PROBLEM A6.2

Mount Trashmore

Virginia Beach has grown its first hill. Rising from the low terrain of this coastal city south of Norfolk is a solitary little Everest, a 65-foot-high future recreation site sculpted from more than a half million tons of crushed, compacted, and essentially decontaminated garbage. Fondly dubbed Mount Trashmore by residents, this new peak began as a health official's pipe dream. . . . [Now it is] a successful example of bold planning by city officials willing to explore some clearly untried paths to solve a waste disposal dilemma and to augment the area's popular recreation facilities, which cater to one million visitors annually.

Standing between two man-made lakes, Mount Trashmore's layers of 18 inches of refuse alternating with six inches of clean soil extend 900 feet by 300 feet To ascend the hill is to see more of Virginia Beach from one spot than is likely anywhere else, since the 38 miles of city shoreline barely jut above sea level.

The grayish mound, now being topped with a final six-foot soil layer, will accommodate a 10,000-seat waterfront amphitheater, a soap-box derby ramp, a hilltop garden, and picnic areas. Docks will be built for unmotorized boats on the lakes already stocked with fish. . . .

Origin of Trashmore

Mount Trashmore Park, which, with 165 acres, will be the largest park in the city's 255 square miles, alleviated a pressing problem for the region. About eight years ago, analysts foresaw a critical waste disposal problem for the city, where population had increased rapidly and where land values had doubled in ten years. Disposal costs at existing, short-term refuse sites were soaring, and the only land still available for refuse was too near residential areas to be suitable for operations. Because of a high water table, putting garbage into deep pits was impossible; and shallow pits, officials knew, are ugly, smelly, and potentially unhealthy. Virginia Beach had to innovate. . . .

New Concepts Utilized

Innovation proved the keystone of Mount Trashmore's development. The new techniques adopted in its creation have helped revise concepts of converting sanitary landfill areas to viable community use. The major difference between a Trashmore and a traditional landfill is that Trashmore's refuse became building blocks above ground rather than being sunk into pits and covered with soil. For five years, 300 to 1,200 tons of waste (more than 70 percent of it from households) were compacted daily by two 25-ton machines which, to everyone's surprise, condensed 50 percent more material per cubic foot than believed possible. . . .

Trashmore towers high above other sanitary landfills in terms of saving space. Only one-seventh of the land normally needed for such a facility was necessary to handle Virginia Beach's—and even some of nearby Norfolk's—garbage.

Source: Houston, J. "Rise of Mount Trashmore; Virginia Beach," *Parks & Recreation* 8 (January, 1973): 28–30.

Answer the following items, using correct units of measure and scientific notation when appropriate. You may assume two-digit accuracy for any numerical values you are given.

1. a) Describe various possibilities for locating a refuse mountain in your region of the country (or elsewhere, if your region is not appropriate). What other recreational facilities would you include on your mountain?

   b) What are some planning considerations the civil and sanitation engineers will have to address?

2. Preliminary plans for a Mt. Trashmore in the town of Gridville call for the construction of a 210-ft.-tall, cone-shaped refuse mountain. Its base will cover approximately 41 acres of land, or about 2.0×10^5 yd^2. The dirt needed for construction will be excavated from a nearby location. The excavated region will become a small recreational lake.

   a) Compare the area the mountain will cover with the area of a region familiar to you, such as the area of a football field, the square footage of your school building, a city block, or a nearby field.

   b) Based on the assumption that this Mt. Trashmore is cone-shaped, find the volume of Mt. Trashmore. The formula for the volume of a cone is (area of the base)(height)/3. What is the significance of the volume of the mountain in this problem?

c) A side view of the cone-shaped Mt. Trashmore looks like a triangle. What are the measurements of the height and base of this triangle?

d) Make a scale drawing of a side view of Mt. Trashmore, and determine the average slope of the mountain.

3. Compacting machines compact 3 $yd.^3$ of moist refuse material into 1 $yd.^3$ of refuse. Construction engineers can then use this compacted refuse as construction material. The town of Gridville is constructing its Mt. Trashmore from 75% compacted refuse and 25% dirt. The dirt will be used for stabilizing and smoothing the mountain.

   a) How many cubic yards of compacted refuse material will it take to construct Gridville's Mt. Trashmore?

   b) How many cubic yards of pre-compacted refuse material will it take to construct Gridville's Mt. Trashmore?

   c) How many cubic yards of dirt will be needed?

4. Suppose that 900 yd.^{3} of compacted refuse materials are delivered to the site of Gridville's Mt. Trashmore each workday.

   a) Let $\text{refuse}_{\text{current}}$ represent the total amount of refuse delivered to the site by the end of the current day, and let $\text{refuse}_{\text{previous}}$ represent the total amount of refuse delivered by the end of the previous day. Write a recursive formula describing the total amount of refuse that arrives at the site by the end of each workday.

   b) How much compacted refuse has arrived by the end of the tenth workday?

5. Make a table of values for the number of workdays since the construction of the mountain began and the amount of compacted refuse delivered. Then graph refuse versus day and describe the graph mathematically. If you can find its equation, do so, and interpret any special numbers in the equation.

6. Each workday, 900 yd.^{3} of compacted refuse material are delivered to this site. Recall that Mt. Trashmore will be constructed from 25% dirt and 75% compacted refuse.

   a) How much dirt is needed each workday?

   b) Write a recursive formula that describes the amount of dirt, d, remaining to be excavated from the lake site at the end of each workday. (Recall that you calculated the total amount of dirt needed for this project in Item 3(b).)

   c) $d(n) = d(n - 1) + k$ represents the general recursive formula for additive patterns of growth. k can be a positive or negative number. What is the value of k, with units, in your formula for part (b)?

7. Complete a dirt-removal table and a graph, similar to what you did for refuse arrival in Item 5, for the amount of dirt remaining to be excavated from the lake site. Note that your values should be decreasing.

8. a) Write a recursive formula that describes the amount of dirt, e, that arrives at the future hill site each workday. The initial value is $e(0) = 0$.

   b) Compare the graph showing the amount of dirt, e, that arrives at the mountain site by the end of each workday to the graph showing the amount of dirt remaining to be excavated from the lake site. (Refer to the graph that you drew for Item 7.) In what ways would these two graphs be the same? In what ways would they be different?

9. Write a closed-form equation for the amount of dirt remaining to be excavated from the lake. Use it to determine approximately how many years it will take to complete the mountain. (Are you surprised by your answer?)

10. Describe reasons for and against spending this amount of time to construct a ski mountain. How could the time to complete the project be decreased? What benefits and problems might a county encounter when building a refuse hill?