Splash of Math
4-8 Teacher's Guide

PART OF THE
SEAWORLD EDUCATION SERIES

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Based on a long-term commitment to education and conservation, SeaWorld and Busch Gardens strive to provide an enthusiastic, imaginative, and intellectually stimulating atmosphere to help students and guests develop a lifelong appreciation, understanding, and stewardship for our environment. Specifically, our goals are ...

- To instill in students and guests of all ages an appreciation for science and a respect for all living creatures and habitats.
- To conserve our valuable natural resources by increasing awareness of the interrelationships of humans and the environment.
- To increase students' and guests' basic competencies in science, math, and other disciplines.
- To be an educational resource to the world.

Want more information?

Visit the SeaWorld/Busch Gardens Animal Information Database at *www.seaworld.org* or *www.buschgardens.org*. Still have questions? Email us at *shamu@seaworld.org* or call **1-800-23-SHAMU** (1-800-237-4268). TDD users call **1-800-TD-SHAMU** (1-800-837-4268). Emails and phones are answered by SeaWorld Educators.

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Splash of Math

4–8 Teacher's Guide

A SEAWORLD PUBLICATION

CONTENTS

To the Teacher

The ***Splash of Math*** Teacher's Guide for grades 4–8 was developed at SeaWorld with input from the San Diego County Office of Education. Our goal is to help you teach your students—in an active, hands-on way—about how mathematical skills relate to real-life situations, specifically marinelife studies and marine zoological park careers. This curriculum supports national standards for mathematics education.

The brief background information in this Guide was written for you, the teacher. It will help you do these activities with your students. As you use this Teacher's Guide, keep in mind that some problems may be solved in more than one way. Answers and problem-solving methods are included for most activities, but in some cases you or your students may find another way to solve a problem—or even other answers that are correct. Also keep your own students' development and experiences in mind. Many of these activities can be customized to fit your classroom and the readiness of your students.

SeaWorld strives to provide teachers with up-to-date information and activities that motivate students to conserve wildlife, the oceans, and the natural world.

Goal of the Splash of Math Unit

Students build skills toward becoming mathematical problem solvers.

Objectives

After completing the SeaWorld 4–8 Splash of Math Unit, the student will be able to...

1. Break complex real-life problems into simpler parts.
2. Clearly communicate mathematical concepts visually and orally.
3. Construct scale drawings and/or models.
4. Make decisions about how to approach problems and use math skills, concepts, and strategies to find solutions.
5. Interpret and analyze numerical data, draw conclusions, and make predictions based on the data.
6. Use formulas to solve problems.
7. Create visual representations of data in the form of graphs.

Vocabulary

data — factual information that can be used as a basis for calculations, reasoning, or decisions.

decimal system — a measurement system in which the basic units increase by powers of ten.

English system — a system of weights and measures, used in the United States, that uses feet, pounds, and gallons.

glucose — a simple sugar that occurs widely in nature.

gram — in the metric system, the basic unit of mass (weight).

kilocalorie — the amount of energy (heat) required to raise the temperature of one kilogram of water one degree Celsius.

liter — in the metric system, the basic unit of capacity.

metric system — a system of weights and measures, used throughout most of the world, that uses meters, grams, and liters.

meter — in the metric system, the basic unit of length.

sounding — a process of determining ocean depth. Sound travels from a transmitter to the ocean bottom, bounces back, and is picked up by a receiver. Using the time from transmission to reception, calculations yield distance.

SeaWorld bird keepers weigh a penguin chick before and after feeding it. Then they calculate and record exactly how much the chick ate.

A Splash of Math

Math is a part of our world.

We encounter and use math every day. When we buy groceries, check the mileage on our car, or cook using a recipe, we are using math. When we lay brick for a patio, we use math. When we rearrange the furniture in our house, we use math. In fact, when faced with a problem, we often use math to help us approach and solve the problem.

We use math at SeaWorld.

A laboratory technologist analyzing whale blood uses math to help estimate red blood cell count. A business analyst uses math to forecast daily attendance for next year. A food service manager uses math to determine food prices. An animal care specialist uses math to chart a dolphin calf's growth. A water quality expert uses math to determine the amount of chlorine to add to the water in Shamu Stadium. An education department receptionist uses math to schedule school groups for field trips. Exhibit designers use math to help them design and build a new whale pool.

Math is simply part of our daily work. A clear understanding of math concepts and experience using math skills are important to do almost every job at SeaWorld.

Students must become mathematical problem solvers.

The idea that math is for people with special talents is a myth, as is the idea that some people "can't do math." In our society, everyone needs a useful knowledge of mathematics. A working knowledge of math prepares us not just for science and technical careers, but for a lifetime of analytical problem-solving.

A SeaWorld animal care specialist bottle-feeds rescued sea lion pups. Stranded animals are often dehydrated, and their weights are below normal. Weighing them regularly helps to assess their recovery.

Students must be able to solve problems on a daily basis and to apply mathematics to the real world.

Math skills help us solve routine problems readily. They also help us find ways to reach a solution when no routine path is obvious. Math skills help us to communicate logically and precisely about relationships, quantities, processes, and cause and effect. Math skills also help us gather information, analyze evidence, and make connections among ideas and between mathematics and other disciplines.

Measurement Systems

Monitoring weight is an important part of assessing an animal's health. SeaWorld animal trainers weigh Shamu regularly. The slide-out platform is a scale.

We use the English system.

Most people in the United States are most familiar with the *English system* of weights and measures. We most often use units of pounds and ounces, gallons and quarts, and feet and inches.

Scientists use the metric system.

Throughout the rest of the world and for scientists everywhere, the *metric system* is most widely used. The metric system is based on units of kilograms and *grams, liters* and milliliters, and *meters* and millimeters. The metric system is called a *decimal system* because the basic units increase by powers of ten.

Each animal at SeaWorld is prescribed a specific amount of vitamins and minerals, based on the animal's weight. Doses are measured in milligrams.

At SeaWorld, we use both the metric system and the English system.

Because the metric system is used by scientists, we use the metric system in this Teacher's Guide. For example, we use metric units to describe ocean depth and sizes of animals.

Because the English system is used by engineers, merchants, and others, we also use the English system in this Guide. We use English units to describe pool capacity, building heights, food amounts, and other measures.

Some of the activities in this Teacher's Guide require students to convert metric to English measures or vice versa. We believe these kinds of problems are common in the real world. The table on the next page shows the most commonly used English and metric measures and their relationships to each other.

Metric System

LENGTH

unit	*abbreviation*	*equal to...*	*English equivalent*
meter	m	(basic unit of length)	39.37 inches
kilometer	km	1,000 meters	0.62 mile
centimeter	cm	.01 meters	0.39 inch
millimeter	mm	0.001 meters	0.039 inch

MASS (WEIGHT)

unit	*abbreviation*	*equal to...*	*English equivalent*
gram	g	(basic unit of weight)	0.035 ounce
kilogram	kg	1,000 grams	2.2046 pounds
milligram	mg	0.001 grams	0.015 grain

CAPACITY

unit	*abbreviation*	*equal to...*	*English equivalent*
liter	l	(basic unit of capacity)	1.057 quarts (liquid) or 0.908 quarts (dry)
milliliter	ml	0.001 liter	0.27 fluid dram

English System

LENGTH

unit	*abbreviation*	*equal to...*	*metric equivalent*
mile	mi.	5,280 feet	1.609 kilometers
foot	ft.	12 inches	30.48 centimeters
inch	in.	0.083 foot	2.54 centimeters

MASS (WEIGHT)

unit	*abbreviation*	*equal to...*	*metric equivalent*
ton	ton	2,000 pounds	0.907 metric ton
pound	lb.	16 ounces	0.454 kilogram
ounce	oz.	437.5 grains	28.350 grams

CAPACITY

unit	*abbreviation*	*equal to...*	*metric equivalent*
gallon	gal.	4 quarts	3.785 liters
quart	qt.	2 pints	0.946 liter
pint	pt.	16 fluid ounces	473.176 milliliters
fluid ounce	fl. oz.	8 fluid drams	29.573 milliliters

SeaWorld Water Systems

OBJECTIVES

Students decide how to solve a complex problem, breaking it down into simpler parts. They practice communicating mathematical ideas.

MATERIALS

- ❑ overhead transparency of sea water table (below, enlarge 200%)
- ❑ copies of ***SeaWorld Water Systems*** funsheet on page 8
- ❑ pencil and paper
- ❑ calculators

"I remember thinking, 'I'll never use math.' Boy was I wrong! Calculators help, but you have to understand what you want to know and which numbers to use to find the answer."

Michael Tucker, Manager of Water Quality at SeaWorld San Diego, uses math to do his job.

BACKGROUND

Marine animals require clean water to stay healthy. At SeaWorld, the water is constantly filtered to remove animal wastes and harmful materials. The SeaWorld Water Quality department monitors the water in SeaWorld animal habitats several times a day. Technicians test the water for temperature, turbidity (water clarity), salinity (salt concentration), bacteria, pH (acidity), and chlorine. (A minimal amount of chlorine is added to the water in some mammal exhibits to destroy harmful bacteria.)

At SeaWorld San Diego, natural sea water comes from Mission Bay. It is filtered several times; it can then be heated or chilled for various animal habitats. At SeaWorld parks in Orlando and San Antonio, sea water is manufactured by adding salts to fresh water.

Throughout the world, ocean water is relatively constant in regard to the major salt constituents. The constituents listed at right comprise more than 99% of sea salt. Other elements add up to less than 1%.

In this activity, students assume the role of new employees in the Water Quality department. Once they are able to answer the following questions correctly, they will be allowed to scuba dive in the pools to do any necessary repair work.

SEA WATER CONSTITUENTS	
chloride	55.1%
sodium	30.4%
sulfate	7.7%
magnesium	3.8%
calcium	1.2%
potassium	1.1%
other elements	<1.0%

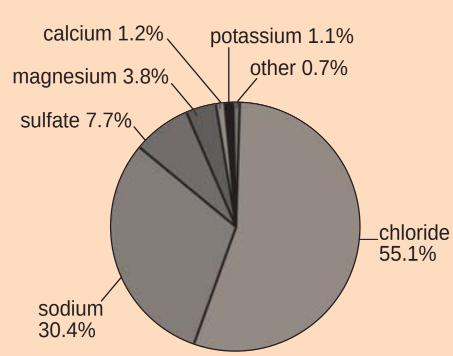
ACTION

1. Distribute a copy of the ***SeaWorld Water Systems*** funsheet to each student and ask students to work through the real-life problems. *(For problem #5, display the "SEA WATER CONSTITUENTS" overhead transparency.)*
2. Once their work is complete, ask students to describe their problem-solving logic and methods. Did all students do each problem the same way?

Water filters at Shamu Stadium run continuously to keep the water clean.

ANSWERS

1. 5,000,000 gallons ÷ 27,000 gallons per minute = 185.2 minutes
   185.2 minutes ÷ 60 minutes per hour = 3.1 hours
2. A filtration system that cycles 80 gallons per minute would take:
   5,000,000 gallons ÷ 80 gallons per minute = 62,500 minutes
   62,500 minutes ÷ 60 minutes per hour = 1,041.7 hours
   The filtration system at Shamu stadium has to be much faster to filter 5 million gallons of water.
3. Penguin Encounter: chill the water year-round to lower the temperature
   Shark Encounter: heat the water year-round to raise the temperature
   Dolphin Bay: monitor the temperature year-round, heat in winter and chill in summer to meet temperature requirements
   Shamu Stadium: monitor the water temperature year-round, chill most of the time
4. No, the Shark Encounter holds 15.96 billion drops of water. You would need 15.96 drops of blood for the sharks to be able to detect it. (280,000 gallons x 3.8 liters per gallon x 1,000 milliliters per liter x 15 drops per milliliter = 15.96 billion drops)
5. Composition of sea water: see graph at right.



Name ______________________________

SeaWorld Water Systems

1. Shamu Stadium contains more than five million gallons of filtered sea water. If the water is filtered at a rate of 27,000 gallons per minute, how long will it take for the water to completely turn over?

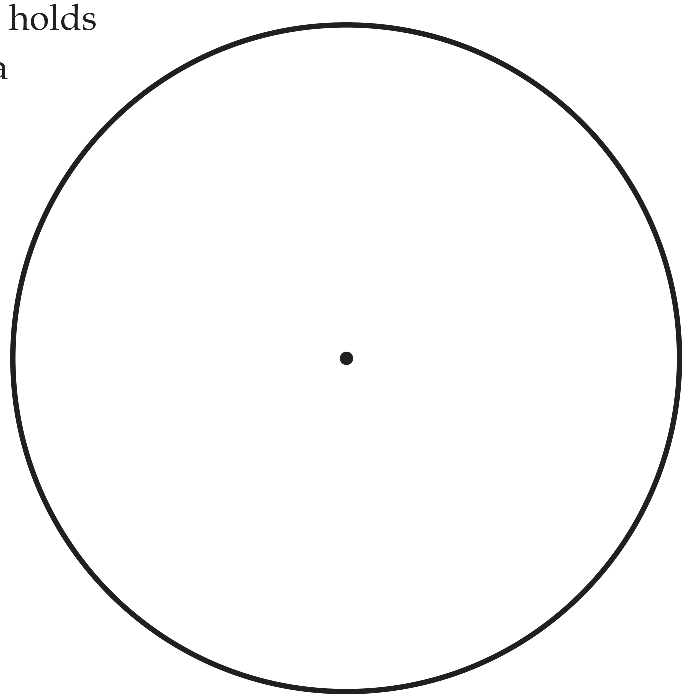
2. An average home swimming pool cycles 80 gallons per minute. Compare this to the filter cycle at Shamu Stadium. Why do you think the system at Shamu Stadium has to be so much faster?

3. The sea water used in SeaWorld San Diego animal habitats comes from Mission Bay. It is filtered several times; it can then be heated or chilled for various animal exhibits. Mission Bay water temperatures can range from about 55°F to 70°F, depending on the season and ocean conditions. Describe in numbers and words what you will need to do to maintain water temperature at the desired ranges for the following exhibits.

Penguin Encounter	42–45° F
Shark Encounter	76° F
Dolphin Bay	63–67° F
Shamu Stadium	52–55° F

4. Sharks are able to detect certain amino acids (such as those found in blood proteins) in concentrations as low as one part per billion. The Shark Encounter holds 280,000 gallons of water. Could a shark smell a drop of blood in this aquarium? (Hint: Determine how many drops are in a gallon. Fifteen drops of water equal 1 ml.)

5. Make a pie chart in the space here illustrating the compositionof salt in sea water. Use a percentage for each constituent of sea salt.



SeaWorld Snack Shop

OBJECTIVES

Students gain experience using *data* to make predictions. They practice clearly communicating their findings.

MATERIALS

- ❑ copies of the ***Food Services Planning Worksheet*** on page 11 and the ***Food Services Data Sheet*** at the bottom of this page (one of each per student or per cooperative learning group)
- ❑ calculator
- ❑ pencil and paper

The SeaWorld culinary operations team uses data such as attendance records and past sales to make sure that employees are prepared to serve park guests.

ANSWERS

1. Assuming that park guests eat proportionately the same kinds of food that they ate last year, you should expect to sell 13% more food this year because attendance is projected to be up by about 13% (170,000 ÷ 150,129 = 1.13). Another assumption is that you will sell the same amount of food every day of the week, although some students may (correctly) guess that more people visit SeaWorld on weekends than on weekdays. Given these two assumptions, you should expect to sell the following:

cheeseburgers	[(2,914 + 45) ÷ 7] x 1.13	= 478
hamburgers	[(2,268 + 34) ÷ 7] x 1.13	= 372
chicken sandwiches	[(1,956 + 47) ÷ 7] x 1.13	= 324
cheese sandwiches	(18 ÷ 7) x 1.13	= 3
french fry orders	[(2,914 + 2,268 + 1,956 + 18) ÷ 7] x 1.13	= 1,156

2. Total ounces of soda projected to be sold Saturday:

[(382 x 12) + (544 x 20) + (290 x 30) + (116 x 36) + (63 x 36)] x 1.13 = 34,588 ounces

small sodas:	382 x 1.13	= 432
regular size sodas:	544 x 1.13	= 615
large sodas:	290 x 1.13	= 328
sports bottles:	116 x 1.13	= 132
sports bottle refills:	63 x 1.13	= 72
milk:	55 x 1.13	= 63
hot cocoa:	70 x 1.13	= 80

3. Students prepare oral reports showing the most popular beverages sold during the week of July 10, last year. Visual aids should include some type of graph (bar, pie, etc.). Students may suggest a variety of reasons for fluctuating sales of sodas and cocoa, including park attendance, average length of park stay, and weather. Students may propose a variety of ways to increase milk sales.

4. Students' sales predictions should reflect that sales of a new food item will result in fewer sales of existing food items.

ACTION

1. For this activity, students take on the role of SeaWorld Food Services Managers. Their responsibility is to plan meals for the expected number of park guests.
2. Distribute ***Food Services Planning Worksheet*** and ***Food Services Data Sheet*** to each student or to each cooperative learning group.
3. To answer the questions on the ***Food Service Worksheet,*** students use the data on the ***Food Services Data Sheet*** and make estimations. They should show the math they use to arrive at a solution and should be prepared to explain to their boss their reasoning and why they think their solution will work.

Food Services Data Sheet

LAST YEAR:	week of July 10	actual weekly attendance:	150,129
THIS YEAR:	week of July 10	projected weekly attendance:	170,000

LAST YEAR'S LUNCH SALES:

Cheeseburger Combo*	2,914	Cheeseburger a la carte	45
Hamburger Combo*	2,268	Hamburger a la carte	34
Chicken Sandwich Combo*	1,956	Chicken Sandwich a la carte	47
Cheese Sandwich Combo*	18		

** combos include french fries*

LAST YEAR'S BEVERAGE SALES:

item	*M*	*T*	*W*	*Th*	*F*	*Sa*	*Su*
small soda *(12 oz.)*	274	188	268	193	296	382	167
regular soda *(20 oz.)*	289	253	271	292	291	544	288
large soda *(30 oz.)*	153	196	161	183	185	290	253
Sports Bottle *(36 oz.)*	69	71	96	71	82	116	63
Sports Bottle refill	33	65	85	86	59	63	64
milk	16	51	50	23	37	55	32
hot cocoa	46	16	22	22	40	70	9

Name ______________________________

Food Services Planning Worksheet

1. Predict how many of each type of sandwich and how many orders of french fries you should be prepared to sell Wednesday of the week of July 10 this year. (Round up to the nearest whole food item.) What assumptions are you making? What (if any) of your assumptions do you suspect may be incorrect?

2. How many ounces of soda do you expect to sell Saturday? Estimate the number of beverages by size and type that you think will be sold. Round up to the nearest whole number.

3. Prepare an oral report to your boss ranking the most popular beverage types sold and which days of the week beverage sales are highest. Create visual aids, and be sure to include graphs. List several reasons why hot cocoa and soda sales might fluctuate daily. Are there factors besides park attendance that influence these sales? Propose an idea for increasing milk sales.

4. Write a memo to your boss suggesting offering another food item that is not on this list. What are your sales predictions, and how will these sales affect the meal projections you’ve already made (in number 1)?

Baby Whale Formula

OBJECTIVES

Students gain practice measuring and making calculations.

BACKGROUND

On January 11, 1997, an orphaned gray whale calf stranded on a beach near Los Angeles, California. The SeaWorld Animal Rescue and Rehabilitation Team began preparations to treat the newborn gray whale, who came to be known as J.J.

Park veterinarians immediately administered fluids, glucose, and antibiotics. A whale milk substitute was developed by park marine mammal experts. At first, J.J. was fed every three hours, around the clock. While one group of animal care specialists created the formula critical for the calf's nutritional needs, another group donned wet suits and climbed into the pool with the whale.

At first, J.J. was fed about 6 liters of formula every three hours. Over time, her food intake increased. Before she was weaned, J.J.'s daily food intake consisted of six 20-liter feedings.

About 14 months after her arrival, a healthy J.J.—by then 8,700 kilograms and 9.4 meters long—was released into the Pacific Ocean off San Diego.

In this activity, students measure ingredients to create a mock whale formula. Substitute bananas for the herring, dry milk for the Zoologic® powder, chocolate drink powder for the dicalcium phosphate, and cinnamon for the lecithin.

MATERIALS

- ❑ bananas
- ❑ nonfat dry milk
- ❑ milk or heavy whipping cream
- ❑ sugar
- ❑ table salt
- ❑ cinnamon
- ❑ chocolate drink powder
- ❑ blender
- ❑ small cups (one for each student)
- ❑ overhead transparency of "J.J.'s Formula" on page 13 (enlarge 200%)
- ❑ overhead marking pen or grease pencil
- ❑ scales for measuring in grams
- ❑ graduated cylinder for measuring in milliliters

SeaWorld animal care specialists poured formula into a funnel attached to a tube that went into J.J.'s mouth.

ACTION

1. Gather the materials for each cooperative learning group.
2. Discuss J.J.'s rescue and rehabilitation at SeaWorld with your students.
3. Display the overhead transparency of J.J.'s formula. Tell students that they will make a batch of J.J.'s formula.

J.J.'s Formula
(amounts listed per liter of formula)

230 g	ground herring (heads removed)
70 g	Zoologic® Milk Matrix Powder (artificial milk replacer powder)
50 ml	heavy whipping cream
7.5 g	glucose
4.5 g	NaCl
3.5 g	lecithin
125 mg	taurine
18.75 g	dicalcium phosphate

(Zoologic® is a product of Pet-Ag, Inc., 201 Keyes Ave., Hampshire, IL, 60140)

4. Inform students that they will be making a few substitutions in the ingredients list. For each of the following substitutions, mark the corresponding change on your overhead transparency.
   - bananas (peels removed) instead of herring (heads removed)
   - nonfat dry milk instead of Zoologic® powder
   - milk instead of heavy whipping cream (substitution optional)
   - table sugar instead of *glucose*
   - cinnamon instead of lecithin
   - chocolate drink powder instead of dicalcium phosphate
5. Your formula will be for humans, so you will omit the taurine. Taurine is an amino acid in whale milk that seems to be absent in the milk of other species. NaCl is table salt.
6. Assist students as they weigh and measure ingredients and supervise the preparation of the formula in a blender. Students sample the formula they make.
7. Within a week of J.J.'s arrival she was drinking seven 7.6-liter feedings of the formula daily. Have students calculate how many liters per day J.J. was ingesting at this point. J.J.'s formula contained 1.08 *kilocalories* per milliliter. How many kilocalories were in one liter of J.J.'s formula? How many kilocalories per day was J.J. ingesting when she first arrived?
8. Before J.J. was weaned onto solid food she was drinking six 20-liter feedings of formula daily. Have students calculate how many liters per day she was drinking at this point. How many kilocalories was she ingesting?

ANSWERS

6. 7 x 7.6 liters = 53.2 liters per day
   1.08 kilocalories per ml
   = 1,080 kilocalories per liter
   1,080 kilocalories per liter x 53.2 liters
   = 57,456 kilocalories per day
7. 6 x 20 = 120 liters per day
   1,080 kilocalories/liter x 120 liters
   = 129,600 kilocalories per day

Communicating About Numbers

OBJECTIVES

Students communicate mathematical ideas and visually represent ideas by constructing charts, graphs, and scale drawings.

MATERIALS

- ❑ ***Ocean Animals*** information cards on pages 16–18
- ❑ graph paper
- ❑ pencils

BACKGROUND

There are various ways we can communicate mathematical concepts. We can write number sentences and formulas, we can verbalize information, we can create engineering drawings, and we can visually portray information in graphs. In this activity students will explore graphing and scale drawings.

For the in-class part of this activity, students may work individually or in learning groups. The first part of the activity is a take-home, parent-participation component.

ACTION

1. Ask students to think of ways we can communicate about mathematical concepts. Discuss formulas, number sentences, graphs, engineering and architectural drawings, and other ways students suggest.
2. Ask students to go home and peruse newspapers and magazines to find information that is expressed in terms of numbers. They may encounter articles that discuss the environment, weather reports, etc. Ask students to discuss what they find with their parents and family. How were numbers used to help communicate? How did the author communicate about the numbers? Students bring to class a copy of an article they discussed with their family and report to the class.
3. Distribute a set of ***Ocean Animals*** information cards to each group of students. Choose one card to go over together, pointing out that the card gives specific numerical information including size, food intake, population, swimming speed, and diving depth. Note the units of each of the measurements.
4. Ask students to think of ways to communicate how they can compare the maximum adult sizes of each of the animals. (They should suggest a bar graph.) Ask students to create graphs that communicate the maximum adult sizes of each animal species. Remind them to define their units of measure and to label both axes.
5. Ask student to suggest ways to graph animal populations, swimming speed, and diving depth for the same animals. Have them create graphs.

6. Discuss the animals' food intake. Note that the animal information cards list food intake as a percent of body weight. Choose one animal and have the students determine the range of amount of daily food intake. Why is giving a percent of body weight a better way to communicate this information than by giving a range?
7. Have students create pie charts depicting various animals' diets at SeaWorld.
8. Next, students gain experience making scale drawings. Have each learning group choose one animal from the ***Ocean Animals*** information cards and trace it onto graph paper. They will use their tracing to create an enlarged drawing in proportion to the size of the original. First, each group decides whether their new drawing will reflect a proportion of 2:1, 3:1, or 4:1. Help them plot key points on their graph paper and create their drawings. Ask students how they would plan to construct a life-size scale drawing of their animal.

ANSWERS

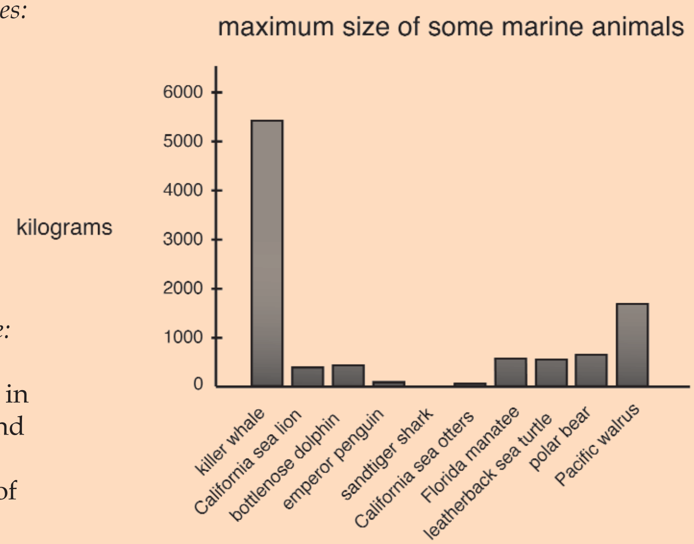
4. *Communicating maximum adult sizes:* Students may create various bar graphs. The top graph here is one example.
5. For animal populations, swimming speed, and diving depth, students may suggest and create various types of bar graphs.
6. *Determining the range of food intake:* Using a Florida manatee as an example, Florida manatees range in size from 363 to 544 kilograms, and they eat 4% to 9% of their body weight per day. On the low side of the range, we can calculate:

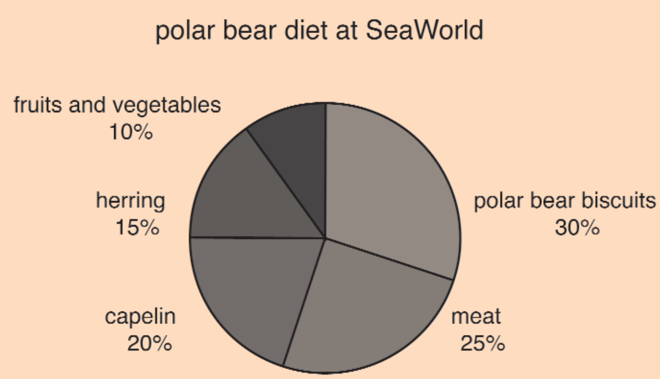
   363 kilograms x 0.04
   = 14.5 kilograms of food per day

   On the high side of the range we can calculate:

   544 kilograms x 0.09
   = 49.0 kilograms of food per day

   Percent food intake is a more accurate picture of how much an individual animal eats, given that the adult size of animals varies. Larger animals of the same species generally eat more than small animals.
7. Students create pie charts such as the graph at right.





Ocean Animals

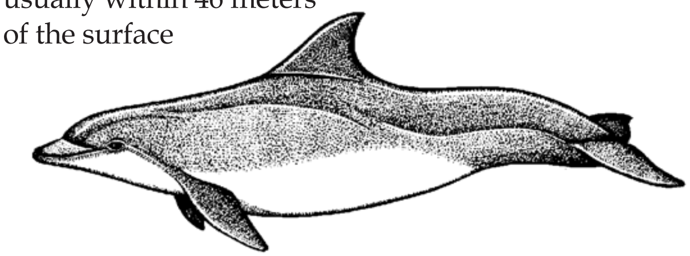
When we describe ocean animals we often use numbers; numbers describe how big an animal is, how fast it swims, or how much it eats. Numbers can also describe an animal's population or life span. These cards use numbers to describe several ocean animals.

Some of the activities in this Teacher's Guide require the use of the information in these cards. Here are some other ideas for ways to use these cards in your classroom:

- Use the facts on the cards to help you prepare lessons and lead discussions in class.
- Copy and cut apart the cards. Distribute a different card to each cooperative learning group or to each student. Visit the school library to learn more about the animals.
- Encourage students to use the information on these cards to develop their own story problems to share with their classmates.

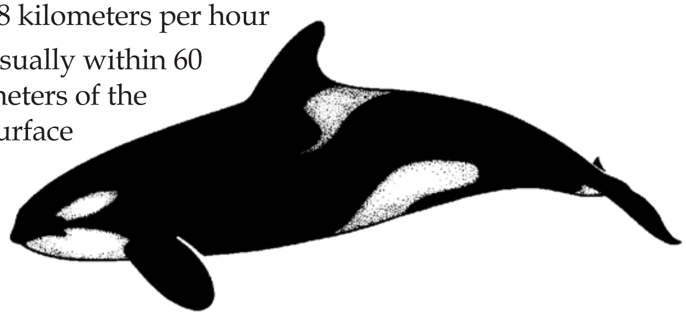
bottlenose dolphin
Tursiops truncatus

adult size:	2.5 to 3.7 meters and 190 to 454 kilograms, females slightly smaller than males
food intake:	4% to 6% of body weight per day
typical diet at SeaWorld:	60% smelt, 20% herring, 15% squid, 5% mackerel
typical life span:	20 to 30 years
population:	unknown, not endangered
swimming speed:	usually 5 to 11 kilometers per hour, as fast as 35 kilometers per hour
diving depth:	usually within 46 meters of the surface



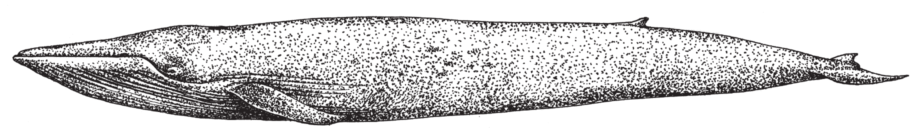
killer whale
Orcinus orca

adult size:	males 5.8 to 6.7 meters and 3,628 to 5,442 kilograms, females 4.9 to 5.8 meters and 1,361 to 3,628 kilograms
food intake:	about 3% to 4% of body weight per day
typical diet at SeaWorld:	50% herring, 30% smelt, 10% squid, 10% mackerel
typical life span:	probably 25 to 35 years
population:	unknown, not endangered
swimming speed:	usually 3 to 10 kilometers per hour, but as fast as 48 kilometers per hour
diving depth:	usually within 60 meters of the surface



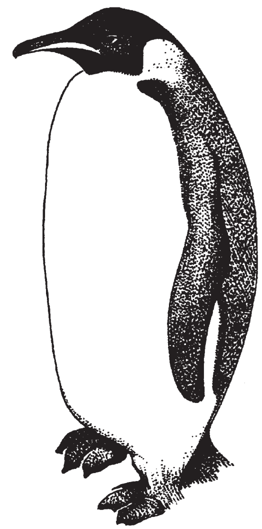
blue whale
Balaenoptera musculus

adult size:	about 21 meters and 64,000 kilograms
food intake:	about 4% of body weight per day during a feeding season that lasts about 120 days
typical life span:	possibly 30 to 90 years
population:	about 11,000
swimming speed:	to 18 to 22 kilometers per hour
diving depth:	unknown



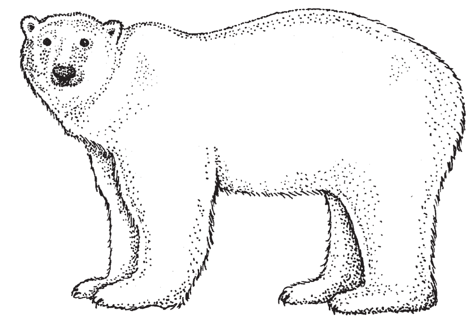
emperor penguin
Aptenodytes forsteri

adult size:	about 1.1 meter and 27 to 41 kilograms
food intake:	on average, about 4% of body weight per day
typical diet at SeaWorld:	80% herring, 20% capelin
typical life span:	about 15 to 20 years
population:	about 436,200 mature adults
swimming speed:	usually 10 kilometers per hour or less
diving depth:	mostly within 21 meters of the surface, as deep as 534 meters



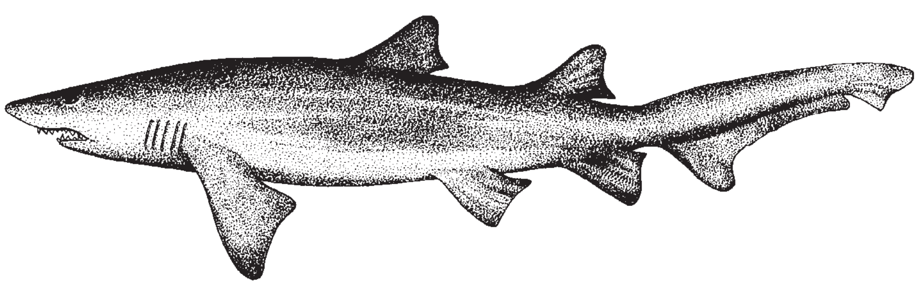
polar bear
Ursus maritimus

adult size:	males 2.5 to 3 meters and 350 to 650 kilograms, females 2.0 to 2.5 meters and 150 to 250 kilograms
food intake:	about 2% of body weight per day
typical diet at SeaWorld:	30% polar bear biscuits, 25% meat, 20% capelin, 15% herring, 10% fruits and vegetables
typical life span:	probably 15 to 30 years
population:	21,000 to 28,000
swimming speed:	as fast as 10 kilometers per hour, usually slower
diving depth:	usually within 4.5 meters of the surface



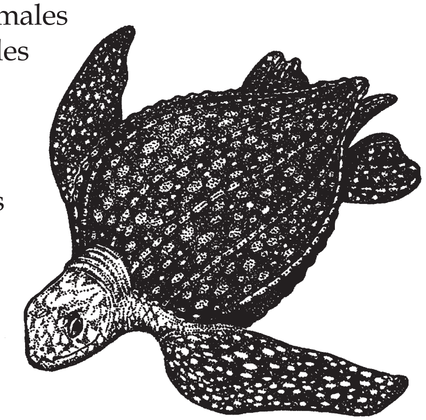
sandtiger shark
Carcharias taurus

adult size:	2.2 to 3.2 meters and about 140 kilograms
food intake:	1% to 10% of body weight per week
typical diet at SeaWorld:	50% blue runner, 40% mackerel, 10% squid
typical life span:	unknown
population:	unknown
swimming speed:	unknown
average depth:	to 191 meters



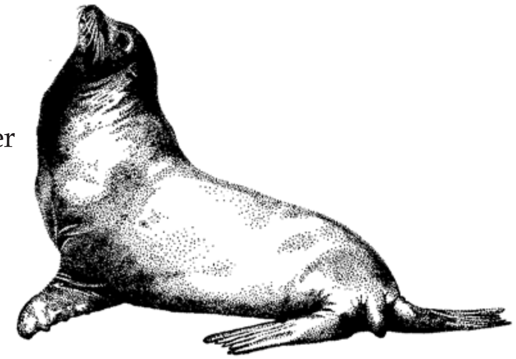
leatherback sea turtle
Dermochelys coriacea

adult size:	1.2 to 1.9 meters and 200 to 506 kilograms (the largest of the sea turtles)
food intake:	unknown
typical life span:	possibly to 80 years
population:	less than 115,000 females (Only mature females are counted, when they come ashore to lay eggs.)
swimming speed:	1.5 to 9.3 kilometers per hour
diving depth:	305 meters in routine dives, as deep as 1,190 meters



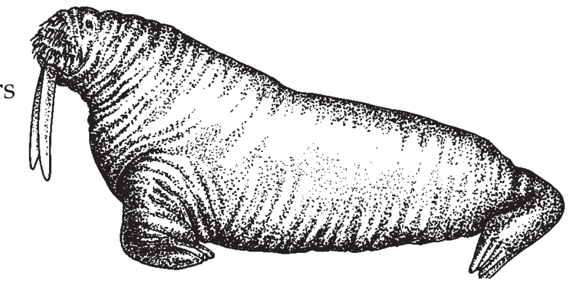
California sea lion
Zalophus californianus

adult size:	males 2.25 meters and 200 to 400 kilograms, females 1.5 to 2 meters and 50 to 110 kilograms
food intake:	about 5% to 8% of body weight per day
typical diet at SeaWorld:	40% herring, 20% mackerel, 20% smelt, 20% squid
typical life span:	15 to 25 years
population:	about 200,000
swimming speed:	as fast as 19 kilometers per hour, usually slower
diving depth:	usually within 74 meters of the surface



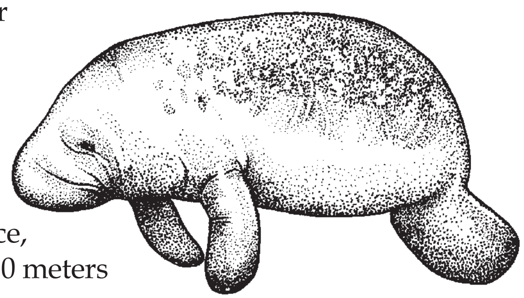
Pacific walrus
Odobenus rosmarus divergens

adult size:	males 2.7 to 3.6 meters and 800 to 1,700 kilograms, females 2.3 to 3.1 meters and 400 to 1,250 kilograms
food intake:	4% to 6% of body weight per day
typical diet at SeaWorld:	45% herring, 15% clams, 15% capelin, 10% mackerel, 10% sardines, 5% squid
typical life span:	about 16 to 30 years
population:	about 200,000
swimming speed:	usually about 7 kilometers per hour, as fast as 35 kilometers per hour in short bursts
diving depth:	usually within 80 meters of the surface



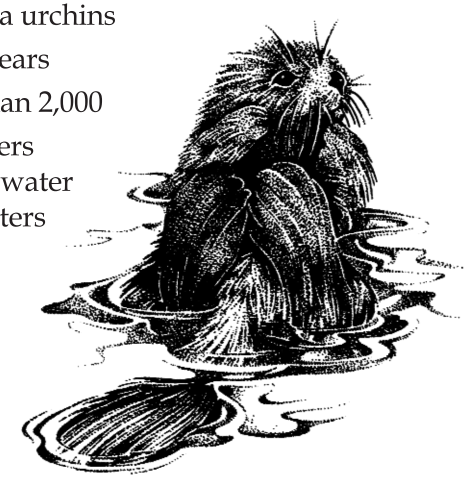
Florida manatee
Trichechus manatus latirostris

adult size:	about 3 meters and 363 to 544 kilograms (Females are usually larger than males.)
food intake:	4% to 9% of body weight per day
typical diet at SeaWorld:	61% romaine lettuce, 21% other types of lettuce, 10% spinach, 7% cabbage, 1% carrots and apples
typical life span:	probably 50 to 60 years
population:	probably less than 3,000
swimming speed:	usually 3 to 10 kilometers per hour, as fast as 24 kilometer per hour in short bursts
diving depth:	usually within 3 meters of the surface, as deep as 10 meters



California sea otter
Enhydra lutris nereis

adult size:	males about 1.5 meters and 29 kilograms, females about 1.2 meters and 20 kilograms
food intake:	20% to 30% of body weight per day
typical diet at SeaWorld:	55% clams, 30% shrimp, 10% crab, 5% sea urchins
typical life span:	about 15 to 20 years
population:	probably less than 2,000
swimming speed:	about 9 kilometers per hour under water and 12.5 kilometers per hour at the surface
diving depth:	usually within about 20 meters of the surface



Mapping the Ocean

OBJECTIVES

Students will use a formula to solve a problem. They will use a two-dimensional coordinate grid to represent data points and to graph a simple figure that communicates the concept of ocean depth.

MATERIALS

- ❑ copies of ***Mapping the Ocean*** data sheet on page 20 and ***Mapping the Ocean*** funsheet on page 21
- ❑ pencil and paper
- ❑ calculators

BACKGROUND

The ocean floor can be mapped by *sounding:* sound is sent from a ship's transmitter to the ocean bottom at an angle. The sound bounces back to the ship at the same angle and is picked up by a receiver. The speed of sound in sea water is about 1,507 meters per second. By using this information and applying a formula, ocean depth can be measured and mapped. In this activity your students will use data to map a section of the ocean floor.

ACTION

1. Describe the process of how the ocean floor can be mapped using sounding. Write the formula for measuring ocean depth on the board.
2. Distribute ***Mapping the Ocean*** data sheet and funsheet to each student. Explain that they are looking at data that was gathered from a ship that was moving straight out from shore. Every 10 km the ship stopped to collect sounding data.
3. Students use the sounding formula and the time information given to determine the depth of the ocean at each data point. They record these depths on the data sheet. *(Suggestion: ask students to round their calculations to the nearest 100 meters.)*
4. Next, students map the ocean floor on the ***Mapping the Ocean*** funsheet. They locate the distance from shore across the x axis, then plot the correct depth *(rounded to the nearest 100 meters)* on the y axis.

ANSWERS

distance	time	depth (m)	depth (km)
10	0.13	100	0.1
20	0.27	200	0.2
30	0.53	400	0.4
40	2.65	2,000	2.0
50	2.65	2,000	2.0
60	2.92	2,200	2.2
70	4.25	3,200	3.2
80	4.25	3,200	3.2
90	2.65	2,000	2.0
100	1.86	1,400	1.4
110	1.33	1,000	1.0
120	3.98	3,000	3.0
130	4.51	3,400	3.4
140	6.10	4,600	4.6
150	6.90	5,200	5.2
160	8.49	6,400	6.4
170	14.60	11,000	11.0
180	6.64	5,000	5.0
190	7.96	6,000	6.0
200	7.43	5,600	5.6

Name ____________________

Mapping the Ocean
data sheet

FORMULA FOR MEASURING OCEAN DEPTH

$$D = V \times \frac{1}{2} T$$

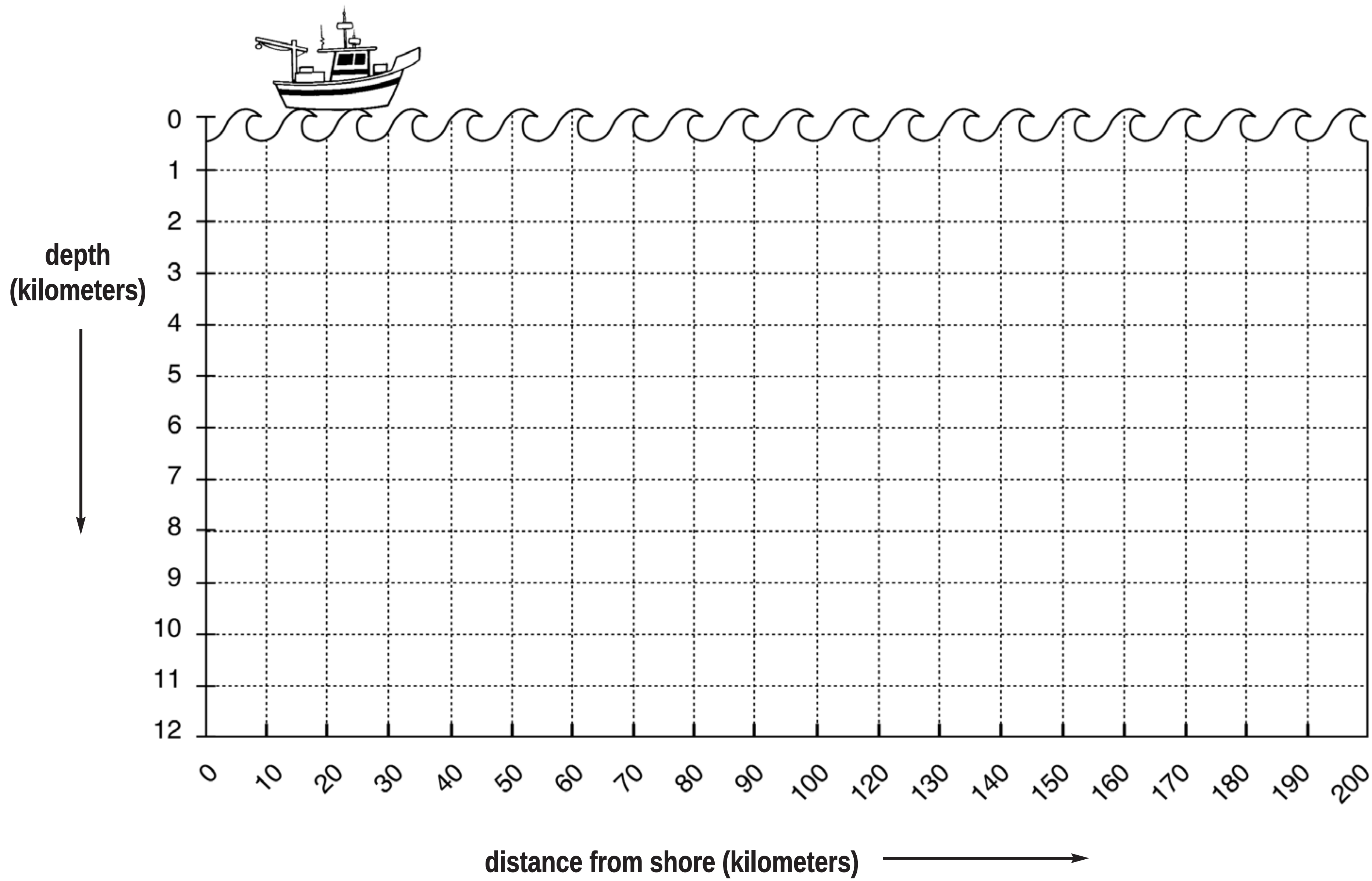
D = depth (in meters)
T = time (in seconds)

V = speed of sound in water
= 1,507 meters per second

distance from shore (km)	time (sec)	depth (m)	depth (km)
10	0.13		
20	0.27		
30	0.53		
40	2.65		
50	2.65		
60	2.92		
70	4.25		
80	4.25		
90	2.65		
100	1.86		
110	1.33		
120	3.98		
130	4.51		
140	6.10		
150	6.90		
160	8.49		
170	14.60		
180	6.64		
190	7.96		
200	7.43		

Name ______________________________

Mapping the Ocean



SeaWorld Skytower

OBJECTIVES

Students read and construct scale drawings and/or models. They practice ratio and geometry skills. They make decisions about how to approach problems and use skills, concepts, and strategies to find solutions.

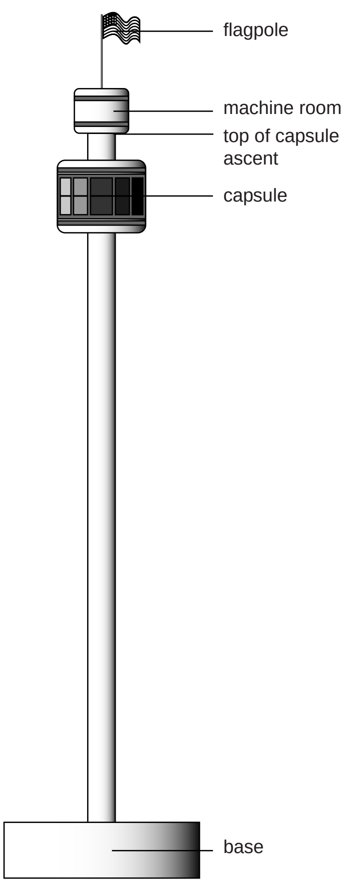
MATERIALS

- ❑ overhead transparency (or copies for each student) of SeaWorld Skytower dimensions and diagram below (enlarge 150%)
- ❑ graph paper or modeling materials such as clay or dough, or cardboard and tape or glue
- ❑ calculators
- ❑ pencil and paper

BACKGROUND

The SeaWorld Skytowers are landmarks in San Diego, California and Orlando, Florida. In this exercise, students explore the SeaWorld San Diego Skytower's dimensions and operating capacity. This activity may be done individually or in learning groups.

SEAWORLD SKYTOWER DIMENSIONS AND OPERATING SPECIFICATIONS



height from base of tower to top of flagpole	320 ft.
height from base of tower to top of capsule ascent	260 ft.
diameter of tower	8 ft.
diameter of capsule	24 ft.
height of capsule	20 ft.
diameter of machine room on top of tower	16 ft.
height of machine room	11 ft.
height of flagpole (including height of flag)	39 ft.
dimensions of American flag	25 ft. by 15 ft.
seating capacity	55 people
hours of operation (spring)	11 a.m.–5 p.m.
duration of ride	5 minutes
speed of ride	1.7 mph
number of revolutions	two on ascent, two on top, two on descent
time to load and unload ride	5–10 minutes

ACTION

1. Students use the given dimensions to make a scale drawing or scale model of the SeaWorld Skytower. Assist them in determining a scale ratio that is workable and practical, and allow more than one class period if necessary.
2. When their models or drawings are completed, have each student or learning group describe to the class how they determined their scale, how they designed the model or drawing, and what challenges they faced. Allow the rest of the class to respond to each group's completed model or drawing.
3. In a separate class period, ask students to use the operating specifications data to estimate the maximum number of passengers that can ride the Skytower in one day. Ask students to share their methods for solving this problem. What assumptions did they make to be able to find a solution?
4. Ask students to calculate the distance a passenger would travel in one round-trip ride. Before they do any calculations, ask them first to determine what unit of measure they will use in their answer, then to outline their problem-solving logic and methodology. What assumptions will they make to be able to find a solution?

SeaWorld's Tree of Lights is made of 2,168 25-watt light bulbs strung from the tip of the Skytower.

ANSWERS

3. *Determining the maximum number of passengers in one day:*
   Assuming 7.5 minutes to load and unload, 7.5 + 5 = 12.5 minutes per trip
   60 minutes per hour ÷ 12.5 minutes per trip = 4.8 trips per hour
   4.8 trips per hour x 6 hours of operation = 28.8 trips (round up to 29 trips)
   29 trips x 55 passengers per trip = 1,595 passengers in one day

4. *Calculating distance traveled in one trip:*
   Using units of number of feet traveled up and down:
   2 x (260 - 20) = 480 feet
   Using units of number of feet traveled around:
   Diameter of capsule is 24 feet and diameter of tower is 8 feet.
   If we assume that people sit in the middle of the donut-shaped capsule, the diameter of seating is 24 - 8 = 16 feet, and the radius of the circle of seats is 8 feet.
   $2\pi r$ = 2 x 3.14 x 8 = 50.24 feet per revolution.
   The capsule makes a total of 6 revolutions, and 6 x 50.24 = 301.44 feet.

Shamu Stadium Geometry

OBJECTIVES

Students use formulas and their knowledge of geometric objects to solve problems involving area and volume. They examine and analyze a diagram and make calculations.

MATERIALS

- ❑ photocopies of ***Shamu Stadium Geometry*** funsheet on page 25 (one per student or one per cooperative learning group)
- ❑ pencil and paper
- ❑ calculator

BACKGROUND

SeaWorld's Shamu Stadium pool complex is home to some of the world's most famous killer whales. At each of the four SeaWorld parks, killer whales inhabit the finest facilities possible. The Animal Welfare Act establishes habitat requirements for all oceanariums including SeaWorld. SeaWorld's facilities not only meet, but exceed these required guidelines. The killer whale habitats at SeaWorld parks are among the largest in the world.

ACTION

1. Distribute copies of the ***Shamu Stadium Geometry*** funsheet.
2. Students work on their own or in groups to solve the problems, design another pool, and create a poster.

(Note that none of these pools are simple geometric shapes; answers will be estimates. For problems 2 and 3, ask students to state their assumptions before doing their calculations.)

ANSWERS

2. *volume of main pool, assuming it is a quarter-sphere and using r = 70*
   $\frac{1}{4} \times [(\frac{4}{3}) \pi r^3] = \frac{1}{4} \times [(\frac{4}{3}) \times 3.14 \times (70 \times 70 \times 70)] = 359{,}007$ ft^3
   359,007 ft^3 x 7.48 gallons per ft^3 = 2,685,369 gallons
   Students may select an r value between 35 and 80; they may also choose to look at this pool as a half-cylinder and use the formula, $\frac{1}{2} \times (\text{depth} \times \pi r^2)$.

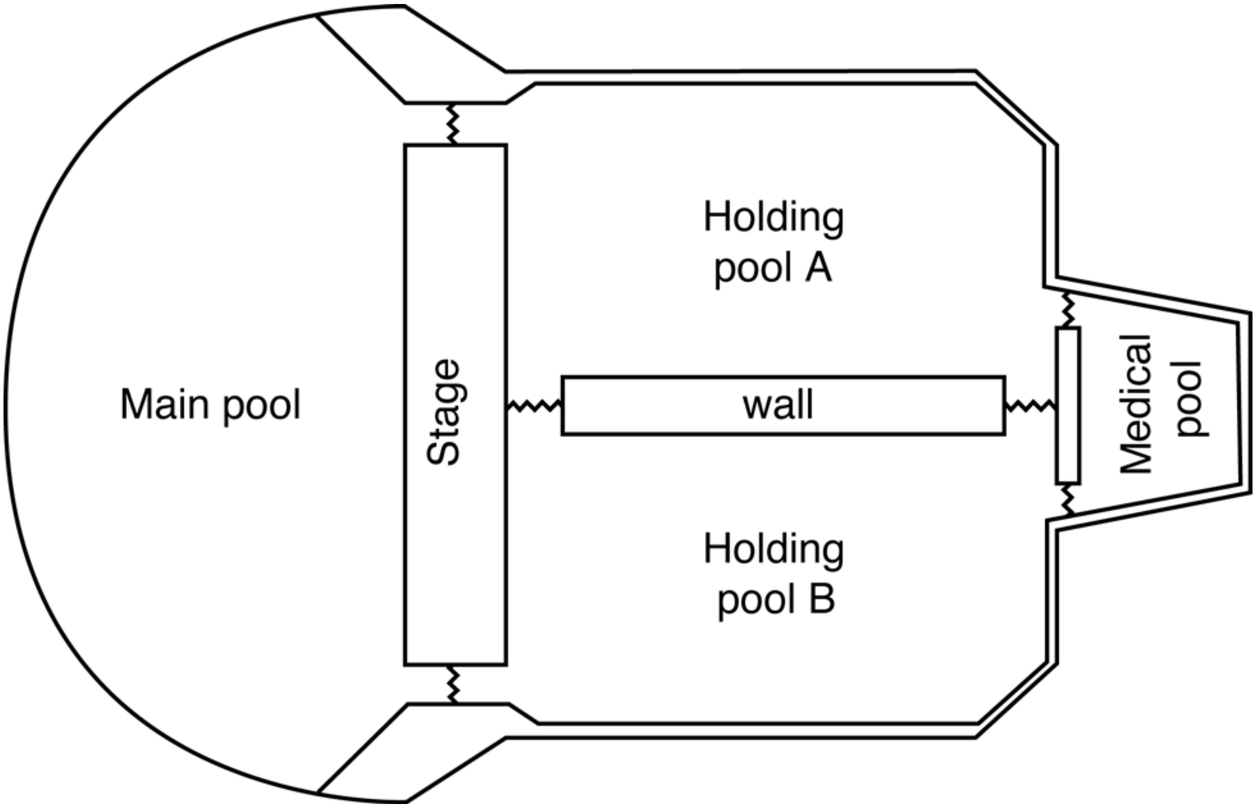
   volume of each side pool: (120 x 75 x 15) = 135,000 ft^3
   135,000 ft^3 x 7.48 gallons per ft^3 = 1,009,800 gallons

   volume of medical pool: 40 x 25 x 8 = 8,000 ft^3
   8,000 ft^3 x 7.48 gallons per ft^3 = 59,840 gallons

3. *Estimating surface area:*
   main pool: $\frac{1}{2} \times (\pi r^2) = \frac{1}{2} \times 3.14 \times (70 \times 70) = 7{,}693$ ft.^{2}
   two side pools: 2 x (120 x 75) = 18,000 ft.^{2}
   medical pool: 40 x 25 = 1,000 ft.^{2}
   TOTAL = 26,693 ft.^{2}
   in acres: 26,693 ft.^{2} x 1 acre/43,560 ft.^{2} = 0.6 acres

Name ______________________

Shamu Stadium Geometry



1. Label pool dimensions:

main pool	80 ft. x 165 ft. x 35 ft. deep
each side pool	120 ft. x 75 ft. x 15 ft. deep
medical pool	40 ft. x 25 ft. x 8 ft. deep

2. Estimate the volume of each pool in cubic feet and in gallons. (1 cubic foot of water = 7.48 gallons)

3. Estimate the water surface area in acres. (1 acre = 43,560 square feet)

4. On the back of this page, design another pool that connects to one of the side pools. What are the dimensions? How much water does it hold? What is it used for?

5. Design and illustrate a poster advertising the Shamu Show that includes reference to the pool size and/or shape.

Feeding Time

OBJECTIVES

Students make decisions about how to solve a complex real-life problem by breaking it down into simpler parts.

MATERIALS

- ❑ paper and pencils
- ❑ calculators
- ❑ ***Ocean Animals*** cards on pages 16–18
- ❑ wholesale seafood costs (below)

BACKGROUND

WHOLESALE SEAFOOD COSTS

food item	*price per pound*
capelin	0.45
clams	1.65
crabs	1.20
herring	0.40
mackerel	0.40
sea urchins	1.40
shrimp	3.50
squid	0.35
smelt	0.35

The animals at each SeaWorld park eat about 4,000 pounds of food daily. Animal care specialists weigh the food before distributing it to the marine animals, and they keep careful records of each animal's daily food intake.

In this exercise, students take on the role of animal care specialists. They use the seafood costs given at left and the ***Ocean Animals*** information cards to solve a complex problem.

Before you begin, copy the table at left onto the board or copy and enlarge it 200% to make an overhead tranparency.

ACTION

1. Pose the following problem to your students:

   Estimate the animal food order and cost to feed 5 sea otters, 10 bottlenose dolphins, 19 California sea lions, 6 killer whales, and 8 emperor penguins for one day.

2. Students work through the problem individually or in learning groups. Ask them to state their assumptions before they begin their calculations.

3. When students have completed their work, discuss the problem together. How did they tackle the problem?

DEEPER DEPTHS

Report on the food-related cost of keeping these animals over the course of their lifetimes. (***Ocean Animals*** cards give typical life spans.)

ANSWERS

Given that for most animals there is a range of sizes and a range of food intake, students will have to make and state their assumptions on the size of the animals and on how much the animals eat. The solution below is correct given the following assumptions.

sea otter weight is 25 kilograms, daily food intake is 25% body weight
bottlenose dolphin weight is 300 kilograms, daily food intake is 5% body weight
California sea lion weight is 300 kilograms, daily food intake is 7% body weight
killer whale weight is 3,000 kilograms, daily food intake is 4% body weight
emperor penguin weight is 40 kilograms, daily food intake is 4% body weight

Converting from metric to pounds: Students must convert metric weights to pounds. They can either convert the animal's weights or they can convert the amount of food each animal eats. For this solution we will start by converting each animal's weight to pounds. *(Numbers are rounded to the nearest pound.)*

sea otter	25 kg x 2.2046 kg/lb. = 55 lb.
bottlenose dolphin	300 kg x 2.2046 kg/lb. = 661 lb.
California sea lion	300 kg x 2.2046 kg/lb. = 661 lb.
killer whale	3,000 kg x 2.2046 kg/lb. = 6,614 lb.
emperor penguin	40 kg x 2.2046 kg/lb. = 88 lb.

Calculating amount of food eaten per day:

sea otter	55 lb. x .25 = 14 lb.
bottlenose dolphin	661 lb. x .05 = 33 lb.
California sea lion	661 lb. x .07 = 46 lb.
killer whale	6,614 lb. x .04 = 265 lb.
emperor penguin	88 lb. x .04 = 4 lb.

Cost of feeding 5 sea otters:

55% clams	14 x .55 x 1.65	=	$12.71
30% shrimp	14 x .30 x 3.50	=	14.70
10% crabs	14 x .10 x 1.20	=	1.68
5% sea urchins	14 x .05 x 1.40	=	.98
TOTAL			$30.07
			X 5
			= $150.35

Cost of feeding 10 bottlenose dolphins

60% smelt	33 x .60 x .35	=	6.93
20% herring	33 x .20 x .40	=	2.64
15% squid	33 x .15 x .35	=	1.73
5% mackerel	33 x .05 x .40	=	.66
TOTAL			$11.96
			X 10
			= $119.60

Cost of feeding 19 California sea lions

40% herring	46 x .40 x .40	=	7.36
20% mackerel	46 x .20 x .40	=	3.68
20% smelt	46 x .20 x .35	=	3.22
20% squid	46 x .20 x .35	=	3.22
TOTAL			$17.48
			X 19
			= $332.12

Cost of feeding 6 killer whales

50% herring	265 x .50 x .40	=	$ 53.00
30% smelt	265 x .30 x .35	=	27.83
10% squid	265 x .10 x .35	=	9.28
10% mackerel	265 x .10 x .40	=	10.60
TOTAL			$100.71
			X 6
			= $604.26

Cost of feeding 8 emperor penguins

80% herring	4 x .80 x .40	=	$ 1.28
20% capelin	4 x .20 x .45	=	.36
TOTAL			$ 1.64
			X 8
		=	**$ 13.12**

Total for all animals:

$150.35
119.60
332.12
604.26
+ 13.12
= $1,219.45

Bibliography

MATHEMATICS BOOKS

The National Council of Teachers of Mathematics (NCTM) recommends a variety of books and other teaching materials that may be purchased through the NCTM Web site. For more information log on to *nctm.org*

BOOKS ABOUT OCEAN ANIMALS

The following publications may be purchased through SeaWorld San Diego. Please call **1-800-23-SHAMU** for information.

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