The FUTURES Channel

MOVIE GUIDE

MOVIES NUMBER **2011-12**

Voyage of the Ventana PARTS 1 & 2

The Movies:

Part 1: The ocean has a tremendous influence on all life on Earth, yet we know relatively little about it. One reason is that the high pressures of the ocean's depths creates an environment which is extremely inhospitable to humans. *(Movie length: 5:09)*

Part 2: The undersea exploration vehicle Ventana is fully equipped to be the eyes, ears and hands of oceanographers who wish to explore the deep ocean. *(Movie length: 5:05)*

Featured: James McFarlane, Chief ROV Pilot, Monterey Bay Aquarium Research Institute.

Background:

The more we learn about the ocean, the more we see that it has a tremendous influence on all life on Earth, whether it be whales or Nebraska farmers. Ocean currents affect planetary wind patterns, and over half of the oxygen produced by plants on earth is produced by ocean algae. The ocean literally gives us breath. Yet we know less about its depths than we know about the surface of the Moon.

Curriculum Connections:

1 Measurement: Volume, Geometry: Solid Figures

The sample container on the Ventana is a cylinder which is 20 centimeters in diameter and 45 centimeters in height. What is its volume?

2 Measurement (speed), Decimals

The sonar on the *Ventana* works by emitting sound waves and measuring the characteristics of their reflections.

The speed of sound in water varies depending on the temperature and salinity (saltiness) of the water, but is around 1,450 meters per second.

What is the distance from the *Ventana* to an object if the total time from sound wave emission to detection of the reflected wave is 0.12 seconds? 0.31 seconds? .02 seconds?

3 Geometry (solids), Percent

Earth is a sphere (or nearly so) with a radius of about 6,000 kilometers. About 70% of its surface is covered with ocean. About how many square kilometers is this?

Measurement (volume, weight, area) 4

Get a drinking glass, preferably a short, wide glass. Fill it to the brim with water (until it is running over). Then carefully slide a thin piece of cardboard across the top of the glass so that there is no air at all in the glass. Holding the cardboard so that it presses flat against the glass, turn the glass and cardboard upside down over a sink. (The cardboard must be tight against the rim of the glass as you turn it over, so that no air is allowed to leak past the cardboard into the glass.) Then gently let go of the cardboard. The cardboard and the water in the glass don't fall because of the pressure of the air pushing up on the cardboard.

Now carefully turn the glass right side up and remove the cardboard. With a measuring cup, measure the amount of water in the glass (in ounces). With a ruler, measure the diameter of the top of the glass (in inches).

Calculate the weight of the water that was in the glass, in pounds. (Water weighs 8.34 pounds per gallon, and there are 128 ounces in a gallon.) Then calculate the area of the top of the glass, in square inches. Using the figure of 14.7 pounds per square inch, calculate how many pounds of pressure the air was applying against the water to hold it in the glass. Compare that figure to the weight of the water.

Ratios 5

There is a manipulator arm in the *Point Lobos* control room that controls the mechanical arm of the *Ventana.* Suppose that for every 8 centimeters you move the manipulator arm, the arm on the *Ventana* moves 500 centimeters. How far would you have to move the control room arm to move the *Ventana* arm 3.4 meters?

Geometry (solids), Measurement (length, weight) 6

Any object which is submerged or partially submerged in water is acted upon by an upwards force called "buoyancy". The amount of buoyant force, in pounds, is equal to the weight of the amount of water that the object displaces.

Thus when the *Ventana* is completely submerged, the buoyant force that acts upon it is the same as the weight of the amount of water that has the same volume as the *Ventana.*

The *Ventana* has a length of 10 feet, a width of 5 feet 6 inches and a height of 7 feet 3 inches. However, it is not a solid box, so for the purposes of this exercise assume that its actual volume is 70% of the box formed of these dimensions.

a) Compute the approximate volume of the *Ventana,* in cubic feet.

b) Convert that to gallons.

c) Find the weight of a gallon of water, and use that to determine the total buoyant force that acts on the *Ventana* when it is underwater.

d) If the *Ventana* weighs about 5,000 pounds when it is not submerged, what is its effective weight under water?

Memo

To: Mission Planning Staff
From: Jim McFarlane/Monterey Bay Aquarium Research Institute
Subject: Pressure at varying ocean depths

I will be out all day on a mission. Please handle the following items while I am gone:

1. In our last mission, Mission #2201, we collected samples at several different depths. I have been asked to supply the lab with the pressure at each sample depth. Remember that pressure at sea level is 14.7 pounds per square inch, and the the pressure increases by that same amount for every 10 meters of depth. Use that information to fill out the following table:

Sample Number	Sample Type	Depth Sample Taken (meters)	Pressure (pounds/ square inch)
2201A	biological	10	
2201B	biological	30	
2201C	geological	70	
2201D	biological	80	
2201E	water sample	150	
2201F	geological	190	

2. Please draw a line graph that shows the pressures you calculated for each of the given depths. Plot depth in meters on the horizontal axis and pressure in pounds per square inch on the vertical axis.

3. What was the pressure at the ocean floor on the mission I completed with Mary Silver, at a depth of 700 meters?

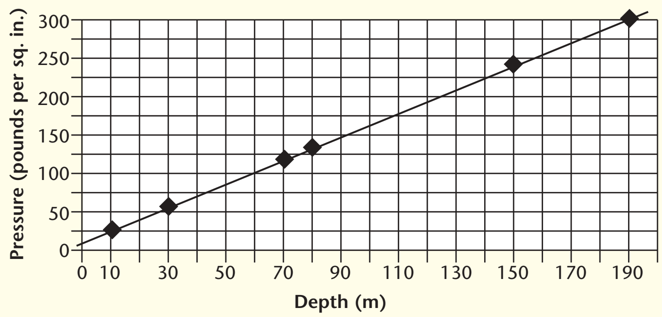
4. It would be helpful to have a general rule for computing the pressure at a given depth. Try to figure out such a rule and test it with some of the pressures you calculated for mission #2201.

Teaching Guidelines: Pressure at Varying Ocean Depths
Math Topic: Algebra (patterns and functions)

1.

Sample Number	Sample Type	Depth Sample Taken (meters)	Pressure (pounds/ square inch)
2201A	biological	10	*29.4*
2201B	biological	30	*58.8*
2201C	geological	70	*117.6*
2201D	biological	80	*132.3*
2201E	water sample	150	*235.2*
2201F	geological	190	*294.0*

2.



You may want to use this graph as an opportunity to investigate the behavior of linear functions. For example, ask students to determine exactly where the line crosses the y axis, and help them to understand that it crosses at 14.7 lb/in.^{2} because that is the pressure at a depth of 0 meters.

Another tactic would be to ask students to compare the change in pressure from 30 meters to 70 meters to the change in pressure from 150 meters to 190 meters, leading to an investigation of the ratio of "change in pressure" to "change in depth" and the realization that this ratio is always the same value.

3. The pressure at that depth is sea level pressure plus 14.7 more pounds per square inch for each 10 meters of depth. This is a proportion: $10/14.7 = 700/n$, where n is the added pressure for a depth of 700 meters. Solving gives n = 1,029 pounds per square inch. Adding the sea level pressure (14.7 lb/in.^{2}) gives a total pressure of 1,043.7 pounds per square inch.

4. The rule could be stated in many ways. Example 1: Start with 14.7 lb/in.^{2} for sea level pressure. Count how many tens there are in the depth, and add 14.7 lb/in.^{2} for each of those. Example 2: Divide the depth by 10, multiply the answer by 14.7 lb/in.^{2}, then add 14.7 lb/in.^{2} to your answer. Example 3: Pressure = 14.7 + (14.7 x depth divided by 10).

If you enjoyed this Futures Channel Movie, you will probably also like these:

Searching for Water on Mars, #3001	If we can find water on Mars, then astronauts won't have to take it with them. But how do you find the water before you send a manned mission?
Undersea Treasure, #3003	A probability map, constructed by a mathematician, locates a sunken U.S. ship with the largest sunken gold treasure in U.S. history, and reveals even greater wonders.
Life Under the Ocean, #2004	A marine biologist studies the jellyfish-like animals living at 3,000 feet, where it is cold, dark and quiet.