Mathematics Governor's Institute 2003
Problem-in-a-Bag Template

Title of Project: ***The "OOL" Problem : Notice no "P"***

Team Members:

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Grade Level and/or Course:

Grades 9 – 12
Algebra I and Geometry

Concept(s) used:

Area
Surface Area
Volume
Measurement
Rate of Change

PA Standard(s) Addressed:

2.1.8 A	Represent and use numbers in equivalent forms.
2.2.11 A	Develop and use computation concepts, operations, and procedures with real numbers in problem solving situations.
2.3.8 A, B	Develop formulas and procedures for determining measurements for area, volume, etc.
	Solve rate problems.
2.3.11 A, C	Select and use appropriate units and tool to measure to the degree of accuracy required in particular measurement situations.
	Demonstrate the ability to produce measures with specified levels of precision.

2.5.8 A, B, D	Invent, select, use, and justify the appropriate methods, materials, and strategies to solve problems. Verify and interpret results using precise mathematical language, notation, and representations. Determine pertinent information in problem situations and whether any further information is needed for the solution.
2.5.11 A, C	Select and use appropriate mathematical concepts and techniques from different areas of mathematics and apply them to solving non-routine and multi-step problems. Present mathematical procedures and results clearly, systematically, succinctly, and correctly.
2.9.11 I	Model situations geometrically to formulate and solve problems.
2.10.11 B	Identify, create, and solve practical problems involving right triangles using the Pythagorean Theorem.

NCTM Standard(s) Addressed:

Number and Operation

Develop fluency in operations with real numbers
Judge the reasonableness of numerical computations

Algebra

Draw reasonable conclusions about a situation being modeled

Geometry

Recognize geometric shapes and structures in the environment
Use geometric models to solve problems in other areas of math
Recognize geometric ideas and relationships and apply them to other disciplines and to problems that arise in the classroom or everyday life.

Introduction / applications:

See problem handout.

Question:

Determine the amount of time that a recreational pool should be closed for cleaning and painting and when the pool should be closed and reopened for use.

Model:

Determine area, volume, and surface area of a pool.

Resources and Materials (estimated cost):

Calculators
Graph Paper
Area and Volume Formulas

Procedures & Activities:

See problem handout.

Answers / Rubric:

See problem handout.

Accommodations/Adaptations

ESL:

Provide suitable vocabulary for unfamiliar words.
Supply additional pictures or photos of the problem situation.
Partner student with a helper.

Special Ed:

Allow extra time for completion of problem.
Supply a template of the solution that would require student to show work but steps to the problem would be outlined.
Alter the numbers so that they are simpler to compute.
Supply the area and/or volume and have the student continue from there.

Enrichment:

Include costs of paint and supplies and have students calculate total cost.
Have students determine the minimum cost needed to complete the problem by including costs and overtime salaries.
Change the shape and dimensions of the pool.

The "OOL" Problem : Notice No "P"

I.M. Sore, manager of Big Biceps Health Club, has a dilemma. It is time for the annual cleaning and painting of the club pool. This always causes problems with the members who rely on the pool for exercise and recreation. Every year, the club underestimates the amount of time that the pool will be out of service. In order to avoid angry members, I.M. Sore wants to calculate closure time more precisely. Pool hours are from 8 am to 10 pm every day of the week.

Based on the given information, your task is to do the following.

Task 1: *Calculate the amount of time needed to empty the pool.*

Task 2: *Calculate the amount of time needed for two workers to apply two coats of paint.*

Task 3: *Calculate the amount of time needed to refill the pool.*

Task 4: *Calculate the total amount of time the pool is out of service. Also, determine at what time the pool should close and reopen.*

Directions:

*For **full credit**, you **must** do the following.*

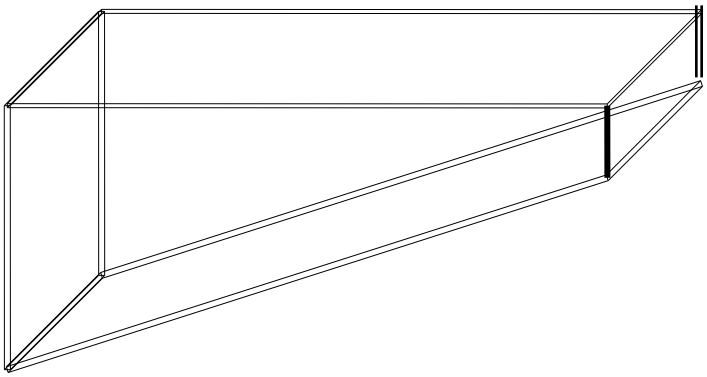
1. ***Show all steps** you used to solve the problem. If you used a calculator or did some of the work in your head, you must write a description of the steps you followed.*

AND

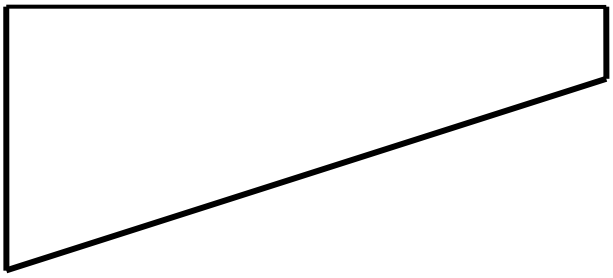
2. *Write an explanation stating the mathematical reason or reasons **why** you chose each of the steps.*

Multiple views of the pool

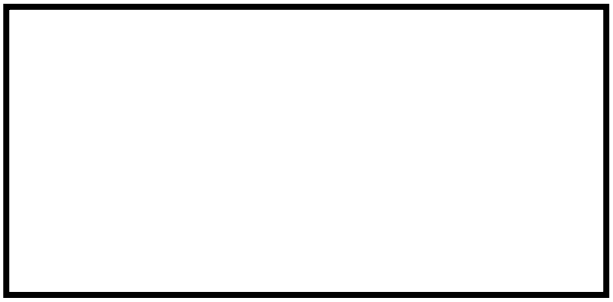
3-D view of the pool



Cross-section view of pool



Overhead view of pool



Task 1

The pool at the health club has a length of 82 feet and a width of 40 feet. The depth of the water at the shallow end is 3 feet and the depth of the water at the opposite end is 16 feet. The bottom of the pool has a constant slope from shallow to deep end. The pool drains at a constant rate of 17.31 cubic feet per minute.

Calculate the amount of time needed to drain the pool. Round your answer to the nearer hundredths.

Task 2

The walls of the pool are 6 inches higher than the water level. Two painters have been hired to complete the job. Painters work from 9 am to 6 pm with a one hour lunch at 1 pm. If each worker can paint 500 square feet per hour, how many hours will be needed to apply two coats of paint? Assume that the second coat of paint can begin immediately upon completion of the first coat.

Task 3

Before the pool can be refilled, the final coat of paint must be allowed to dry for 4.5 hours. Water can be pumped into the pool at a rate of 10.22 cubic feet per minute. Calculate the amount of time needed to refill the pool. Round your answer to the nearer hundredths hours.

Task 4

Calculate the total amount of time that the pool will be out of service. Express your answer in hours and minutes. Round to the nearer whole minute.

In order to keep the inconvenience to the members at a minimum, decide which day and at what time the pool should close and reopen on the condition that lifeguards must be scheduled for a minimum of four hours. Justify your answer.

Sample Solution

Task 1

To find the time needed to empty the pool, first determine the volume of the pool. Since the shape of the pool is a trapezoidal prism, you will need to multiply the area of the base (the trapezoid) times the width of the pool.

This will give you (16+3)/2 times 82 times 40 = 31160 cubic feet.

To find the time needed for draining, you will divide the volume by the draining rate. You will first need to convert 17.31 cubic feet per minute to cubic feet per hour by multiplying by 60 minutes/hour. This yields 1038.6 cubic feet per hour. Dividing 31160 cubic feet by this value yields 30.00 hours.

Task 2

You need to calculate the surface area of the pool. There are five surfaces that are involved. Two congruent trapezoids and three rectangles make up the sides and bottom of the pool. You must remember to add 6 inches to the given depths since the pool extends 6 inches above the water level.

Area of the Pool Bottom:

To calculate the length of the bottom of the pool, use the Pythagorean Theorem using the 13 feet and 82 feet as the sides. The hypotenuse will be 83.02 feet. Then, to calculate the area of the bottom multiply 83.02 by 40 to get 3320.8 square feet.

Area of the Trapezoidal Side:

The area of the trapezoid is determined by multiplying the average of the two bases by the height. This will be (16.5 + 3.5)/2 times 82 which equals 820 sq. feet. Since there are two sides, you need to double this result. Final area of both trapezoids is 1640 square feet.

Area of Rectangular Sides:

The area of the rectangular ends of the pool is found by multiplying the length by the width.

3.5 times 40 yields 140 sq. feet
16.5 times 40 yields 660 sq. feet

The Total Surface Area is found by adding the above values to give a total of 5760.8 square feet.

Since one painter can paint 500 square feet per hour, both painters can cover 1000 square feet per hour. Since two coats are needed, double the surface area to get 11521.6 square feet and divide by 1000 square feet per hour. This gives an answer of 11.5216 hours. Rounding to the nearer hundredths yields 11.52 hours to paint the pool.

Task 3

To find the time needed to fill the pool, convert the pump rate of 10.22 cubic feet per minute to cubic feet per hour. This conversion is 613.2 cubic feet per hour. Next, divide the volume (31160 cubic feet) by 613.2 cubic feet per hour to get 50.82 hours to fill the pool.

Task 4

To find the total amount of time that the pool will be out of service, add the 30 hours for draining, 16.02 hours for painting/drying, and 50.82 hours for filling. This gives a total project time of 96.84 hours. Since the question asks for hours and minutes, you will need to convert 0.84 hours to the nearer whole minute. This gives you 50 minutes. Therefore, the total project time requires 96 hours and 50 minutes.

One possible scenario is to begin draining the pool after it closes on Saturday at 10 pm. The pool will be drained by Monday at 4 am. Painters will begin painting at 9 am Monday and will finish at 12.31 pm on Tuesday. With 4.5 hours of drying time, the pool can begin filling at 5:01 pm on Tuesday. The pool will be ready to open by 7:50 pm on Thursday. However, since the lifeguard must be scheduled for a minimum of 4 hours and the pool closes at 10 pm, the club manager should wait until the following day at 8 am to reopen the pool. Therefore, the pool closes at 10 pm on Saturday and can be ready by 8 am Friday. This means that the members will without the use of the pool for 5 days.