

Determining Actual Aquarium Volume

Objective

The learner will explore the factors that affect the actual volume of an aquarium.
The learner will calculate the actual volume of the classroom aquarium.

Introduction

When you fill an aquarium with water, you expect the volume of water in the aquarium to be the same as the advertised volume. So you might think that a 10 gallon aquarium will hold 10 gallons of water, however this is seldom the case. In this activity you will explore the various factors that impact the *actual* volume of an aquarium and account for those factors in your calculations.

It is important for an aquarium owner to know the actual volume of water in their aquarium for a couple of reasons. One reason would be to apply the correct dosage of a chemical water treatment. For example, certain chemicals can be added to the water to get rid of harmful parasites. These chemical treatments can be ineffective if volume is underestimated and potentially lethal if it is overestimated. Before determining the concentration or amount of chemical to be used, it is necessary to accurately calculate the water volume.

Another reason an aquarium owner would need to know the actual volume of water in their aquarium would be to determine how many fish could be kept in the aquarium without overcrowding. A general guideline suggested to prevent overcrowding is 1-inch of fish per gallon of water. This guideline can be applied with most varieties of aquarium fish, but some species, like GloFish® fluorescent fish and other types of zebrafish, can safely be kept in higher densities because they are schooling fish. If you were to utilize the 1-inch of fish per one gallon of water rule, then an aquarium containing twenty 3-inch fish would need to have at least 60 gallons of water ($20 \times 3 = 60$).

National Standards Addressed

Science as Inquiry A—Abilities necessary to do scientific inquiry

Materials Per Group

Ruler (cm)/meter stick
Calculator

Materials for Classroom

Aquarium

Safety Precautions

While there are no safety related issues with this lab, prudent laboratory practices should be followed.

Procedures

Part A: Determining the Maximum Volume

The first step in finding the actual volume of an aquarium is to determine its maximum volume. In Part A, you will measure the dimensions of the aquarium in order to get this information. It is important to realize that the glass walls of the tank have a meaningful thickness, so measuring the dimensions from the outside walls will not yield an accurate calculation of the maximum volume.

1. Measure the length, width and depth (in centimeters) of the *inside* walls of the aquarium. Record your measurements in Table 23.1.

Part B: Adjusting for Water Level

Aquariums are not usually filled to the very top, therefore it is necessary to account for the empty space *above* the surface of the water. In Part B you will measure the dimensions of this space in order to calculate the volume adjustment for water level.

1. Estimate where the water level would be when the aquarium is filled.
2. Measure the distance (in centimeters) from the upper rim of the aquarium to the water level estimated in Step 1. (To clarify, this is the depth of the space above the water level in the tank.) The length and width of this space is the same as the length and width of the aquarium measured in Part A. Record the length, width and depth of this space in Table 23.2.

Part C: Adjusting for Substrate

Aquariums often have some kind of substrate material such as sand, rock, or gravel. These materials have their own volume, and therefore will cause a decrease in the actual water volume when added to the aquarium. In Part C you will estimate the volume of water displaced by substrate.

1. Estimate the maximum depth (in centimeters) of each substrate material in the aquarium.
2. The length and width of each substrate material is the same as the length and width of the aquarium measured in Part A. Record the length, width and depth of each substrate material in Table 23.3.

Data

Table 23.1 - Part A: Determining the Maximum Volume

Length (cm)	Width (cm)	Depth (cm)	Volume (cm ³)	Volume (gal)

Table 23.2 - Part B: Adjusting for Water Level

Length (cm)	Width (cm)	Depth (cm)	Volume (cm ³)	Volume (gal)

Table 23.3 - Part C: Adjusting for Substrate

Substrate Material	Length (cm)	Width (cm)	Depth (cm)	Volume (cm ³)	Volume (gal)

Calculations (Be sure to show ALL work.)

Part A: Determining the Maximum Volume

1. Calculate the maximum volume of the aquarium in cm³ by multiplying the length, width and depth of the aquarium (L x W x D). Record your answer in Table 23.1.
2. Convert the maximum volume of the aquarium (in cm³) to gallons. (1.0 cm³ = 0.000264 gal.) Record your answer in Table 1.

Part B: Adjusting for Water Level

1. Calculate the volume of empty space above the surface of the water (in cm³) by multiplying the length, width and depth of the empty space (L x W x D). Record your answer in Table 23.2.

2. Convert the volume of the empty space above the surface of the water (in cm^3) to gallons. $1.0 \text{ cm}^3 = 0.000264 \text{ gal}$. Record your answer in Table 23.2.

Part C: Adjusting for Substrate

1. Calculate the volume of water displaced by each substrate material (in cm^3) by multiplying the length, width and depth of each substrate material (L x W x D). Record your answers in Table 23.3.

2. Convert the volume of water displaced by each substrate material (in cm^3) to gallons. $1.0 \text{ cm}^3 = 0.000264 \text{ gal}$. Record your answers in Table 23.3.

Determining the Actual Volume of Water in the Aquarium

1. Calculate the actual volume of water in the aquarium (in gallons) by subtracting the volume of empty space above the surface of the water (as determined in Part B) and the volume of water displaced by each substrate material (as determined in Part C) from the maximum volume of the aquarium (as determined in Part A).

Discussion Questions:

1. Identify and explain some additional reasons (other than the ones in the introduction) why knowing the actual volume of water in an aquarium might be important.

2. Besides the substrate materials, what other objects are commonly found in a fish aquarium? Do you think it would be necessary to include an adjustment in the actual volume calculation to account for these objects? Why or why not.

3. How could a person determine the volume of water displaced by one of the objects identified in Question 2?

4. Do you think that the actual volume of the substrate material in an aquarium equals the volume calculated in Part C? Explain.

5. Using the general guideline that 1-inch of fish be placed in one gallon of water, how many 4-inch fish could be placed in your classroom aquarium using the actual volume of water calculated in the lab? Show your calculations.

Elaborations and Extensions

Have students determine the volume of other common objects found in an aquarium using measurement or water displacement.

Have the students calculate the number of fish the aquarium could hold using the calculated volume and the general rule of one inch of fish per gallon of water.

Give the students a percentage of the volume of the water to change in the aquarium and have them calculate the volume of water that needs to be changed.

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Intended Grade Level

9th, 10th, and 11th

Teacher Information

To begin this exercise, students should have access to an empty aquarium so they will be able to measure inside the walls in Part A.

Have two substrate materials available to add to the aquarium once they are ready to proceed with Part C.

Sample Data (Based on a seventy-gallon aquarium)

Table 23.1 - Part A: Determining the Maximum Volume

Length (cm)	Width (cm)	Depth (cm)	Volume (cm ³)	Volume (gal)
120.0 cm	38.0 cm	61.0 cm	278,000 cm ³	73.4 gal

Table 23.2 - Part B: Adjusting for Water Level

Length (cm)	Width (cm)	Depth (cm)	Volume (cm ³)	Volume (gal)
120.0 cm	38.0 cm	6.0 cm	27,400 cm ³	7.2 gal

Table 23.3 - Part C: Adjusting for Substrate

Substrate Material	Length (cm)	Width (cm)	Depth (cm)	Volume (cm ³)	Volume (gal)
Sand	120.0 cm	38.0 cm	3.0 cm	13,700 cm ³	3.6 gal
Gravel	120.0 cm	38.0 cm	2.0cm	9120 cm ³	2.4 gal

Sample Calculations

Part A: Determining the Maximum Volume

1. Calculate the maximum volume of the aquarium in cm³ by multiplying the length, width and depth of the aquarium (L x W x D). Record your answer in Table 23.1

$$120.0 \text{ cm} \times 38.0 \text{ cm} \times 61.0 \text{ cm} = 278,000 \text{ cm}^3 \text{ (rounded)}$$

2. Convert the maximum volume of the aquarium (in cm³) to gallons. (1.0 cm³ = 0.000264 gal.) Record your answer in Table 1.

$$278,000 \text{ cm}^3 \times 0.000264 \text{ gal/cm}^3 = 73.4 \text{ gal}$$

Part B: Adjusting for Water Level

1. Calculate the volume of empty space above the surface of the water (in cm^3) by multiplying the length, width and depth of the empty space (L x W x D). Record your answer in Table 23.2.

$$120.0 \text{ cm} \times 38.0 \text{ cm} \times 6.0 \text{ cm} = 27,400 \text{ cm}^3$$

2. Convert the volume of the empty space above the surface of the water (in cm^3) to gallons. $1.0 \text{ cm}^3 = 0.000264 \text{ gal}$. Record your answer in Table 23.2.

$$27,400 \text{ cm}^3 \times 0.000264 \text{ gal/cm}^3 = 7.2 \text{ gal}$$

Part C: Adjusting for Substrate

1. Calculate the volume of water displaced by each substrate material (cm^3) by multiplying the length, width and depth of each substrate material (L x W x D). Record your answers in Table 23.3.

$$\text{Sand: } 120.0 \text{ cm} \times 38.0 \text{ cm} \times 3.0 \text{ cm} = 13,700 \text{ cm}^3$$

$$\text{Gravel: } 120.0 \text{ cm} \times 38.0 \text{ cm} \times 2.0 \text{ cm} = 9120 \text{ cm}^3$$

2. Convert the volume of water displaced by each substrate material (cm^3) to gallons. $1.0 \text{ cm}^3 = 0.000264 \text{ gal}$. Record your answers in Table 23.3.

$$\text{Sand: } 13,700 \text{ cm}^3 \times 0.000264 \text{ gal/cm}^3 = 3.6 \text{ gal}$$

$$\text{Gravel: } 9120 \text{ cm}^3 \times 0.000264 \text{ gal/cm}^3 = 2.4 \text{ gal}$$

Determining the Actual Volume of Water in the Aquarium

1. Calculate the actual volume of water in the aquarium (in gallons) by subtracting the volume of empty space above the surface of the water (as determined in Part B) and the volume of water displaced by each substrate material (as determined in Part C) from the maximum volume of the aquarium (as determined in Part A).

$$73.4 \text{ gal} - 7.2 \text{ gal} - 3.6 \text{ gal} - 2.4 \text{ gal} = 60.2 \text{ gal}$$

Discussion Questions and Possible Answers

1. Identify and explain some additional reasons (other than the ones in the introduction) why knowing the actual volume of water in an aquarium might be important.

The volume of water in the aquarium is needed to select proper pumps, filtration equipment and aerators.

If treating the aquarium to adjust the pH, nitrate ion, chloride ion or phosphate ion concentrations, the volume of water is needed.

Oftentimes a 15 – 20% water change is required to maintain good water quality in an aquarium. Knowing the actual volume of water is needed to know how much water needs to be removed/replaced.

2. Besides the substrate materials, what other objects are commonly found in a fish aquarium? Do you think it would be necessary to include an adjustment in the actual volume calculation to account for these objects? Why or why not.

Other objects could include the fish, decorative rocks, plants and shelter for fish. While these objects do displace water, the volume is probably not significant enough to require an adjustment.

3. How could a person determine the volume of water displaced by one of the objects identified in Question 2?

If the objects are regularly shaped, the dimensions could be measured and the volume calculated. If the objects are irregularly shaped, the volume could be measured using water displacement in a graduated cylinder or an overflow bucket.

4. Do you think that the actual volume of the rock or gravel substrate in an aquarium equals the calculated volume from Part C? Explain.

Probably not. The layer of rock or gravel has gaps that allow water into the spaces. It is not a solid layer. Also, the rock or gravel could be porous.

5. Using the general rule that 1-inch of fish requires one gallon of water, how many 4-inch fish could be placed in your classroom aquarium using the actual volume of water calculated in the lab? Show your calculations.

$$\# \text{ fish} \times 4 \text{ inches} = 60.2 \text{ gal}$$

$$\# \text{ fish} = 60.2/4 = 15 \text{ fish}$$