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4-H MARINE PROJECT
UNIT THREE

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WHAT IS AN OCEAN ?

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4-H MARINE PROJECT

UNIT THREE

WHAT IS AN OCEAN?

(MEMBER GUIDE)

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WHAT IS AN OCEAN?

The dictionary defines the ocean as the "whole body of saltwater that covers nearly three-fourths of the surface of the globe"* Actually there are five major ocean systems: the Atlantic, the Pacific, the Indian, the Arctic, and the Antarctic Oceans. These oceans are easily found on a world map or globe (see the figure below).

OCEANS OF THE WORLD

The word pacific means peaceful. How did the Pacific Ocean get its name?

The word atlantic means strong. How did the Atlantic Ocean get its name?

What continents border the Pacific Ocean?

What continents border the Atlantic Ocean?

What continents border the Indian Ocean?

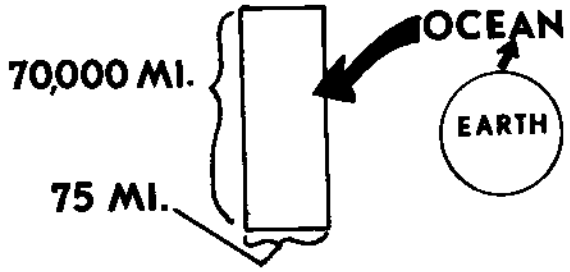
The Arctic Ocean is partly frozen and surrounded by land. How does this differ from the Antarctic Ocean?

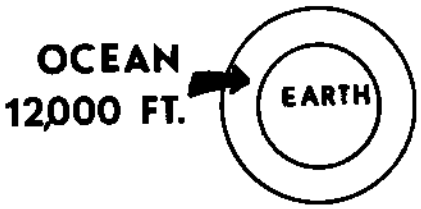
* Webster's Seventh New Collegiate Dictionary. 1971. G.S. Merriam Co., Springfield, Massachusetts.

ACTIVITY: Find and circle the names of the five world oceans in the word puzzle below.

I N A E C O N A I D N I K S A
D A O L B C N Z R F R N H E L
E E N P N A I X F E T L L X P
A C V T M S L C Z Z Y I I C I
D O C R A D P V X X U P O V O
F C B G A R C T I C O C E A N
Y I M H T C C G C L B C R S S
T T K M U B N T V I N V Q C D
R N L I I M M P I P M B Z B R
N A E C O C I F I C A P N T L
N L Y R Z W X R F V O O L Y M
O T I Y X T F T Y B L C O I N
P A O U C Y P Y T N P P E O O
C I N K Z T H K W T Y K F A P
X P B N W R C J Q I O L B V N

The oceans are tremendous, containing nearly 330 million cubic miles of water. A single cubic mile of water contains about 9.5 trillion gallons of water. There is enough water in the oceans to fill a cylinder 75 miles in diameter and 70,000 miles high. If the earth were made smooth both above and below the water, the ocean would completely cover the earth to a depth of 12,000 feet.

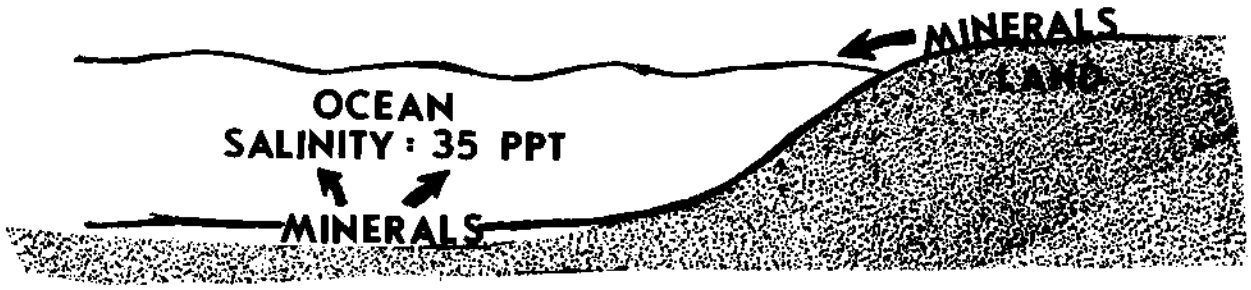




The oceans were formed during the early history of the earth, probably three to four billion years ago. It is believed that the earth was formed from cooling, condensing gases. From a hot, molten state, the earth eventually cooled to the point where water vapor condensed and the water cycle began. Water trapped in molten rock was released as the rock cooled, increasing the amount of atmospheric water. Once the earth's surface cooled enough to allow standing water to remain, the filling of the oceans began. It may have taken more than a billion years for the oceans to fill to their present volume.

HOW DID THE OCEANS GET SALTY?

Natural salts and minerals found in seawater originated from two sources. The process of erosion released large amounts of minerals from rock and soil. These were carried to the sea by flowing water. Much of the mineral content of seawater also came from the seafloor itself. There has been a slow increase in the ocean's SALINITY (salt content) during its long history. The present ocean SALINITY is about 35 PARTS PER THOUSAND (PPT). In other words, a thousand buckets of seawater contain enough salt to fill 35 of them with salt; however, ocean salinity varies with location, season, and depth.



Seawater is a soup, a complex mixture of more than 70 elements and thousands of compounds. Many of these compounds are the products of natural processes of living organisms. Many are produced by chemical reactions that occur in seawater itself. In the past century, however, human technology has added much to the ocean soup with thousands of manufactured chemicals. Many of these chemicals have caused considerable harm to the environment and affected the quality of seawater.

ACTIVITY: You will need one-half cup of salt, two cups of sand, one cup of warm water, and a piece of glass, plastic, or metal.

1. Mix, then pour the sand and salt in a shallow pan, forming a pile. The pan represents the ocean floor. What do the sand and salt represent?

2. Slowly pour the water over the sand-salt pile. What happens to the pile?

   How are mountains changed by rain and wind over millions of years?

3. Place a drop of tap water and a drop of water from the pan on a small piece of glass, metal, or clear plastic. Allow it to evaporate.

   Describe what remains in place of the two drops. Is there a difference? Why?

The Great Salt Lake in Utah was once a large inland sea. It is now eight times saltier and much smaller than it was originally. What happened to change the large sea to a very salty lake?

WHAT IS THE OCEAN FLOOR LIKE?

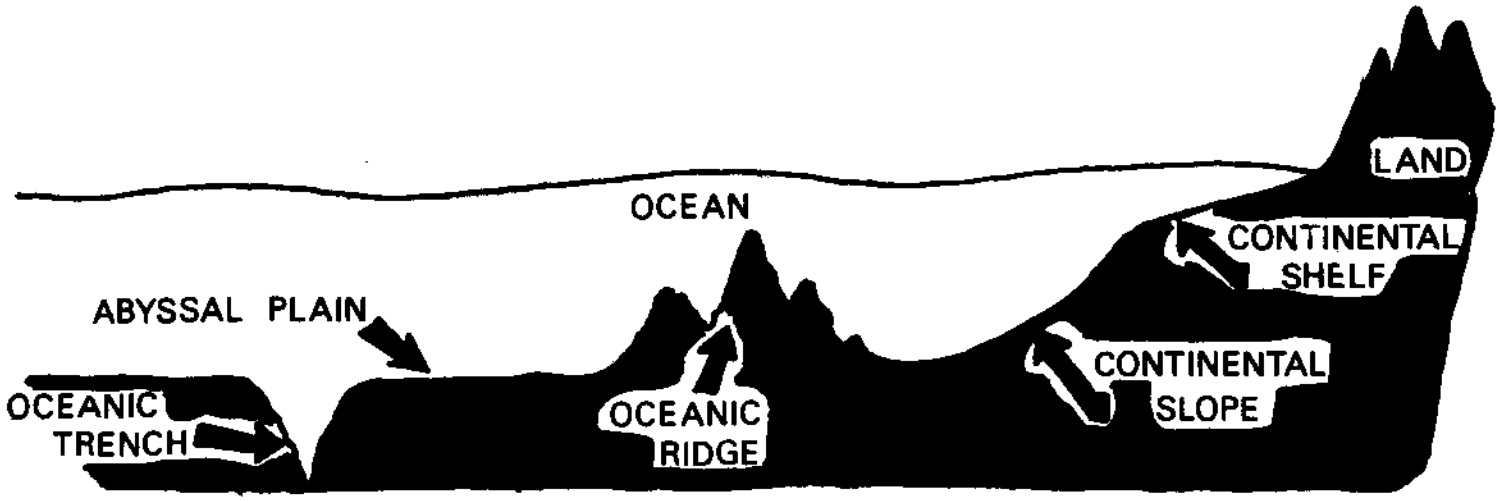
The oceans occupy large depressions in the earth's surface called BASINS. How these were formed is not known; however, scientists agree that it was a very slow process. The oceans have been undergoing constant change throughout their entire history. Mountains that are now thousands of feet above sea level were once part of the ocean floor. The Ice Ages, movement of the continents (CONTINENTAL DRIFT), and other dramatic processes have reshaped the oceans during their long history.

Picture a canyon larger than ten Grand Canyons, a 40,000 mile long mountain chain, or a 3000 mile long cliff over one mile high. These are some of the awesome features hidden on the ocean floor.

The oceans show several general features. A shallow rim, called the CONTINENTAL SHELF, surrounds the continents. This area is usually less than 600 feet in depth and may extend from a few hundred feet to hundreds of miles from the shore. It is the most productive part of the ocean and most susceptible to human activity.

Moving seaward, the continental shelf slopes downward, forming the CONTINENTAL SLOPE. It may plunge uninterrupted for two to three miles to the ocean floor and is one of the most impressive features of the ocean basin. The face of the CONTINENTAL SLOPE is cut by deep gorges and canyons, probably created by undersea land slides.

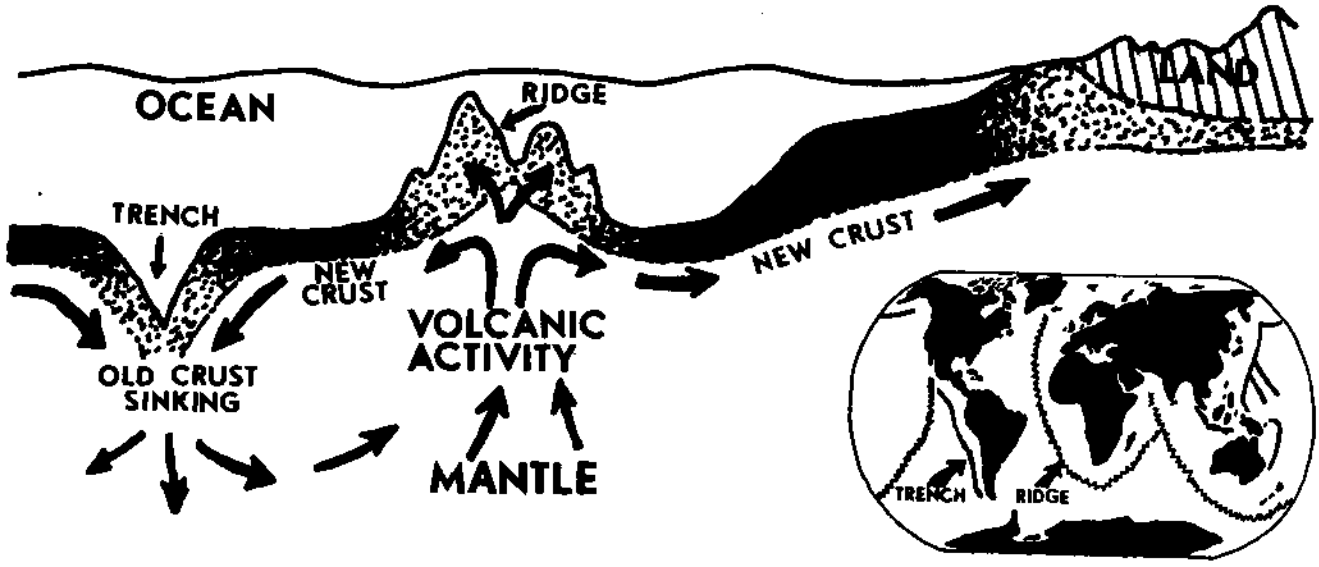
The deep ocean floor, called the ABYSSAL PLAIN, averages two miles in depth and occupies five sevenths (5/7) of the total sea area. In many areas it is completely flat, covered by sediments that have accumulated over millions of years. This vast, flat plain is often interrupted by towering mountains and mountain ranges called OCEANIC RIDGES.



FEATURES OF THE OCEAN FLOOR

A continuous, undersea mountain range runs along the Atlantic, Indian, Antarctic, and Pacific Oceans, stretching nearly 40,000 miles. It is the longest mountain range in the world, averaging more than one mile high. Another interesting feature of the ocean floor is the deep openings called OCEANIC TRENCHES. They are all V-shaped and very deep, reaching more than 30,000 feet below the surface.

The mystery of the formation of the OCEANIC TRENCHES and RIDGES may be explained by the theory of CONTINENTAL DRIFT. Scientists believe that the oceanic ridges are areas of new crust formation. Undersea volcanic activity produces new ocean floor material that spreads out from the ridges. At the same time, old existing crust slowly sinks into the deep ocean trenches and is recycled into the earth's interior (see the figure below). As the sea floor spreads out, it carries the continents with it, making them move apart.



CONTINENTAL DRIFT : OCEAN TRENCHES & RIDGES

The process of CONTINENTAL DRIFT, or seafloor spreading, is very slow. In fact the total movement of continents is just a small fraction of an inch each year.

ACTIVITY: Unscramble the names of important ocean features.

SBYASLA NPALI _ _ _ _ _◯_ /_ _ _◯◯

NTNENOCILAT PESOL ◯_ _◯_ _ _ _ _ _ _ /_◯_ _ _

NTENNLOCITA FSHLE _◯_ _◯_ _ _◯_ _ /_ _ _ _◯

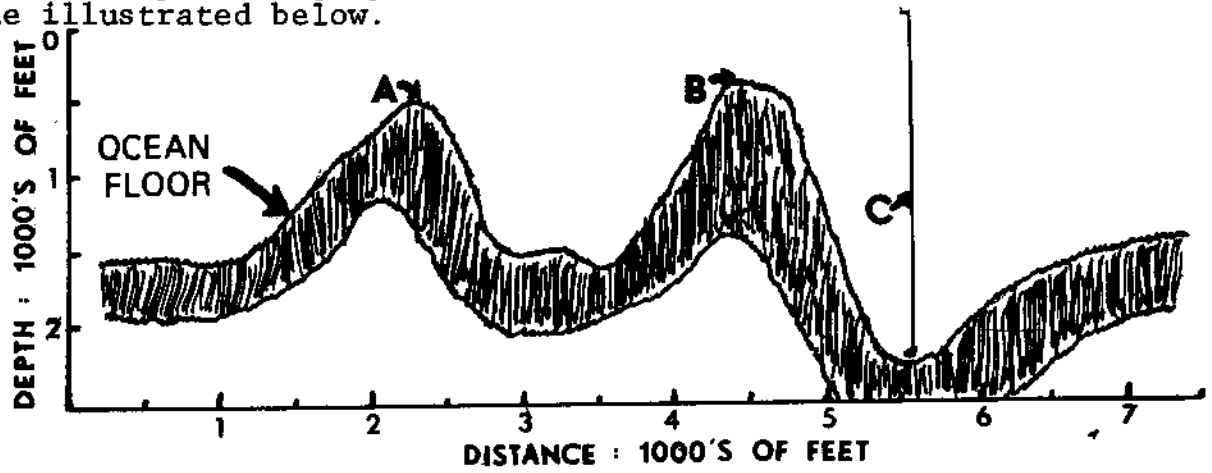
NCEAOCI NCHRET _ _ _ _◯_ _ ◯_◯_ _ _

EACNCIO DGEIR _ _ _ _◯_ _ ◯_◯_ _

Unscramble the circled letters to answer the question: What do scientists call seafloor spreading? _ _ _ _ _ _ _ _ _ _ _ /_ _ _ _ _

HOW IS THE OCEAN FLOOR MAPPED?

Before the 1950's there was little information available about the shape of the ocean floor. Ocean depths were usually measured by long line soundings, a very slow, tedious process. After World War II, the continuous recording ECHO SOUNDER was invented. This device uses the principle of echo-location using sound waves. Sound waves are sent out from a ship board instrument and bounce off the ocean floor. The returning sound waves are picked by a recording instrument on the ship which measures the length of time it takes the sound waves to return to the ship. The deeper the water, the longer it takes the sound waves to travel to the bottom and back to the ship. The recording instrument then plots a graph of the ocean floor contour much like the one illustrated below.



ECHO-SOUNDING CHART OF THE OCEAN FLOOR

How tall are the two mountains shown (A, B)?

What is the depth of the lowest point (C)?

Approximately how far apart are the two mountain peaks (A, B)?

ACTIVITY: Simulate the sound waves of an echo sounder, using a long heavy extension cord or rope (about 20 feet long).

1. Two students, one the transmitter and one the receiver, hold the ends of the cord, allowing a little slack in the cord. The transmitter strongly flicks his/her wrist to produce a wave that travels down the cord to the other end and bounces back. This activity represents the echo sounding signal bouncing off the ocean floor and being received by the ship.

2. Use a stop watch to determine the length of time it takes the wave to travel down the cord and back. Record the data on the next page. Do not flick the cord too strongly; a moderate wave is needed. Produce waves of the same size for each measurement.

3. Shorten the length of the cord by five feet and repeat the measurement twice.

LENGTH OF CORD (ft)	TIME OF WAVE TRAVEL (sec)
20	_____
15	_____
10	_____

What happens to the time as the cord is shortened?

If the cord were very long, what might happen to the wave signal?

Some ocean depths are so great that the echo sounding signals are lost. Charges of explosives are used as signal starters in place of the echo signal so that a strong signal will return to the ship.

The greatest depth of the ocean is the Mariana Trench, almost 36,000 feet deep. Use an ocean floor map (National Geographic, December, 1981) and locate the trench. It is off the eastern coast of the Philippine Islands.

WHAT CAUSES THE TIDES?

Nearly everyone has visited a coastal beach and noticed the gradual, daily change in water level along the shore. These changes are called TIDES and are caused by the gravitational pull of the moon and sun on the earth's surface. GRAVITY is the attraction between bodies. The earth's gravity keeps the moon in orbit around the earth, while the moon's gravity causes tides on the earth. The sun's gravity holds the earth in orbit around it and influences the tides.

Visit your school or local library and read about gravity in an earth science book or an encyclopedia.

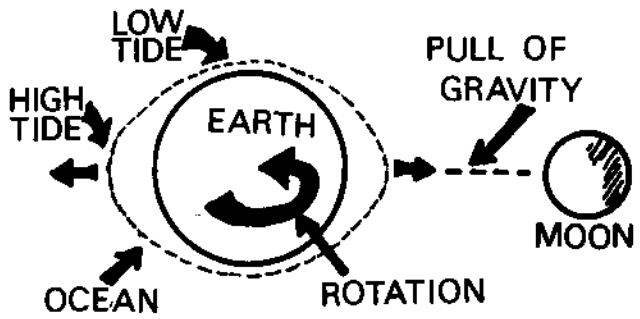
ACTIVITY:

1. The distance between objects affects their gravitational attraction; the closer the objects, the greater the attraction. During its orbit around the earth, the moon is closer to the earth at certain times than others. Discuss with your classmates how this could affect the tidal levels.

2. The mass (amount of matter) of objects affects their gravitational attraction; the greater the mass, the greater the attraction. The sun is several million times more massive than the moon. Which should have the greater gravitational effect on the earth, the sun or the moon?

The sun is approximately 93,000,000 miles from the earth, while the moon is a mere 200,000 miles away. Because the sun is so far from the earth, its gravitational effect on the tides is about half that of the moon. Because of this, the tidal cycles follow the lunar (moon) cycles.

The moon's gravitational pull on the earth causes a bulge in the ocean on opposite sides of the earth. This bulge is actually a huge wave that travels over the earth. The crest (top) of the wave is HIGH TIDE, while the trough (bottom) of the wave is LOW TIDE. While the water directly under the moon is pulled toward it, the earth is pulled away from the water on the opposite side. The result is high tides on sides of the earth opposite the moon and low tides on the sides of the earth at right angles to the moon. (See the figure below.)



GRAVITY, CENTRIFUGAL FORCE AND TIDES

The rotation of the earth on its axis also affects the tides by increasing the bulging effect on the ocean through CENTRIFUGAL FORCE. Objects moving in a circular path tend to move outward from the center of movement. Remember the last time you were sitting in a car making a sharp turn? You were thrown to the side. This is an example of CENTRIFUGAL FORCE. Likewise, the ocean is thrown outward from the earth's surface by the spinning motion of the earth.

ACTIVITY: You will need a heavy grade balloon, a small bucket with a handle, and some water.

1. Fill the balloon with water until it is the size of a softball. Do not fill it to the point of bursting. Place the balloon on a smooth, wet surface and spin it with a hard twist of the wrist.

What happens to the shape of the balloon? Why?

2. Fill the bucket with water to a depth of two or three inches. Holding it by the handle, swing it briskly up and over your head. Make sure there are no obstructions in the way and do not stop during the swing as the water will spill out.

   What holds the water in the bucket?

The earth's rotation on its axis causes the huge tidal bulges on the ocean's surface to travel over the earth. This usually results in two high tides and two low tides each day for any one place. However, due to the irregular shape of the continents and the ocean basin, many coastal areas have fewer daily tides or extremes between high and low tide levels. The TIDAL RANGE is the difference between high and low tide levels. The Great Lakes in the United States and the Mediterranean Sea in Europe have TIDAL RANGES of only a few inches. The Bay of Fundy in Nova Scotia has a TIDAL RANGE of over 40 feet.

The EBBING (outgoing) and FLOWING (incoming) tides often produce strong currents, especially in channels, rivers, and inlets. The EBBING tides remove sediments and carry nutrients from the shoreline. The FLOWING tidal currents bring in fresh food supplies and fresh seawater.

ACTIVITY: Discuss the following questions with your classmates and record your answers.

1. What are some problems coastal residents and boating enthusiasts must face when living and working in areas with extreme tides?

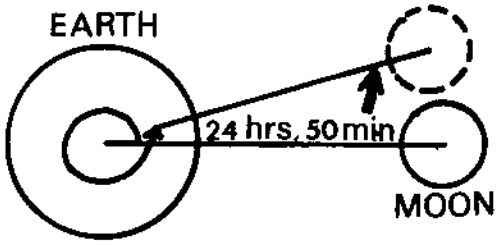
2. What are some benefits of tidal currents to marine organisms?

3. What are some hazards of strong tidal currents to swimming and fishing enthusiasts?

WHAT ARE THE TIDAL CYCLES?

If you look at a tide chart, you will notice that the tides run about 50 minutes later each day. This is because the moon revolves around the earth as the earth rotates on its axis. During the time

the earth completes one rotation (24 hours), the moon has traveled more than 54,000 miles in its orbit around the earth. If a given point on the earth is directly under the moon, it takes approximately 24 hours and 50 minutes for it to pass under the moon again. (See the figure below.) You have probably noticed that the moon appears in the same place in the sky about 50 minutes later each evening.



TIDES ARE 50 MINUTES LATER EACH DAY

Tide tables give the times and water levels of the tides. These are predictions based on past records of tides. Tides can be affected by storms, wind, and the location of the sun and moon. For this reason, the true tidal level may be far above or below the predicted level. Below is an excerpt from a tide table for Hampton Roads at Sewells Point (1983). The water level (measured in feet) is measured from the MEAN LOW TIDE which is the average water level for low tide. A minus sign indicates that the water level is below the MEAN LOW TIDE, while no sign indicates that the water level is at or above the MEAN LOW TIDE.

TIDE	DAY	TIME	WATER LEVEL	DAY	TIME	WATER LEVEL	DAY	TIME	WATER LEVEL
AM LOW	1	12:43	0.0	2	1:30	-0.2	3	2:16	-0.3
HIGH		6:52	2.4		7:37	2.5		8:23	2.6
PM LOW		1:00	-0.1		1:44	-0.2		3:27	-0.3
HIGH		7:15	2.7		8:00	2.9		8:43	3.0

ACTIVITY: Use the tide chart to answer the following questions.

1. On day one (1), how much time lapses between each tide? Write your answers in the spaces provided.

   AM 12:43 _____ AM 6:52 _____ PM 1:00 _____
   AM 6:52 PM 1:00 PM 7:15

   How many tides occur each day? (As you can see, the tides change about every six hours.)

2. Note the times of the first low tide for all three days. They are 12:43, 1:30, and 2:16, respectively. How much later does this low tide occur each day? Why?

12:43	_____	1:30	_____
1:30		2:16	

3. On day one (1), what is the tidal range between each low and high tide? (Determine the difference between each tide.)

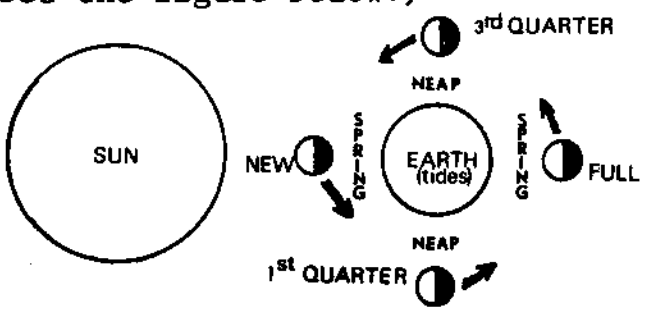
0.0	_____	2.4	_____	-0.1	_____
2.4		-0.1		2.7	

Notice that the tidal ranges increase. Discuss possible reasons for this with your classmates.

4. Note the water levels of the first low tide for each day. They are 0.0, -0.2, and -0.3 feet, respectively. What is happening to the low tide level?

Note the water levels for the first high tide for each day. They are 2.4, 2.5, and 2.6 feet, respectively. What is happening to the high tide level?

The daily changing water levels of high and low tides, as shown in question 4, are caused by the sun. The sun also influences the tides, but since it is so far from the earth, its effect is much less than that of the moon. When the sun and moon line up on the same or opposite sides of the earth, their gravitational pull on the earth combines and the tidal ranges gradually increase. Called SPRING TIDES, the high tides are higher than average and the low tides are lower than average. SPRING TIDES occur during NEW and FULL MOONS. The tide table above indicates approaching SPRING TIDES. When the sun and moon are at right angles to the earth, their gravitational pull is spread over the earth. The result is a below average tidal range. The high tides are not very high and the low tides are not very low. These are called NEAP TIDES and occur during QUARTER MOONS. (See the figure below.)



SPRING AND NEAP TIDES

ACTIVITY:

1. Using a calendar which indicates the lunar (moon) phases, record which dates have SPRING and NEAP TIDES for the current month.

   MONTH _____ SPRING TIDES _____
   NEAP TIDES _____

2. Below are six lines that represent the major tidal levels during a monthly tidal cycle. Using what you have learned about SPRING and NEAP TIDES, label the lines with the terms listed below.

   NEAP HIGH TIDE
   AVERAGE LOW TIDE
   SPRING HIGH TIDE
   SPRING LOW TIDE
   AVERAGE HIGH TIDE
   NEAP LOW TIDE

3. A number of factors can affect tides, such as wind and storms. With the help of your classmates, discuss how each of the conditions stated below may affect the tides.

   A. A STORM DURING SPRING HIGH TIDES.

   B. A STRONG WIND BLOWING TOWARD LAND.

   C. A STRONG WIND BLOWING TOWARD WATER.

   D. A TIME WHEN THE MOON AND SUN ARE CLOSE TO THE EARTH. (Hint: How does this affect their gravitational pull on the earth?)

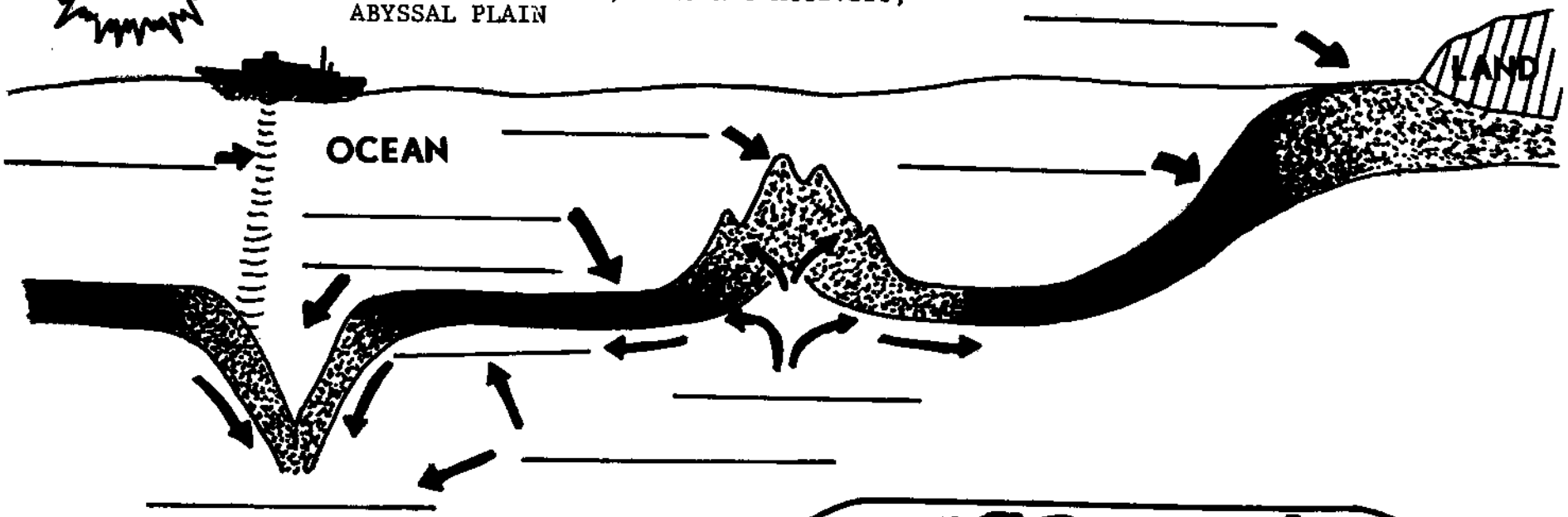
   E. A TIME WHEN THE MOON AND SUN ARE FAR FROM THE EARTH.

If you want to know more about the oceans, visit your school or local library and read the following books:

The Edge of the Sea by Rachel Carson, 1955, Houghton Mifflin Co.,
The Seven Seas by Elizabeth Clemons, 1971, Knopf Publishers,
World Beneath the Oceans by Thomas Gaskell, Natural History Press.

Label the illustration with the terms listed below.

CONTINENTAL SHELF, CONTINENTAL SLOPE, ECHO SOUNDER, OCEANIC RIDGE,
OCEANIC TRENCH, CONTINENTAL DRIFT, NEW CRUST,
OLD SINKING CRUST, VOLCANIC ACTIVITY,
ABYSSAL PLAIN



Name the world oceans indicated by the **letters**.

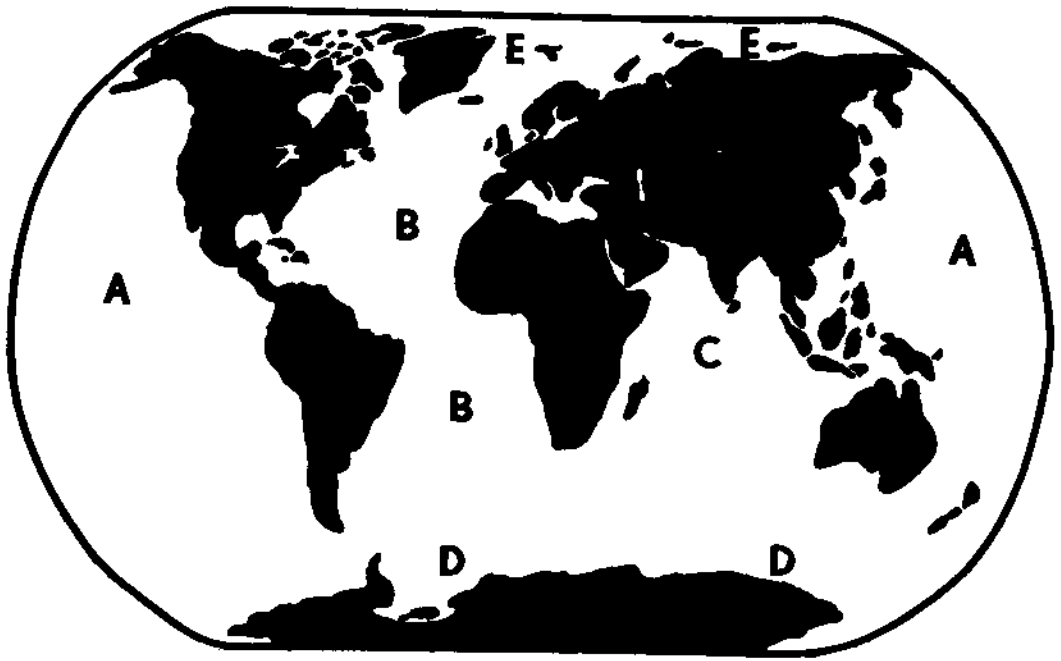
A. _____

B. _____

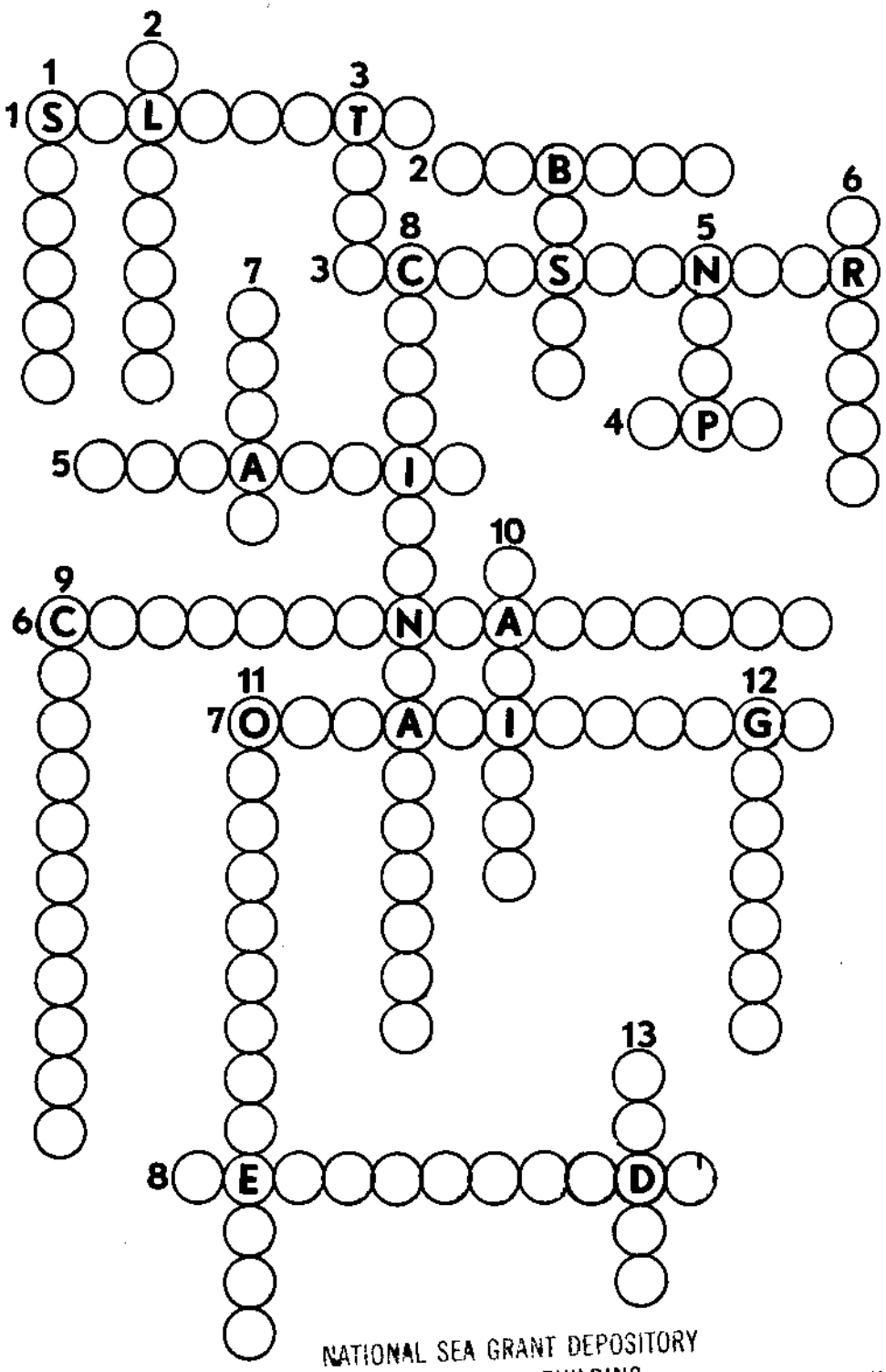
C. _____

D. _____

E. _____



CROSSWORD PUZZLE



ACROSS

1. salt content of seawater
2. outgoing tide
3. used to map the ocean floor
4. parts per thousand
5. "strong"
6. sea floor spreading
7. undersea mountain chain
8. average water level at low tide

DOWN

1. full and new moon tide
2. incoming tide
3. coastal water level change
4. depression containing the ocean
5. quarter moon tide
6. frozen ocean
7. covers 3/4 of the earth
8. shallow coastal seafloor
9. _____ force
10. "peaceful"
11. deep seafloor opening
12. attractive force between bodies
13. _____ range