Aquaculture Measurements Made Easy

Grade Level:
6-12

Subject Area:
Geometry, Mathematics, Aquaculture

Time:
Preparation: 10 minutes
Activity: 45 minutes (or split into two 30 minute sessions)
Clean-up: 10 minutes

Student Performance Standards (Sunshine State Standards):
07.03 Solve time, distance, area, volume, ratio, proportion, and percentage problems in agriscience (SC.912.L.14.4; SC.912.P.12.2; SC.912.P.12.3 SC.912.P.12.4; SC.912.P.12.9; MA.912.A.1.4, 5, 8; MA.912.A.2.1; MA.912.G.3.1; MA.912.G.8.6; MA.912.S.3.2).
13.04 Calculate volume in circular, rectangular, and irregular shaped water structure (LA.910.1.6.1, 2, 3, 4, 5; MA.8.G.5.1).
15.03 Identify and describe important growing facility construction and site requirements (SC.912.L.17.16; SC.912.P.10.14, 15; MA.912.A.1.1, 2, 4, 5; MA.912.A.5.1, 4, 7; MA.912.A.10.1,2; MA.912.G.1.4; MA.912.G.2.7; MA.912.G.4.1, 4, 5; MA.912.G.6.1, 2, 4, 5; MA.912.G.8.2).

Objectives:
1. Students will be able to utilize common conversions of the metric system.
2. Students will be able to identify and use geometric formulas.
3. Students will be able to calculate stocking strategies.
4. Students will be able to calculate substance concentrations of water.

Abstract:
The metric system is a universal language used by all countries in the world except for the United States and Belize. Because of its international appeal, the scientific community has adopted the metric system as its base of measurement. Therefore it is important for students to be as fluent in the metric system as possible when dealing with science, agroscience, or environmental technology. This lesson will introduce students to the metric system. It will walk them through simple conversions used on a daily basis in both large aquaculture production facilities and the simple classroom aquarium. The first set of calculations will work on the volumes of different size and shaped tanks. The second component will have

students calculate concentrations (how much salt is needed to attain a certain salinity), and stocking densities (how many eggs can be stocked in a certain volume of water). Not only will students practice their metric conversions, but they will also understand how and why it is important for biologists to be familiar with these geometric formulas that are used every day.

Interest Approach:

Ask the students how many centimeters are in an inch, or how many feet in meters. See if they can discuss why the metric system is so important (it's a universal language). Tell them that the USA is one of only two countries in the world that does not officially "speak" in metric.

Student Materials:

1. *Aquaculture Measurements Made Easy* handout
2. Calculator
3. Ruler
4. Partner
5. Portable scale (200g or less will work)
6. Lima beans or jelly beans (at least 300)
7. 50 ml and 100 ml graduated cylinder
8. Water (50 ml)

Teacher Materials:

Material	*Store*	*Estimated Cost*
Calculators (students can supply their own)	WalMart, Target	$3 and up
Small rulers or tape measure	Office Depot, WalMart	$1 and up
Bag of lima beans or jellybeans	Local grocery store	$5 and up
Portable scale	Carolina Biological	$20 and up
50 ml/100 ml graduate cylinders	Carolina Biological	$1.50 and up
Worksheets (*Aquaculture Measurements Made Easy*)	NA	NA
The Metric System handout	NA	NA

Student Instructions:

1. Read *The Metric System* handout for homework.
2. Find your partner or group.
3. Gather your materials and supplies.
4. Using the worksheets, follow the directions to work though the calculations.

Teacher Instructions:

Preparations:

1. Assign *The Metric System* handout for a homework reading.
2. Copy worksheets for each student.
3. Divide class into partners or groups depending upon number of supplies.
4. Give a scale, 50 ml graduated cylinder, 100 mL graduated cylinder, ruler, calculator, and at least 300 beans to each group.

Activity:

1. Give the students an oral quiz on some of the most common metric conversions (e.g., feet to meters, inch to centimeter, gallons to liters) and see how they do.
2. Hand out the worksheets and supplies to each group/partner set.
3. Walk though each section step by step with the class (it can be done in two class periods if time is an issue).

Post work/Clean-up:

1. If there are any jellybeans left….let the students eat them!
2. Rinse all glassware thoroughly and dry.
3. Put scales, rulers, calculators, etc. away.

Anticipated Results:

1. Students will gain confidence in using the metric system and understand some of the most common conversions.
2. Students will know how to calculate the volume of different sized and shaped tanks using the metric system.
3. Students will know how to calculate stocking strategies using different methods (volumetric and weight).
4. Students should be able to calculate how to create specific concentrations of substances in water (e.g., how much salt to add in order to reach a given salinity).

Support Materials:

1. *The Metric System* handout

2. *Aquaculture Measurements Made Easy* handout
3. Creswell, L. 1993. Aquaculture Desk Reference. Ed. Frank Hoff. Florida Aqua Farms, Inc. Dade City, Florida, USA. 205 pp.
4. Conversion Tables. Published by Florida Aqua Farms, Inc. 1984. 21 pp.
5. Online Conversion: http://www.onlineconversion.com/

Explanation of Concepts:

Metric system

Geometry and using formulas for calculations

 **Support Materials** 

The Metric System Handout

The proper function of recirculating aquaculture systems requires knowledge of the volume of the system components and the rate at which water flows through the system. Designing a system which requires flooring, decks, stands, and other structures also requires a knowledge of the weight of the tanks and system components when filled with water and designing structures capable to support that load. These parameters can be calculated using the metric measurement system or the English system, currently used in many segments of U.S. industry.

Metric measurements are almost universally used by scientists (although some pumps and aquarium equipment still use English measurements (gallons per hour, for example). However, the simplicity and flexibility of the Metric System makes it advantageous over English units of measure.

The Metric System is a decimal system of physical units based on the meter (Greek *metron*, "measure"). Introduced and adopted by law in France in the 1790s, the meter (39.37 inches) was one-millionth of the distance of a line from the equator to the North Pole going through Paris (of course, at the time they erroneously believed the Earth was a perfect sphere). Later, it was defined as the distance between two fine lines marked on a bar of platinum-iridium alloy, in 1960 as 1,650,763.73 wavelengths of the reddish-orange light given off by a form of the element krypton, and finally in 1983, the meter was defined as the length of the path traveled by light in a vacuum during a time interval of 1/299,792,458 of a second. Since the 1960s the International System of Units ("*Système International d'Unités*" in French, hence "SI") has been the internationally recognized standard metric system.

The Metric System is a decimal system — units of measure increase or decrease by orders of 10. These units use Greek prefixes; for example, *deca* equals ten, *hecto* equals one hundred, *kilo* equals one thousand, *mega* equals one million, *giga* equals one billion, and *tera* equals one trillion. Multiples and submultiples are related to the fundamental unit by factors of powers of ten, so that one can convert by simply moving the decimal place: 1.234 meters is 1234 millimeters, 0.001234 kilometers, etc.

Another advantage of the metric system, particularly for aquaculture, is that volume and mass (weight) are related to water. For example, 1 liter (volume) =

1,000 milliters (volume) = 1,000 cubic centimeters (volume/length) and weighs 1 kilogram (or 1,000 grams). To illustrate the advantages of the metric system over the English system, consider the following calculation.

You have a tank that you are going to use to transport fish in the back of your pickup truck, and you need to know how much it will weigh when filled with water. Let's say that the tank is 3' x 3' x 3'. So how much would it weigh when filled?

3' x 3' x 3' = 27 $ft.^3$ …so… 1 $ft.^3$ = 7.48 gallons x 27 = 201.96 gallons….and…..
1 gallon weighs 8.3453 pounds….so the final weight is 201.96 x 8.3453 = 1685.41 lbs.

Now, let's calculate the same for a tank that is similar in size, say 1 meter on a side:

1 m x 1 m x 1 m = 100 cm x 100 cm x 100 cm = 1,000,000 cm^3 = 1,000,000 milliliters = 1,000 liters (1,000 milliliters in a liter) = 1,000 kilograms = 2,200 lbs (2.2 pounds = 1 kilogram)

Calculating Dosage Rate — The use of therapeutics, disinfectants, or simple additives such as salt, must be carefully introduced into aquaculture tanks and systems at a desired concentration. The difference between treating a sick fish and killing it could rely on an accurate calculation of dosage. Appendix 3 provides some examples for determining dosage rates in a variety of tank designs. Note that determination of the volume of the tank (Objective 3) is the first step in the calculation of dosage. Also, use of the metric system is far more practical than English units of measure (ounces per gallon, for example), because most concentrations are defined as parts per million (ppm) or parts per thousand (ppt — usually designated by the symbol ‰). For example, the salt concentration of seawater is 35 ‰ — so, to make seawater, you would add 35 grams of salt to 1 liter of water (1,000 grams, or milliliters = 1 kilogram, or liter). Similarly, to add a medication at a rate of 25 ppm to a 50 liter aquarium — 25 milligrams (mg) in 1 liter of water = 1 ppm (1,000 grams in a liter, 1,000 milligrams in a gram = 1,000,000 mg in a liter). Therefore, 25 mg/liter of treatment x 50 liters = 1,250 mg or 1.25 grams.

Calculating Stocking Density — It is important for a culturist to know how many organisms he has to accurately stock culture systems. Correctly stocked systems can maximize productivity and profit. Too often, a culturist will overstock ponds or tanks in an effort to maximize productivity. Overstocked systems can lead to reduced growth, high incidence of disease, and high predation; understocked systems increase production costs and sometimes lead to overfeeding.

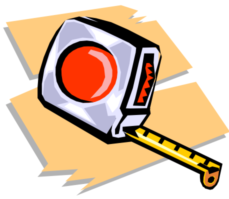
Since the culturist cannot reasonably count the number of animals to stock into a tank or pond, he must rely on estimating the population using a sub-sample. Appendix 3 provides some good examples of this method. Notice that a sub-sample can be measured volumetrically, usually by measuring water displacement, or by weight.

For example, you are going to stock seed clams into growout bags at a density of 5,000 clams/bag. Since you can't reasonably count that many seed, 1) count out 50 clam seed (each about the size of a dime), 2) place 100 ml of water into a 250 ml graduated cylinder, 3) add the clams to the water and read the new water level (amount of displacement)…let's say it is now 145 ml…therefore, 50 clam seed had a volume of 45 ml, 4) calculate the volume to achieve 5,000 clams.

Using a proportion: 45/50 = X/5,000 or 50X = 45 x 5,000 or 50 X = 225,000 or X = 4,500 ml or 4.5 liters.

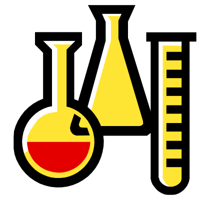
This calculation could also be accomplished using weight of clams measured with an electronic balance.

Name:______________________



AQUACULTURE

Measurement Made Easy



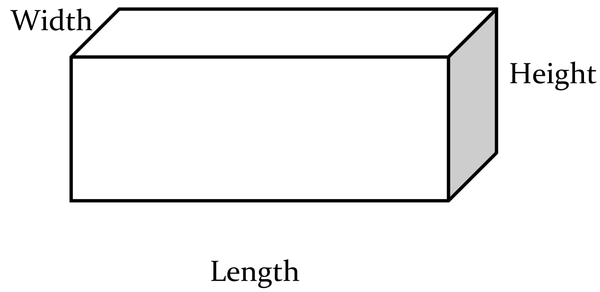
Part I. Volume

In aquaculture, it is necessary to be able to calculate the volume of water in all culture facilities whether it is a pond, raceway, tank, or transport unit. Estimating the volume of tanks accurately is essential to stocking organisms, feeding, managing water quality, and adding chemical treatments. Aquaculturists must be able to convert between English and metric units. In this laboratory activity, you will estimate the volume of three containers used in the culture of fish.

Here are the conversion factors you might find useful:

To Convert From:	Into:	Multiply by:
Inches	Centimeters	2.54
Feet	Meters	0.305
Cubic Inches	Gallons	0.0043
Cubic Inches	Liters	0.0164
Cubic Feet	Cubic Meters	0.0283
Cubic Feet	Liters	28.316
Gallons	Liters	3.785
Liters	Gallons	0.2642
Cubic Centimeters	Liters	0.001

A. Rectangular Tank



Volume = Length x Width x Height

Measure the rectangular tank:

Length ______________ Width ______________ Height ______________

Using the table above convert inches to centimeters:

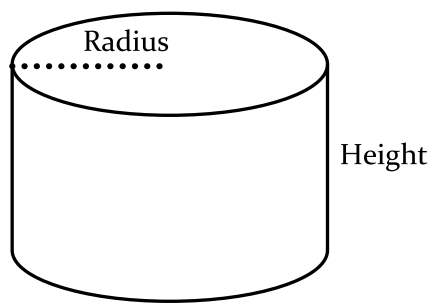
Length ______________ Width ______________ Height ______________

Calculate the volume of the tank: ________________ cm^3

Convert the volume from cm^3 to liters:

B. Circular Tank (Cylinder)

Volume = π x Radius^2 x Height



Measure the circular tank:

Diameter ______________ Radius ______________ Height ______________

Using the table above convert inches to centimeters:

Radius ______________ Height ______________

Calculate the volume of the tank: ________________ cm^3

Convert the volume from cm^3 to liters:

C. Large Circular Tank (12 ft diameter, 6 ft height)

Convert to Metric:

Diameter ______________ Radius ______________ Height ______________

Calculate the volume of the tank in liters:

Part II. Calculating Concentrations and Stocking Density

A. Just Add Salt

Now that you have a tank, you need to make saltwater to culture your fish. How much salt would be needed to fill the tanks with 30 parts per thousand (ppt) saltwater?

Hint: 1 ppt = 1 gram/liter *In other words:* 30 ppt = 30 grams/liter

Since you know the volume in liters for each of the tanks, how much salt will be needed to fill the tanks with 30 ppt saltwater? Report units in grams and kilograms.

A. Rectangular tank (10 ft length, 2 ft width, 20 inches height):

B. Small circular tank (4 ft diameter, 3 ft height):

C. Large circular tank (12 ft diameter, 6 ft height):

D. Salt is sold in 50-lb bags. How many would be needed to make saltwater for the large circular tank?

Here are the conversion factors you might find useful:

To Convert From:	Into:	Multiply by:
Grams	Kilograms	0.001
Kilograms	Pounds	2.205
Grams	Pounds	0.0022

How much salt would be needed (lbs)?

How many bags would be needed?

B. Stocking Density

It is important for a culturist to know how many organisms he has to accurately stock culture systems. Correctly stocked systems can maximize productivity and profit. Too often, a culturist will overstock ponds or tanks in an effort to maximize productivity. Overstocked systems can lead to reduced growth, high incidence of disease, and high predation. In this laboratory exercise, students will estimate the number of eggs to be stocked into a recirculating aquaculture system. We will use beans to represent fish eggs and will estimate stocking densities by volumetric and weight measurements.

Desired Stocking Density: 20,000 eggs

Weight Measurements:

1. Count three sets of 100 eggs.
2. Weigh each set of eggs.

A. _______________ B. _______________ C. _______________

3. Determine the average weight of the three sets.

Average = (A + B + C) / 3

4. Determine the average weight of a single egg.

   Weight of single egg = Average / 100

5. What is the weight of eggs needed to stock the tanks with 20,000 eggs?

Volumetric Measurements:

1. Count three sets of 100 eggs (beans).
2. Place 50 ml of water into a 100-ml graduated cylinder.
3. Add the first set of 100 eggs (beans) to the cylinder. Read and record water level.

   Water level: (a)______________

4. Remove the eggs and repeat for the other two sets of 100 eggs. Replace water if necessary.

   Water level: (b) ______________ (c) ______________

5. Determine the average water displacement for the three sets.

   Water Displacement = Volume of water with eggs – 50 ml

   (a) ______________ (b) ______________ (c) ______________

   Average = (a + b + c) / 3

6. How much water was displaced by 100 eggs?

7. How much water would be displaced by a single egg?

8. How much water would be displaced by 20,000 eggs?