



**WASTEWATER TECHNOLOGY  
T R A I N E R S**

*Transforming today's operators into tomorrow's water quality professionals*

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**Problem of the Day  
2015.Jun.22**

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What is the volume, in million gallons, of a recycled water reservoir that is 175 feet in diameter and 28 feet deep?

## Introduction

If you're just starting out in a career as a water quality professional, especially if your math skills haven't been worked in a long time, a question like today's may cause concern. Regardless of the question, remember to let the units guide you.

To tackle today's problem you have to understand that volume is always in units of length times length times length. In the United States at least, we typically see volume in units of  $\text{ft}^3$  ( $\text{ft} \times \text{ft} \times \text{ft}$ ), and you'll hear people say "cubic feet." But we only have two units of length given in the problem. Ah, but remember, given diameter, we can find the area of the circle. Area is always in units of length times length,  $\text{ft}^2$ , and you'll hear people say "square feet." So the area times the depth will give us volume in cubic feet,  $\text{ft}^3$ .

Just as often, maybe more so, volume in the water business will be in units of gallons. The conversion factor we need is:

$$\frac{7.48 \text{ gal}}{\text{ft}^3} \quad \text{or} \quad \frac{\text{ft}^3}{7.48 \text{ gal}}$$

How this conversion factor is entered into the solution bridge depends on where you want the units to end up. Remember if you want to cancel units, the same units have to be in the numerator and denominator of the solution bridge.

Volumes are often so large in the water business, we use million gallons (Mgal) as a unit. The conversion factor we need is:

$$\frac{10^6 \text{ gal}}{\text{Mgal}} \quad \text{or} \quad \frac{\text{Mgal}}{10^6 \text{ gal}}$$

Remember,  $10^6$  is shorthand (scientific notation) for a 1 with six 0s after it, 1,000,000, or a million. A lot of times operators will convert between gallons and million gallons "in their head." Under the pressure of a certification exam, "in your head" means "I'm going to make a stupid mistake." You can't afford to make stupid mistakes, so use the conversion factor.

## Solution

The question asks for the answer in million gallons. These units are entered between heavy vertical lines, as always, followed by an equals sign and the blank solution bridge.

**Problem of the Day:** What is the volume, in million gallons, of a recycled water reservoir that is 175 feet in diameter and 28 feet deep?

$$\left| \text{Mgal} \right| = \underline{\hspace{15em}}$$

The following list summarizes the information given in the problem statement expressed in the appropriate units:

1. Diameter of tank = 175 ft
2. Depth of water = 28 ft

There are no units of Mgal in the list to start the solution bridge. You can always start with a conversion factor with the units needed, so we start with the second conversion factor given above.

Mgal	=	Mgal			
		10 <sup>6</sup> gal			

We have to cancel gal out next but we don't have anything in the list with these units. Again, we can use a conversion factor to "make the units work." We use the first conversion factor given above entered so gal cancels in the denominator and numerator.

Mgal	=	Mgal	7.48 gal			
		10 <sup>6</sup> gal	ft <sup>3</sup>			

The cubic feet (ft<sup>3</sup>) are canceled by entering the volume of the tank which is 0.785 x diameter<sup>2</sup> x depth. Note, instead of entering diameter<sup>2</sup>, diameter x diameter is entered. Since all the units have now canceled except those needed in the answer, we know the solution bridge is complete. The arithmetic gives the answer.

Mgal	=	Mgal	7.48 gal	0.785	175 ft	175 ft	28 ft
		10 <sup>6</sup> gal	ft <sup>3</sup>				

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Mgal	=	Mgal	7.48 gal	0.785	175 ft	175 ft	28 ft
		10 <sup>6</sup> gal	ft <sup>3</sup>				

$7.48 \times 0.785 \times 175 \times 175 \times 28 \div 1,000,000 = \underline{5.0 \text{ Mgal}}$ .

**Discussion**

I don't know why a lot of operators don't like using units in their calculations. Maybe it takes a couple of extra seconds to write the units out, but, once you get the hang of it, the units will tell you how to start the problem, how to do the problem, whether to divide or multiply by a conversion factor, they'll even do algebra for you without you knowing it! And, they'll keep you from making stupid mistakes. I think that's worth spending the extra few seconds.

**Happy calculating! Let us know, by leaving a comment, if you want us to do a specific problem, if you see a mistake, or if you have a question on any of the Problems of the Day you are looking at.**