National Exams December 2018

18-Env-B5, Industrial & Hazardous Waste Management

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 an OPEN BOOK EXAM.

   Any non-communicating calculator is permitted.

4. The value of each question is noted next to the question.

5. The exam consists of 11 questions.

**Q.1.** *(5 points)*

Why is the generation of hazardous waste not only a result of large-scale industry? What are some other sources?

**Q.2.** *(10 points)*

Briefly explain what you know about each of following terms:

a. Soil Vapor Extraction
b. Chemical Stabilization
c. Bioventing
d. Toxicity Characteristic Leaching Procedure
e. Autoterotrophic bacteria

**Q.3.** *(5 points)*

What is the difference between:

a. catabolism and anabolism
b. biotransformation and mineralization

**Q.4.** *(5 points)*

Explain how to determine if a material is hazardous or not according to the Ontario Regulation "R.R.O. 1990, Reg. 347"?

**Q.5.** *(5 points)*

Briefly describe the In-situ Vitrification process for hazardous waste treatment.

**Q.6.** *(5 points)*

Suggest reasons why (or why not) each of the following might be considered hazardous under EPA regulations:

a. A railroad tank car of fuming sulfuric acid
b. Solvents, after use as a cleaning agent
c. Radioactive tracers after use in a university lab
d. Mercury
e. Soil that has had gasoline spilled on it

**Q.7.** ***(10 points)***

You are auditing a refinery site to determine the likelihood of a release from its existing tanks and pipes. The site has more than 150 tanks, 75 miles of pipes, and more than 2000 valves. You have one day to inspect this part of the site. Devise and justify a sampling plan to determine the condition of the tanks, pipes, and valves.

**Q.8.** ***(10 points)***

An incinerator which normally burns waste with a heating value of 700 - 1,000 Btu/lb and is designed to handle $2 \times 10^7$ Btu/hr must burn a rubber waste with a heating value of 12,000 Btu/lb. Estimate the maximum size of a waste batch for this system to perform effectively. Assume the residence time in the incinerator is 6 min.

**Q.9.** ***(15 points)***

Provide a preliminary design of an air stripping column to remove toluene from ground water. Levels of toluene range from 0.1 to 2.1 mg/L and this must be reduced to 50 µg/L. A hydrogeologic study of the area indicates that a flow rate of 110 gal/min is required to ensure that contamination not spread. Laboratory investigations have determined the overall transfer constant, $K_La = 0.020$ sec$^{-1}$. Use a column diameter of 0.61 m and an air to water ratio of 15. Specifically determine: Liquid loading rate, stripping factor, height of the tower and provide a sketch of the unit indicating all required appurtenances. Use: Temp = 20°C = 293 K; Influent: $C_{in}$ = 2.1 mg/L; and Effluent: $C_{out}$ = 0.05 mg/L.

**Q.10.** ***(15 points)***

An industrial waste stream contains 650 mg/L of hexavalent chromium at a flow rate of 35 L/min. Determine the amount of sulfur dioxide required to reduce the chromium to the less toxic trivalent form.

**Q.11.** ***(15 points)***

A 2 m$^3$ bioreactor operates at a biomass concentration of 2 g/L, measured as mixed liquor suspended solids (MLVSS) and treats 4000 L/d of liquid waste containing 1000 mg/L of TOC. The suspended solids are separated in a clarifier following the bioreactor with recycle of separated sludge. The recycle flow rate is 2 m$^3$ /day. Each day 1200 Liters of recycle are wasted. The effluent from the clarifier contains 40 mg/L (MLVSS). What is the solid retention time? If short, how can the SRT be increased?