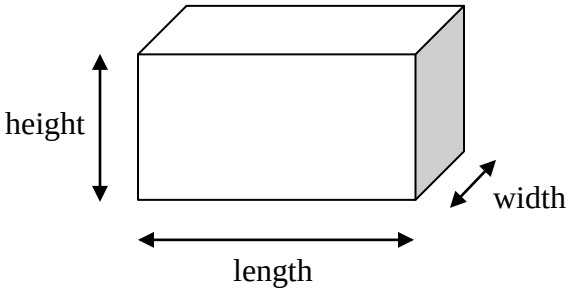
Volume Calculations

You will often have to do volume calculations in your line of work. Volume is the amount of space in a region. For a rectangular shaped region, the volume is given by

Volume of rectangular region = length x width x height.



Note: Which side you call length, width or height doesn't matter. You can even call them different names: For instance, you might call one side *depth*.

Since volume is a distance times a distance times a distance, the units of volume are always given as some distance unit cubed. In this country, volume is often measured in cubic feet (ft^3) or cubic yards (yd^3).

A more general way of finding the volume of a region is to find the surface area and then multiply by the depth. The surface area is just the area of one face of the surface (and which face you choose doesn't matter—the remaining face is then the "depth".)

Volume = Surface Area x Depth

For instance, in Worksheet #4, you learned that the area of a circular region is given by

Area of circle= π x R^2 where R is the radius of the circle, and π is 3.14.

So if you have a circular pond and need to know the volume of water in the pond, use

Volume = Surface Area x Depth = (π x R^2) x (Depth)

Example 1: A circular pond is 10 feet across and 1 foot deep. What is the volume of water it holds?

Volume = Surface Area x Depth = (π x R^2) x (Depth) = (π x (5 ft)^2) x (1 ft) = 78.5 cubic feet of water.

Example 2: A rectangular planting bed is 10 ft by 15 ft. You want to add 4 inches of soil to the bed. What volume of soil do you need?

You can use either formula for the volume, but you first need to convert the 4 inches into feet—all the distance units must be the same before you can do a volume calculation:

$$(4 \text{ inches}) \times \left(\frac{1 \text{ ft}}{12 \text{ inches}} \right) = \frac{4}{12} \text{ ft} = \frac{1}{3} \text{ ft}$$

So then, Volume = Surface Area x Depth = (10 ft x 15 ft) x (1/3 ft) = 50 ft^3 of soil is needed.

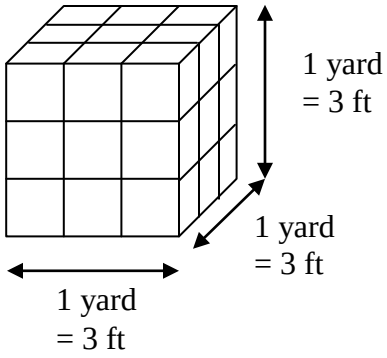
Example 3: A plot of 600 square feet is to be excavated to a depth of 6 inches. Calculate the volume of the excavated material in its compacted state.

Volume = Surface Area x Depth = (600 ft^2) x (1/2 ft) = 300 ft^3 of material will be excavated. Really, the volume excavated will be greater than this as material expands when excavated. But after it settles the excavated material should equal this amount.

You may also have to convert from one volume unit to another. For instance, how many cubic yards are there in 300 cubic ft? To do this you need to come up with a conversion ratio (we did a similar procedure in Worksheet #4 to convert from square ft to square yards.) A picture helps. Imagine a cube 1 yard on each side (see below). Since there are 3 ft in 1 yard, the volume can be found by counting all the little 1 cubic ft cubes. When you do that, you should be able to see that there are 27 cubic ft in 1 cubic yard. You could also get the same result using our volume formula from above:

Volume = Surface Area x Depth = (3 ft x 3ft) x (3 ft) = 27 cubic ft = 1 cubic yard.

1 cubic yard:



So we can find the number of cubic yards in 300 cubic feet by:

$$\left(300\ \text{ft}^3\right) x \left(\frac{1\ \text{yd}^3}{27\ \text{ft}^3}\right) = 11.1\ \text{yd}^3$$

Example 4: You have a truck dump 5 cubic yards of sand at a job site. You have a plot of land that is 1000 square feet. How deep can the sand be spread over this region?

This one is a little trickier. But we can see how to do it by looking at our formula for calculating the volume: Volume = Surface Area x Depth. We are given the Volume of the sand. We are given the Surface Area of the plot. So all we have to do is solve for the Depth. We can rearrange the volume formula to get:

$$\text{Depth} = \left(\frac{\text{Volume}}{\text{Surface Area}}\right)$$. But before we can use this formula we need to convert our 5 cubic yards into cubic feet (remember that when using the volume formula the numbers have to have the same units). So

$$\left(5\ \cancel{yd^3}\right) x \left(\frac{27\ ft^3}{1\ \cancel{yd^3}}\right) = 135\ ft^3$$

Now we can use the formula for the Depth:

$$\textbf{Depth} = \left(\frac{\textbf{Volume}}{\textbf{Surface Area}}\right) = \frac{135\ ft^3}{1000\ ft^2} = 0.135\ ft$$. This can be converted to inches:

$$\left(0.135\ \cancel{ft}\right) x \left(\frac{12\ inches}{1\ \cancel{ft}}\right) = 1.62\ inches$$. This is the depth of the sand over the 1000 square foot region.

CALCULATING AMOUNT OF ACTIVE INGREDIENT AND AMOUNT OF PRODUCT

Many herbicides and insecticides have labels that specify the amount of active ingredient of the product. The active ingredient is the ingredient that actually has the herbicidal or insecticidal action. The amount of product that you are to apply is often given in terms of this active ingredient. To find the amount of product to apply when given the amount of active ingredient needed use

$$\textbf{Amount of product} = \left(\frac{\textbf{amount of active ingredient}}{\textbf{\% active ingredient (in decimal form)}}\right)$$

Example #5: A herbicide label recommends applying 0.5 lbs active ingredient per acre. The product contains 45% active ingredient. How much product is needed to treat an acre at the recommended rate?

Using the formula,

$$\textbf{Amount of product} = \left(\frac{0.5\ lb}{0.45}\right) = 1.11\ lb$$ of product should be applied.

Exercise #6: You have a 5-gallon container of an emulsifiable concentrate formulation of an insecticide. This product contains 25% active ingredient. How many gallons of active ingredient are contained in the container?

Just rearrange our formula:

$$\text{(Amount of product)x(\% active ingredient (in decimal form))} = \text{= amount of active ingredient}$$

So the amount of active ingredient in the container is

(5 gallons) x (0.25) = 1.25 gallons of active ingredient.

Converting Label Application Rates to Actual Application Numbers

Example #7: A label says to mix two tablespoons of an emulsifiabile concentrate-formulation pesticide in 5 gallons of water to treat 1,000 square feet of ground cover, but you actually have 1,500 square feet of area to cover. How many tablespoons of the pesticide do you need for the 1500 square foot plot of land?

Set up a ratio of tablespoons of pesticide to the area of the plot. You want the same ratio for your plot as the ratio given on the product label:

$$\frac{\text{2 tablespoons}}{\text{1000 ft}^2} = \frac{\text{X tablespons}}{\text{1500 ft}^2}$$ where X is the amount of the product you should use on the 1500 ft^2 plot. To solve this for X, multiply both sides of the equation by 1500 ft^2:

$$\frac{\text{2 tablespoons}}{\text{1000 ft}^2}\left(\text{1500 ft}^2\right) = \frac{\text{X tablespons}}{\cancel{\text{1500 ft}^2}}\left(\cancel{\text{1500 ft}^2}\right)$$

Solving this for X gives X = 3 tablespoons. So 3 tablespoons of active ingredient are needed for 1500 ft^2 of land.

Homework Problems

1. You order 4 cubic yards of loose mulch and have it delivered to a job site. A rectangular planting bed measures 35 ft by 13 ft. You want to apply the mulch to the bed so the depth is 1/3 of a foot. Did you order enough mulch? What is the exact amount of mulch needed?

2. A planting bed that is 7 yards by 3 yards needs new soil to a depth of 6 inches. What is the volume of soil needed? Ignore any shrinkage/settling of the soil.

3. A round pond measures 15 feet across and is 2 feet deep. What is the volume of water in cubic feet needed to fill the pond? 1 gallon of water has a volume of 0.134 cubic feet. How many gallons of water are needed to fill the pond?

4. You have a truck dump deliver 220 cubic feet of sand at a job site. You have a plot of land that is 1800 square feet. How deep can the sand be spread over this region?

5. You need to topdress the front nine greens of your golf course with sand. You wish to apply a 1/8-inch deep layer. The total square footage of the greens is 5,400 square feet. Your sand is stored in a 6 ft. x 10 ft. rectangular bin that is 1.5 ft. high. It is completely filled with sand. Will you have enough sand to top dress all nine of the greens? Show your calculations.

6. You have a 9-pound bag of granules of an insecticide. The product contains 15% active ingredient. Calculate the number of pound of active ingredient contained in the 9-pound bag.

7. The directions say to apply 2 oz. of active ingredient of a 70% wettable powder formulation of fungicide per 1,000 square feet. How many oz. of actual product do you need to apply to cover the 1,000 square foot area at the recommended rate?

8. The directions say to mix 1 teaspoon of an emulsifiable concentrate (liquid) insecticide per gallon of water to cover 1,000 square feet of lawn. Your lawn actually covers 1,550 square feet. How many gallons of spray mix do you actually need? How many teaspoons of the insecticide will you need to add to that mix?

9. A 2.5-gallon jug of Roundup Pro herbicide contains 41% of the active ingredient glyphosate. For turf restoration, the manufacturer recommends 2 and 2/3 ounces of Roundup Pro per gallon of spray. Your sprayer holds 2.5 gallons. How much Roundup Pro should you use to fill up your sprayer?

10. An emulsifiable concentrate (liquid) herbicide says to use 1 quart per 100 gallons of spray. Your sprayer holds 2.5 gallons. How many fluid ounces of herbicide should you use to completely fill up your sprayer with the recommended amount of herbicide? 1 quart = 32 fluid ounces. 1 gallon = 128 fluid ounces.