

National Examination, May 2010

04-Env-A6 – Solid Waste Engineering and Management

3 hours duration

NOTES:

1. There are 12 questions for a total possible examination mark is 100.
2. This examination is a **CLOSED BOOK EXAM**.
3. Candidates are permitted **ONE** (1) letter sized aid sheet (8.5 “x 11”) both sides.
4. Candidates may use one of two calculators, a Casio or Sharp approved models.
5. 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.

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- 13 points 1. Landfill mining is likely to play an important role in the future of waste management. Please provide concise answers to the following items:
- 1.1 List four (4) reasons why one would consider landfill mining.
 - 1.2 Provide a list of health and safety requirements.
 - 1.3 Briefly describe items to be considered in the work plan.
 - 1.4 Show a layout with labels of the equipment use in landfill mining.
- 10 points 2. Outline the steps in composting source-separated organic waste in a high-tech central composting facility from: receiving the waste to refining the compost. Use a block diagram to illustrate the various equipment components and process stages. Clearly label each piece of equipment.
- 10 points 3. define or describe briefly the following terms:
- 3.1 turbulence factor in combustion processes
 - 3.2 at-site time
 - 3.3 compost
 - 3.4 hazardous waste
 - 3.5 moisture content
 - 3.6 pyrolysis
 - 3.7 integrated solid waste management
 - 3.8 three T's in incineration
 - 3.9 vadose zone
 - 3.10 anaerobic digestion
- 5 points 4. The chemical composition of a typical residential MSW was determined to be:
- $$\text{C}_{760}\text{H}_{1980}\text{O}_{875}\text{N}_{13}\text{S}$$
- Determine the energy content of this waste.
- 10 points 5. The household waste generation rates given below were observed over a period of time on a typical collection route. Assuming that curbside density of the waste is 120 kg/m^3 , estimate the percentage of the time a 24m^3 collection truck with a compaction ratio of 2.5 will need more than one trip to service 82 households. The observed waste generation rates are: 42, 60, 35, 27, 50, 94 and 72 kg/household.week.

48 points

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- 5 points 6. Estimate the theoretical amount of gas (methane and carbon dioxide) that could be produced under anaerobic conditions from waste with the following chemical composition: $C_{60}H_{96}O_{38}N$.
- 10 points 7. A landfill has a compacted density of 600 kg/m^3 , a refuse depth of 9m, a moisture content of 20% by volume and a 1 m thick clay cover with a 2% slope. Estimate:
- 7.1 The quantity of leachate that would be generated each year
 - 7.2 How long will it be before each year's deposit of refuse is saturated and leachate flows from that section make and state your assumptions about rainfall and evapo-transpiration values.
- 5 points 8. For a population of 25,000, estimate the annual area requirements (excluding buffer zone) for a normally compacted landfill having a refuse depth of 4 m (excluding cover material). State any assumptions.
- 20 points 9. List:
- 9.1 Five(5) steps to be considered in the preparation of solid waste for composting
 - 9.2 Three (3) factors to consider in controlling leachate from a landfill
 - 9.3 Briefly describe three (3) strategies you would consider in devising a leachate treatment solution
 - 9.4 Six (6) important factors to be considered in the site selection of a sanitary landfill site.
 - 9.5 Three (3) common problems with landfill sites that you must be able to respond to.
- 5 points 10. Illustrate how you calculate compacted density.
- 3 points 11. What are the key parameters that you must consider in the design of a composting operation?
- 4 points. 12. Sketch a cross section through a sanitary landfill and name all associated components.

52 points

TOTAL POINTS 100

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