National Examination, December 2008

04-Env-A6 – Solid Waste Engineering & Management

3 hours duration

NOTES:

1. There are **14** questions for a total possible examination mark of **100**.
2. This examination is an **CLOSED BOOK EXAM.**
3. A Casio or Sharp model calculator is permitted.
4. 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.
5. One Aid sheet written on Both sides is permitted.

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points 6 1. Name and briefly discuss 3 considerations that are critical in solid waste management.

points 6 2. Name and briefly discuss 3 different leachate management alternatives.

points 8 3. Name and briefly discuss 4 common problems that you must consider when designing a landfill.

points 5 4. For a population of 50,000 estimate the annual area required (excluding buffer zone) for a normally compacted landfill having a refuse depth of 4 m excluding cover material. State any assumptions made.

points 10 5. As consulting engineer, you have been commissioned to develop a comprehensive solid waste management system for a community interested in achieving greater recovery and reuse of their solid wastes. Two of the possible alternatives are separation at home or separation at a materials recovery facility. What important factors must you consider in evaluating these two alternatives?

points 10 6. Outline strategies that you would propose to your client municipality that will reduce Green House Gas emissions due to solid waste generation.

points 5 7. Based on the energy contents of the components of municipal solid waste as collected (Table 1), determine the energy content in refuse consisting of 50% paper and 20% metal, glass and ash, with the balance being food and other organic wastes.

TABLE 1 TYPICAL ENERGY CONTENT FOR COMBUSTIBLE MATERIALS

MATERIAL	Typical Energy Content (kJ/kg)
Municipal Solid Waste	
• Per unit weight of refuse	10,500
• Per unit weight of combustibles	23,200
• Per unit weight of paper	16,300
• Per unit eight of organics	5.800

50

points 3 8. Name 3 variables that govern landfill gas production.

points 6 9. Sketch a cross section through a sanitary landfill and name all associated components.

points 9 10. A mass-burning incinerator with heat recovery operates on 400 t/d of municipal solid waste with natural gas as a supplementary fuel. A plan for residential source separation is expected to reduce the amount of paper and cardboard collected by 20%. For the incinerator to maintain steam production, the heating value of the lost combustibles will have to be replaced by natural gas at an average cost of $\$0.40/m^3$.

10.1 Neglecting changes in collection costs, what price per tonne would need to be received for the paper for the municipality to break even?

The higher efficiency of incineration of natural gas compared to refuse can be neglected. (Energy content of paper = 16,300 kJ/kg; energy content of natural gas = 37,300 kJ/m^3. Make and state any assumptions.

points 10 11. Sketch a diagram of essential process components of a typical resource recovery plant.

points 10 12. You have been commissioned to devise a strategy for extending the life of a community landfill. Outline what you would propose.

points 5 13. A residential area of 40 ha contains 300 single-family residences and 8 ha with multiple-family units housing 400 people. With two curb-side pick-ups per week, how many trips on each collection day would one packer truck (4 tonne capacity) need to make in order to serve this area? Assume 4 residents/single family unit. Table 2 is your reference data source.

TABLE 2 URBAN SOLID WASTE GENERATION

SOLID WASTE SOURCE	kg/capita/day
Residential	1.1
Commercial	0.9
Special*	0.9
Total MUNICIPAL	**2.9**

* construction debris, leaves, street litter & large discards

93 subtotal

points 7

14. You completed an analysis of a municipal solid waste and summarized its'composition in Table 3. Now using these data, estimate the moisture content and density of this municipal solid waste.

TABLE 3 SOLID WASTE ANALYSIS

	Sample 100 kg	*moisture**		VALUES ESTIMATED dry solids		*density**
COMPONENTS	kg	%	kg	%	kg	kg/m^3
Paper	45	7	3.2	93	41.9	80
Organics	20	70	14.0	30	6.0	300
Metal (Fe)	7	3	0.2	97	6.8	480
Glass	10	2	0.2	98	9.8	160
Ashes	3	8	0.2	92	2.8	480
Miscellaneous	15	20	3.0	80	12.0	160
SOLID WASTE	**100**					

* from Reference

TOTAL 100