Lesson B3–2

Determining Area and Volume

Unit B. Employability in Agricultural/Horticultural Industry

Problem Area 3. Using Mathematics Skills

Lesson 2. Determining Area and Volume

New Mexico Content Standard:

Pathway Strand: Agribusiness Systems

Standard: **IV:** Employ AFNR industry concepts and practices to manage inventory.

Benchmark: **IV-A:** Monitor inventory levels to accomplish practical inventory control.

Performance Standard: **1.** Maintain optimum inventory levels. **2.** Apply just-in-time concept. **3.** Calculate cost of carrying inventory. **4.** Perform logistics management.

Student Learning Objectives. Instruction in this lesson should result in students achieving the following objectives:

1. Describe the methods used to calculate the area of objects of various shapes.
2. Identify the applications of determining area in agriculture.
3. Describe the methods used to calculate the volume of various shapes.
4. Identify the applications of determining volume in agriculture.

List of Resources. The following resources may be useful in teaching this lesson:

Rogers, Betty C. *Mathematics for Agriculture,* Second Edition. Danville, Illinois: Interstate Publishers, Inc., 2000.

Smith, John. VAS 30106 Surveying in Agriculture. Urbana, Illinois: Vocational Agricultural Service, 1993.

Thurow, Larry. VAS 6015 Mathematical Applications in Agriculture. Urbana, Illinois: Vocational Agricultural Service, 1992.

List of Equipment, Tools, Supplies, and Facilities

Writing surface
Overhead projector
Transparencies from attached masters
Copies of Student Lab Sheets
Calculator

Terms. The following terms are presented in the lesson (shown in bold italics):

Area
Circle
Equilateral triangle
Isosceles triangle
Length
Parallelogram
Rectangle
Right triangle
Square
Scalene triangle
Trapezoid
Triangle
Volume
Width

Interest Approach. Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations.

Have the students participate in the following discussion. What are some agricultural occupations which might require mathematical skills in determining area and volume? What are some examples of problems common to certain occupations? How many of you have had to use mathematical skills to complete a job?

Summary of Content and Teaching Strategies

Objective 1: Describe the methods used to calculate the area of objects of various shapes.

Anticipated Problem: How is area calculated for objects of various shapes?

I. ***Area*** is the measure of the amount of surface.

A. Area is reported in square inches, square feet, square meters, etc.

B. A ***rectangle*** is a four-sided figure with four right angles. The length of the opposite sides of a rectangle are equal.

1. The formula for determining the area of a rectangle is area = length × width.
2. ***Length*** is the longer side of a rectangle.
3. ***Width*** is the shorter side of a rectangle.

C. A ***square*** is a type of rectangle where all four sides are of equal length. The formula for determining the area of a square is area= length × width.

D. A ***triangle*** is a shape bound by three sides with three angles.

1. Triangles can be of various shapes and sizes depending on the lengths of the sides and the angles.
2. A ***right triangle*** is a triangle with an angle of 90 degrees. The area of right triangles can be found by multiplying the base times the height (altitude) and dividing by two—area = (b × h) ÷ 2.
3. An ***equilateral triangle*** is a triangle with all sides of equal length.
4. An ***isosceles triangle*** is a triangle with only two sides are of equal length.
5. A ***scalene triangle*** is a triangle where all sides are unequal in length.
6. The area of an equilateral triangle, isosceles triangle, or scalene triangle can be determined by multiplying the height by the base and dividing by two. Remember, you must first calculate the altitude or height of these triangles. Then, calculate the area of the two new right triangles formed.

E. A ***parallelogram*** is a four-sided object with the opposite sides equal and parallel to each other. The formula to find the area of a parallelogram is area = base × height.

F. A ***trapezoid*** is a two-dimensional, four-sided, closed shape with two opposite sides parallel to each other.

1. To find the area of a trapezoid, determine the average length of the parallel sides and multiply it by the height.
2. To find the average length of the parallel sides, add the length of two sides and divide by two.
3. The formula is area = (ps2 + ps2) ÷ 2 × h.

G. A ***circle*** can be described as a closed curve in two dimensions with all parts on the curve at equal distance from a single enclosed center point.

1. The formula to find the area of a circle is pi (3.14) times the radius squared.
2. Radius is determined by dividing the diameter by 2.

Many techniques can be used to help students master this objective. Students need text materials to help understand how to determine the area of various objects. VAS Unit 6015 Mathematical Applications in Agriculture is recommended. TM: B3–2A can be used to demonstrate area. Use TM: B3–2B to show students the formulas for areas of various shapes. Use TM: B3–2C to demonstrate how to calculate the altitude (height) of a triangle. TM: B3–2D can be used to show various types of triangles.

Objective 2: Identify the applications of determining area in agriculture.

Anticipated Problem: How is calculating area used in agriculture?

II. The ability to successfully calculate area is used in many agricultural occupations and functions.

A. Area is used to determine the number of acres in a field. The following conversions are useful in determining area:
1 rod = 16.5 feet = 5.0292 meters
1 yard = 3 feet = 36 inches = .9144 meters
1 meter = 3.281 feet = 1.094 yards
1 acre = 43,560 square feet
= 4,840 square yards
= 4,047 square meters
= 16 square rods
Number of acres = number of square feet divided by 43,560

B. The following formulas are used to determine the number of acres in various shapes.
1. Area of a rectangle in acres = (width in feet × length in feet) ÷ 43,560.
2. Area of a triangle in acres = (base in feet × height in feet) ÷ (2 × 43,560). If it is not a right triangle, height can be located in the field by laying out a perpendicular line from the base to the opposite corner or angle.
3. Area of a trapezoid in acres = (ps2 in feet + ps2 in feet) ÷ 2 × h ÷ 43, 560.
4. A quadrilateral is a four-sided figure where the sides are not parallel. To determine area, divide the area into triangles, calculate the area of each triangle, and then total them.

C. Area is used in determining sizes of various structures.
1. In determining the size of a structure such as a greenhouse, shed, barn, etc., calculate by multiplying the length times the width.
2. Area is measured in feet squared, yards squared, meters squared, etc.

Use a variety of techniques to help students learn how to calculate area in agricultural applications. Providing text materials will enhance student learning. VAS Unit 30106 Surveying in Agriculture is recommended. Use LS: B3–2A to evaluate students' ability to calculate area in agricultural applications.

Objective 3: Describe the methods used to calculate the volume of various shapes.

Anticipated Problem: How is the volume of various shapes determined?

III. Calculating the volume of a structure is clearly related to determining the surface area of the structure.

A. ***Volume*** can be defined as the amount of space that an object occupies.

B. Common units of volume measurement in agriculture are bushels, tons, gallons, cubic inches, cubic feet, and liters.

C. The volume of a rectangle or square cube is found by multiplying length times width times height (volume = length × width × height).

D. The volume of a round or cylindrical structure is found by first finding the area of the circle portion and then multiplying by the height of the cylinder (volume = area of circle × height of cylinder, or volume = 3.14 × ® × r) × height).

E. The volume of a cone is found by determining the area of the base, multiplying by the height, and dividing by three because the volume of a cone is 1/3 the volume of a cylinder (volume = 3.14 × ® × r) × h ÷ 3).

F. The volume of a spherical structure is calculated by dividing pi by 6 and multiplying by the diameter cubed (volume = (pi ÷ 6) × (diameter × diameter × diameter)).

Use a variety of techniques to help students master this objective. Providing text materials will enhance student learning. Chapter 4 in VAS Unit 6015 Mathematical Applications in Agriculture is recommended. Use TM: B3–2E to illustrate formulas for determining the volume of various objects.

Objective 4: Identify the applications of determining volume in agriculture.

Anticipated Problem: Why does one need to know how to calculate volume in agriculture?

IV. The need to calculate volume or cubic space in agriculture is required when determining the number of gallons in storage tanks, tons of products in hauling equipment, bushels of grain in storage bin, etc. To make these calculations, you need to be able to calculate volume.

A. Calculating volume is closely related to finding the surface area of the structure except it also includes depth.

B. The following are examples of volume calculations used in agriculture.

1. You want to apply fertilizer to your yard. The directions call for 15 pounds of material per 4,500 square feet of yard area. Your yard is 150 feet wide and 130 feet long. Your house, garage, and driveway are 2,000 square feet. Determine the amount of fertilizer needed to cover your yard.

   Step 1: Find the total area.

   150 ft. × 130 ft. = 19,500 sq. ft.

Step 2: Subtract the house and garage area.

19,500 sq. ft. – 2,000 sq. ft. = 17,500 sq. ft.

Step 3: Divide the amount of square feet one bag will cover into the square feet of the yard.

17,500 sq. ft. ÷ 4,500 ft. per 15-lb. bag = 3.9 bags

Step 4: Multiply the number of bags by the weight of each bag.

3.9 bags × 15 lb. per bag = 58.5 lb.

2. You want to inventory the amount of liquid nitrogen in your upright storage cylinder. The tank diameter is 15 feet with a liquid height of 10 feet. The bulk density of liquid nitrogen is 10.66 pounds per gallon and the volume of 1 gallon is 0.1337 cubic feet. What is the total amount of liquid nitrogen in the tank?

Step 1: Find the radius of the tank.

15 ft. diameter ÷ 2 = 7.5 ft. radius

Step 2: Find the volume of the tank in cubic feet.

3.14 × (7.5 ft. × 7.5 ft.) × 10 ft. = 3.14 × 56.25 × 10 = 1,766.25 cu. ft.

Step 3: Calculate the amount of liquid nitrogen in gallons.

1,766.25 cu. ft. ÷ .1337 cu. ft. per gal. = 13,210.54 gal.

Step 4: Determine the total weight of liquid nitrogen in the storage tank.

13,210.54 gal. × 10.66 lb. per gal. = 140,824.35 lb. of liquid nitrogen

3. To order enough concrete for a sidewalk you must know how to figure volume. Concrete is usually ordered in units of cubic yards. The concrete sidewalk you are building is 3 feet wide, 60 feet long, and 4 inches thick. Determine the volume in cubic yards you will need. One cubic yard is equal to 27 cubic feet, and 4 inches is equal to 4/12 feet.

Step 1: Calculate volume in cubic feet.

3 ft. × 60 ft. × 4/12 ft. = 60 cu. ft.

Step 2: Convert cubic feet to cubic yards (3 ft. = 1 yd.; 1 cu. yd. = 27 cu. ft.).

60 cu. ft. ÷ 27 cu. ft. per cu. yd. = 2.2 cu. yd. of concrete

Use a range of teaching strategies to illustrate how to apply figuring volume in agriculture. VAS Unit 6015 Mathematical Applications in Agriculture and Mathematics for Agriculture are recommended as text materials. Use LS: B3–2B to have students demonstrate their ability to compute volume.

Review/Summary. Focus the review and summary of the lesson around the student learning objectives. Call on students to explain the content associated with each objective. Use their responses as the basis for determining any areas that need to be covered again. Questions at the ends of the chapters in the recommended textbooks may also be used in the review process. Use the lab activities in reviewing and reinforcing student learning.

Application. Application can involve the following student activities:

Calculating Area—LS: B3–2A

Calculating Volume—LS: B3–2B

Evaluation. Evaluation should focus on student achievement of the objectives for the lesson. Various techniques can be used, such as student performance on the application activities. A sample written test is attached.

Answers to Sample Test:

Part One: Matching

1=c, 2=d, 3=a, 4=e, 5=f, 6=g, 7=b

Part Two: Completion

1=Length, width

2=isosceles

3=scalene

4=parallelogram

Part Three: Problems

1=77.47 acres

2=448.8 gallons

3=42.12 cubic yards

Sample Test Name _____

Test

Lesson B3–2: Determining Area and Volume

Part One: Matching

Instructions. Match the term with correct response. Write the letter of the term next to the definition.

a. area	d. triangle	g. trapezoid
b. rectangle	e. circle	
c. square	f. volume	

_____ 1. A four-sided figure with four right triangles and all sides of equal length.

_____ 2. A shape bound by three sides with three angles.

_____ 3. Determined by measuring the amount of surface.

_____ 4. A closed curve with all points on the curve equal distance from the center point.

_____ 5. The amount of space that an object occupies.

_____ 6. A two-dimensional, four-sided, closed shape with two opposite sides parallel.

_____ 7. A four-sided figure with four right triangles and the length of opposite sides being equal.

Part Two: Completion

Instructions. Provide the word or words to complete the following statements.

1. _____ is described as the longer side of a rectangle, while _____ is the shorter side.
2. An _____ triangle is one with only two sides of equal length.
3. A triangle where all three sides are unequal in length is called a _____ triangle.
4. A _____ is a four-sided object with opposite sides equal and parallel to each other.

Part Three: Problems

Instructions. Complete the following problems and show your work.

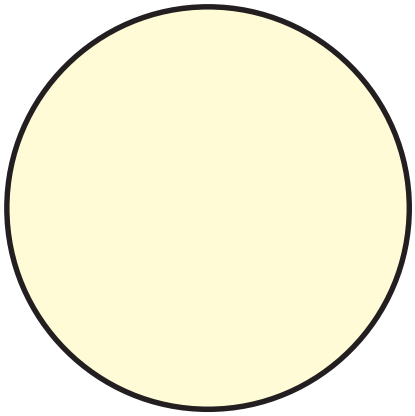
1. Determine the area in acres of a field that is 500 yards wide and 750 yards long.

2. How many gallons of water will a tank 10 feet long, 3 feet wide, and 24 inches deep hold? One cubic foot is equal to 7.48 gallons.

3. How many cubic yards of concrete is in a slab 35 feet wide, 65 feet long, and 6 inches thick?

Area

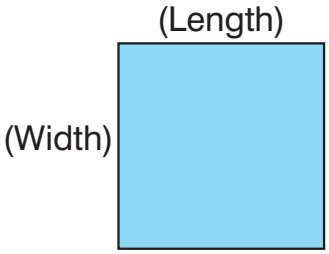
Rectangle



Circle

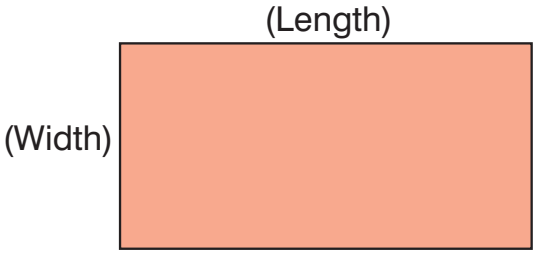
The area enclosed by a rectangle and a circle is indicated by the shaded portions.

Formulas for Determining Area



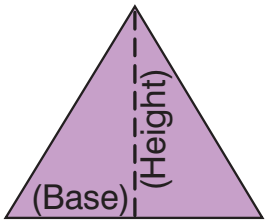
Square

Formula: Area = length × width



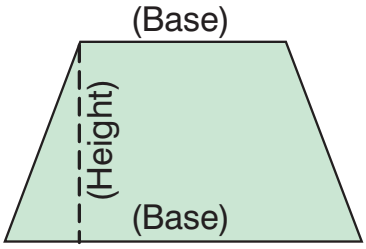
Rectangle

Formula: Area = length × width



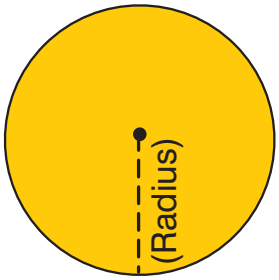
Triangle

Formula: Area = $\frac{\text{base} \times \text{height}}{2}$



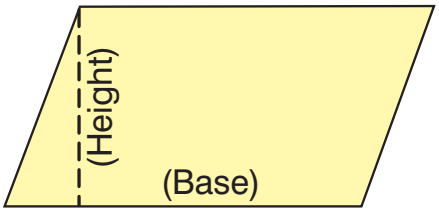
Trapezoid

Formula: Area = $\frac{\text{base} + \text{base}}{2} \times \text{height}$



Circle

Formula: Area = radius^2 × 3.14

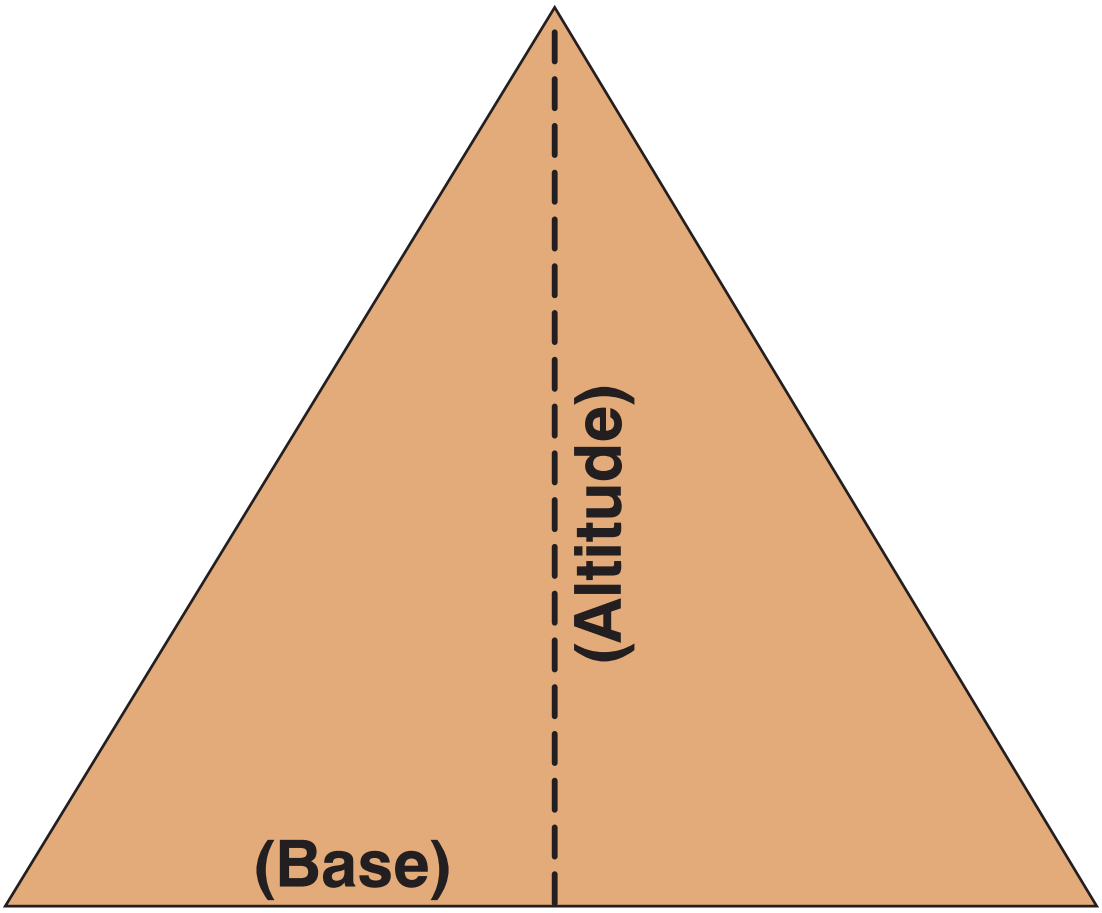


Parallelogram

Formula: Area = base × height

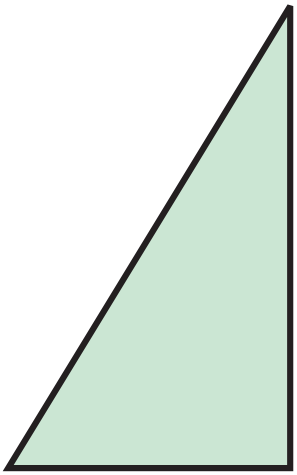
TM: B3–2C

Altitude of a Triangle

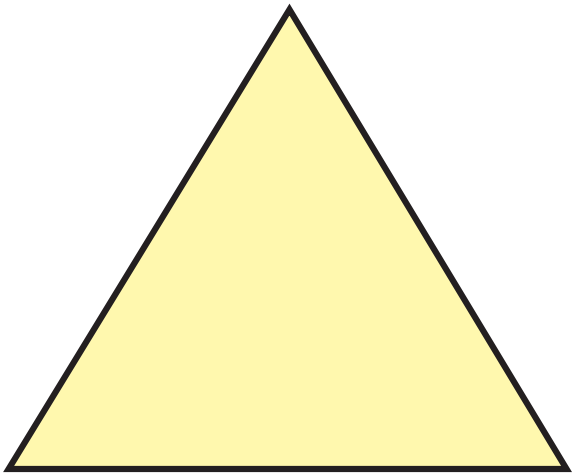


Altitude of a triangle can be located by laying out a perpendicular line from its base to the opposite angle.

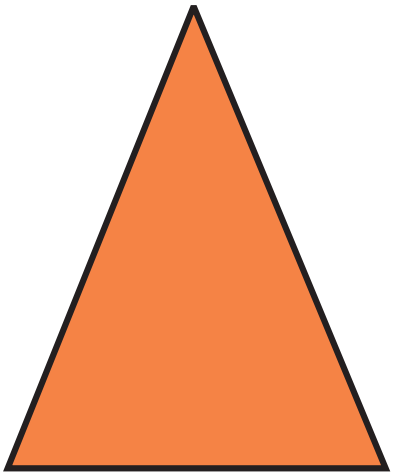
Various Triangles



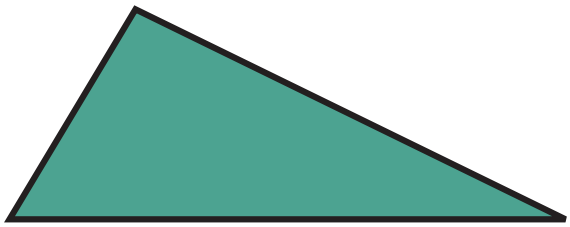
Right Triangle



Equilateral Triangle

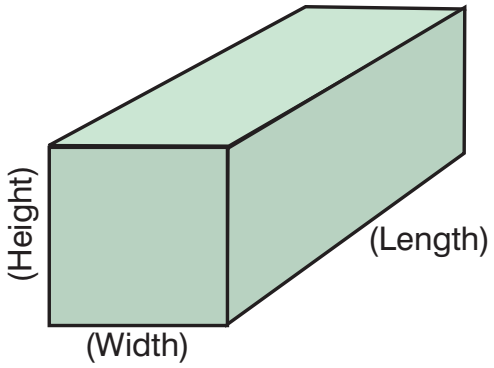


Isosceles Triangle



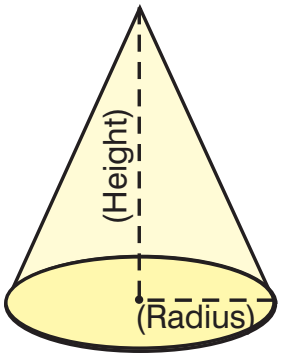
Scalene Triangle

Determining Volume



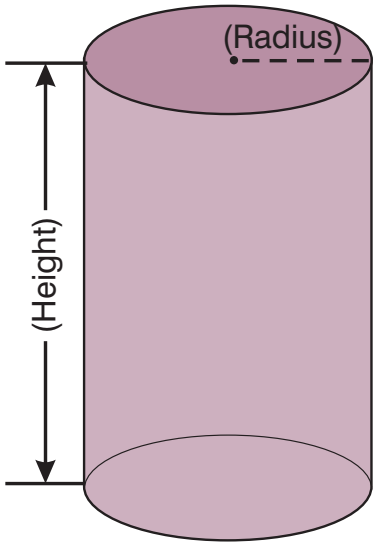
Square or Rectangular Cube

Formula: Volume = length × width × height



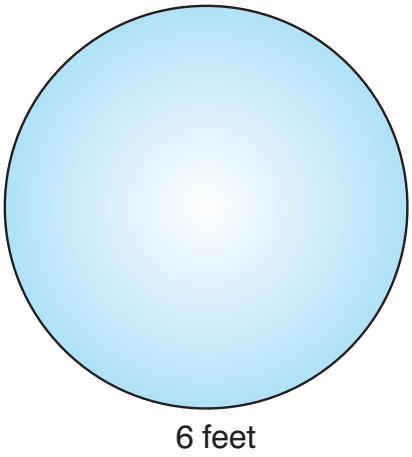
Cone

Formula: Volume $= \frac{r^2 \times 3.14 \times \text{height}}{3}$



Cylinder

Formula: Volume = $r^2 \times 3.14 \times$ height



Sphere

Formula: Volume $= \frac{3.14}{6} \times \text{diameter}^3$

Name_____

Lab Sheet

Calculating Area

This activity will give you a better understanding of how area is calculated in agriculture.

Purpose:

To learn how to apply area formulas in agriculture applications.

Materials:

Lab sheet
Writing utensil
Calculator

Procedure:

1. Answer the following problems regarding area calculation in agriculture.
2. Show your work with all problems, including formulas.

Area Problems

1. Find the floor area of a greenhouse that is 60 feet long and 30 feet wide.

2. Find the area of a right-triangular field that has a base of 1,000 feet and a height of 2,000 feet. Convert your answer to acres.

3. Find the area in acres of a field that is 80 rods wide and 160 rods long.

4. Find the area in acres of a trapezoid-shaped field that has one parallel side 880 feet long, an altitude of 550 feet, and another parallel side of 1,100 feet.

5. Find the area of a circular grain storage structure foundation. The radius of the circular foundation is 15 feet.

Name _____

Lab Sheet

Calculating Volume

This activity will give you a better understanding of how volume is calculated.

Purpose:

To learn how to apply volume formulas in agriculture applications.

Materials:

Lab sheet
Writing utensil
Calculator

Procedure:

1. Answer the following problems regarding volume.
2. Show your work on all problems, including the formulas.

Volume Problems

1. Suppose that an area receives 12 inches of rainfall during a season. This means the amount of rain is equivalent to water that is 12 inches deep over the entire area.
   a. How many cubic feet of rain have fallen on one acre of land that has an area of 43,560 square feet?

   b. Each cubic foot is equivalent to about 7.48 gallons. If you had to provide irrigation water of the same amount, how many gallons of water would you have to pump? (Round to the nearest gallon.)

2. The amount of timber on a logging truck is commonly reported in cords, where each cord is 129 cubic feet of wood. The volume of wood is estimated by assuming the trees are shaped approximately like a cylinder. However, because the diameter at one end is larger than the diameter at the other end of the log, a common approximation of the volume is found by using the average of the two diameters to compute the volume.
   a. The logs on a certain logging truck are about the same. Each has a diameter of 25 inches at the large end and 14 inches at the small end. Determine the average of the two diameters of these logs. (Hint: The average is computed by adding the numbers and dividing them by how many numbers you have added.)

   b. The logs on this truck are 36 feet long. Using the average diameter computed above, determine the volume of each log. (Round to the nearest .01 cubic foot.)

   c. There are 17 logs on this truck. What is the total volume of wood on the truck? (Round to the nearest cubic foot.)

3. A 90-inch concrete sidewalk is to be constructed. It will be 3 feet wide and 4 inches deep.
   a. Since concrete is normally ordered in yards (that is, cubic yards), convert the measurements from inches and feet to yards.

   b. Identify the geometric figure in the construction that you can use to compute the volume. Compute the total volume of the construction, in cubic yards. (A sketch might be helpful.)

   c. Allow 10 percent for spillage. How many cubic yards should you add to your needs for spillage? What will your total needs be, rounded up to the nearest cubic yard?

Lab Sheet Key

Calculating Volume

1. a. Use 1 foot instead of 12 inches.

   Volume of rain = area × height

   Volume of rain = 43,560 sq. ft. × 1 ft. = 43,560 cu. ft.

   b. Gallons of rain = cu. ft. × gal. per cu. ft.

   Gallons of rain = 43,560 cu. ft. × 7.48 gal. per cu. ft. = 325,829 gal. (rounded)

2. a. Average diameter = (large diameter + small diameter) ÷ 2

   Average diameter = (25 in. + 14 in.) ÷ 2 = 19.5 in. This must be converted to feet to calculate the volume in Part B.

   Average diameter = 19.5 in. × 1 ft. per 12 in. = 1.625 ft.

   b. Volume per log = pi × r^2 × h

   Volume per log = 3.14 × $(1.625 \text{ ft.} \div 2)^2$ × 36 ft. = 74.62 cu. ft. (rounded)

   c. Total volume = volume per log × number of logs

   Total volume = 74.62 cu. ft. × 17 logs = 1,269 cu. ft. (rounded)

3. a. Length = 90 ft. × 1 yd. per 3 ft. = 30 yd.

   Width = 3 ft. × 1 yd. per 3 ft. = 1 yd.

   Depth = 4 in. × 1 yd. per 36 in. = .11 yd.

   b. The shape is a rectangular solid.

   Volume of sidewalk = length × width × height

   Volume of sidewalk = 30 yd. × 1 yd. × .11 yd. = 3.30 cu. yd.

   c. Spillage allowance = 3.30 cu. yd. × 10% = .33 cu. yd.

   Total volume needed = volume of sidewalk + spillage allowance

   Total volume needed = 3.30 cu. yd. + .33 cu. yd. = 4 cu. yd. (rounded)