UNIVERSITY OF GHANA

BSc. (Eng.) MATERIALS SCIENCE AND ENGINEERING
END OF SECOND SEMESTER EXAMINATIONS: 2016/2017
DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

MTEN 414: ENVIRONMENTAL ENGINEERING AND WASTE MANAGEMENT (3 CREDITS)

TIME ALLOWED: TWO (2) HOURS FIFTEEN (15) MINUTES

INSTRUCTIONS: ANSWER ALL QUESTIONS

1.

(a) Draw a simplified diagram of the following:

(i) Solid waste management system

(ii) Solid waste management hierarchy

[6 marks]

(b) A cannery receives on a given day 12 tons of raw produce, 5 tons of cans, 0.5 tons of cartons, and 0.3 tons of miscellaneous materials. Of the 12 tons of raw produce, 10 tons become processed product, 1.2 tons end up as a produce waste, which is fed to cattle and remainder is discharged with the wastewater from the plant. Four tons of the cans are stored internally for future use and the remainder is used to package the product. About 3 percent of the cans used are damaged. Stored separately, the damaged cans are recycled. The cartons are used for packaging the canned product, except for 5 percent that damaged and subsequently separated for recycling. Of the miscellaneous, 25 percent is stored internally for future use; 50 percent becomes waste paper, of which 35 percent is separated for recycling with the remainder being discharged as mixed waste; and 25 percent becomes a mixture of solid waste materials. Assuming the materials separated for recycling and disposal are collected daily.

(i) Prepare a materials balance for the cannery on this day and materials flow diagram accounting for all of the materials.

(ii) Determine the amount of waste per ton of product

[Note: 1 tonne equivalent to 907.185 Kg] [10 marks]

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(c) State only two deficiencies of the solid waste management hierarchy.

[4 marks]

2.

(a) Describe the processes involved in the closure of a Modern Landfill site.

[6 marks]

(b) A landfill with a gas collection system is in operation and serves a population of 200,000 Municipal Solid Waste (MSW) is generated at a rate of 1.95 Kg $(capita)^{-1}$ day^{-1}. Gas is produced at an annual rate of 6.5 L kg^{-1} of MSW delivered to the landfill. The gas contains 55% methane. Gas recovery is 15% of that generated. The heat content of the landfill gas is approximately 17,500 KJ m^{-3} (a value lower than the theoretical value because of dilution of the methane with air during recovery). The landfill company and a developer have proposed to build a subdivision in the vicinity of the landfill and pipe the methane generated to the homes to be used for heating. The homes are estimated to use an average of 110 x 10^6 KJ of heat energy each year. Peak usage during winter is 1.5 times the average usage. How many homes can be built in the subdivision? [9 marks]

(c) Distinguish between scooping and screening in Environmental Impact Assessment (EIA).

[5 marks]

3.

(a) Briefly explain the following terms: Fluffy lift, Benches and Closed-loop recycling. [6 marks]

(b) A landfill that is 12 hactare in area has a liner of thickness 1700 m^3 of leachate is collected. The hydraulic conductivity of the liner is 3.9 x 10^{-10} ms^{-1}. What is the head of water above the liner?

[1 hactare is equivalent to 10000 square metres] [4 marks]

(c) Discuss the characteristics of municipal solid waste (MSW) that are favourable for:

(i) Thermal processing

(ii) Recycling and

(iii) Landfilling.

[7 marks]

(d) Explain why separate sewers and sanitary sewers are preferred over combined sewers. [3 marks]

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