engineering qualitative or quantitative argument supporting the use of renewable resources for energy that may reverse the trend of global warming. In your argument, consider the pros and cons of renewable resources, conversion efficiencies, energy supply and a carbon tax. **[10]**

Marking Scheme

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May 2012

1. (i) 6 (ii) 8 (iii) 6 marks; 20 marks total

2. (i) 7 (ii) 7 (iii) 6 marks; 20 marks total

3. (i) 7 (ii) 7 (iii) 6 marks; 20 marks total

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

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

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

7. (i) 10 (ii) 10 marks; 20 marks total