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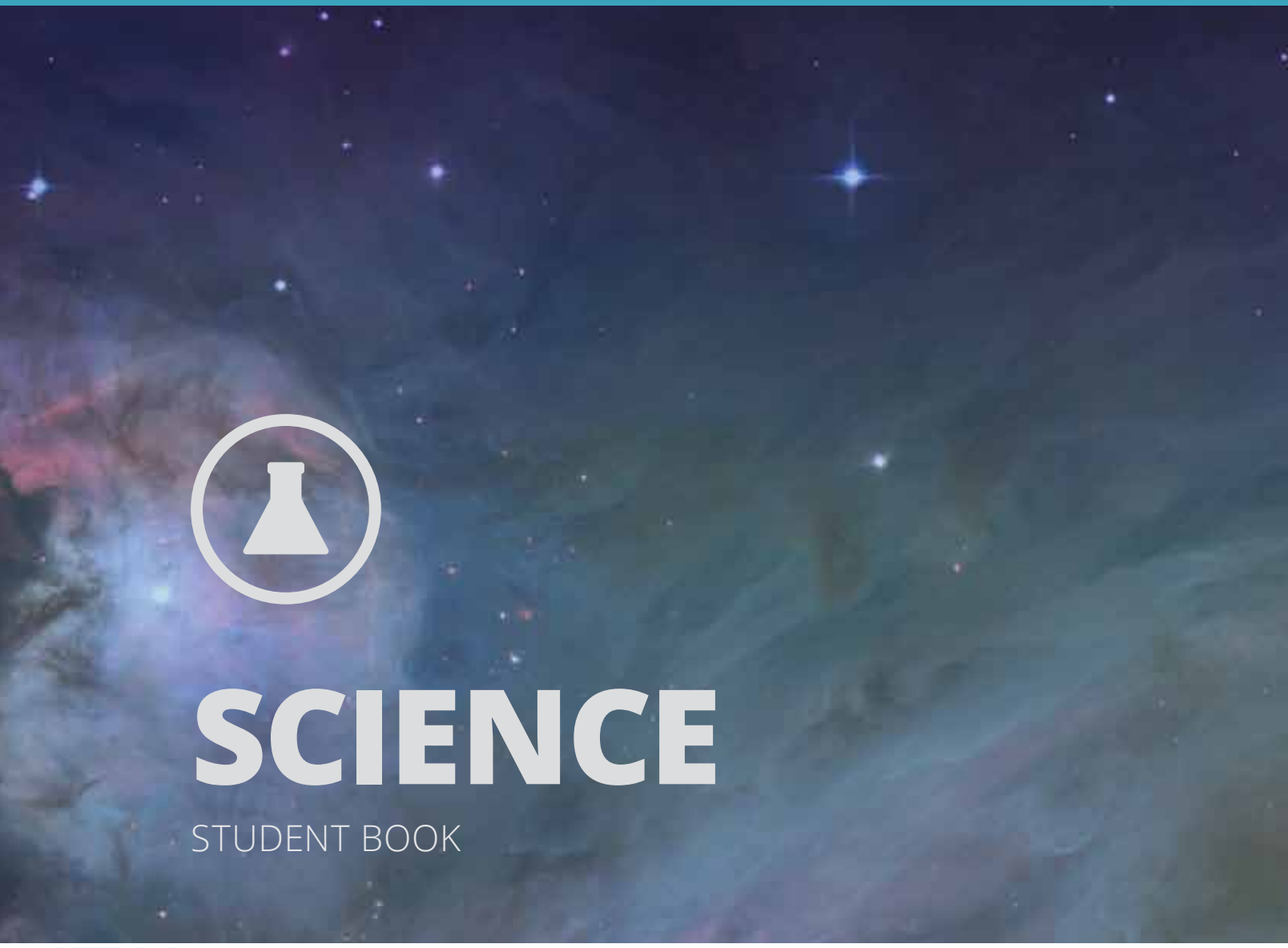

SCIENCE

STUDENT BOOK

9th Grade | Unit 8

Alpha Omega
PUBLICATIONS

SCIENCE 908
Oceanography

LIFEPAC Test is located in the center of the booklet. Please remove before starting the unit.

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Oceanography

Introduction

Anyone who has been privileged to observe undersea exploration has most likely been thrilled by both the adventure and the beauty of it. Psalm 107:23 and 24 states:

> *They that go down to the sea in ships,*
> *that do business in great water;*
> *These see the works of the LORD,*
> *and his wonders in the deep.*

Oceans cover more than 70 percent of the earth's surface. They are very important to us for transportation, food, and recreation. The minerals in the sea become increasingly important as the supply on land decreases. Climate on the land is controlled by the large size of the oceans. Water evaporates from the ocean to form clouds. Winds carry the clouds across the land providing rain or snow. God has endowed our oceans with bounties of fish, minerals, and power. The water in the ocean is never still. It is constantly changing and constantly showing the works of God.

The science of oceanography will help you understand the role the oceans play in meeting the challenges of the future. In this LIFEPAC®, you will study the history of oceanography, the geology of the ocean, and the biological, chemical, and physical properties of the ocean.

Objectives

Read these objectives. The objectives tell you what you will be able to do when you have successfully completed this LIFEPAC. When you have finished this LIFEPAC, you should be able to:

1. List steps in the development of oceanography.
2. Name and describe techniques of oceanographic investigations.
3. Cite the major discoveries.
4. Identify research vehicles and their missions.
5. Describe the geological structure of the oceans.
6. Name and describe means used to profile the ocean floor.
7. Describe sedimentation processes.
8. Identify and locate major ocean currents.
9. Name the principal marine life.
10. List ways of developing the ocean's potential food source.
11. Describe fish farming.
12. Design a simple food web for the ocean.
13. Describe the exchange process between ocean and atmosphere.
14. List important chemicals in the ocean.
15. List factors determining salinity.
16. Describe the formation of tides.
17. Describe a wave.
18. Estimate the ocean's petroleum reserves.

Survey the LIFEPAC. Ask yourself some questions about this study and write your questions here.

1. HISTORY OF OCEANOGRAPHY

Oceanography is a fairly new science. It combines the pure science of biology, chemistry, and physics and employs the technologies of geological research, marine resources, energy conversion, climatology, and marine engineering. In order to better understand the ocean environment, ocean exploration requires a special kind of scientist/engineer to lead the search.

As you study the history of oceanography in this section, you will learn about the chronology of oceanography, the techniques for investigation, some of the major discoveries, and some submersible research.

SECTION OBJECTIVES

Review these objectives. When you have completed this section, you should be able to:

1. List steps in the development of oceanography.
2. Name and describe techniques of oceanographic investigations.
3. Cite the major discoveries.
4. Identify research vehicles and their missions.

VOCABULARY

Study these words to enhance your learning success in this section.

fathom (faŦh´ um). A unit equal to six feet; used mostly in measuring water depth.

fetch (fech). The distance of open water over which a wind blows.

plankton (plangk´ tun). Small organisms that float or drift in water and provide an important source of food for fish and other marine life.

seamounts (sē ´ mounts). Undersea mountains of heights above 1,000 meters that rise from the ocean floor, but do not rise above the surface of the water.

Note: *All vocabulary words in this LIFEPAC appear in* **boldface** *print the first time they are used. If you are not sure of the meaning when you are reading, study the definitions given.*

Pronunciation Key: h**a**t, **ā**ge, c**ã**re, f**ä**r; l**e**t, **ē**qual, t**ė**rm; **i**t, **ī**ce; h**o**t, **ō**pen, **ô**rder; **oi**l; **ou**t; c**u**p, p**u̇**t, r**ü**le; **ch**ild; lo**ng**; **th**in; */ŦH/* for **th**en; */zh/* for mea**s**ure; */u/* represents */a/* in **a**bout, */e/* in tak**e**n, */i/* in penc**i**l, */o/* in lem**o**n, and */u/* in circ**u**s.

CHRONOLOGY OF OCEANOGRAPHY

Historians credit Benjamin Franklin as the first person to promote scientific study of the ocean. While Postmaster General in 1770, Franklin ordered the production of Gulf Stream charts in order to improve the mail service between England and the American colonies. The result was that navigators could choose the appropriate currents and thus shorten their travel time.

Oceanography as a science. The true beginning of deep-sea oceanographic research, however, occurred approximately one hundred years after Franklin—1873 to be exact—when the British mounted a three-year, round-the-world voyage on HMS *Challenger,* whose mission was to collect and analyze data. So much data was accumulated and odd specimens collected that the scientific community began turning its attention toward the sea.

Charles Darwin, whose *The Origin of Species* produced much worldwide controversy, contributed much to our understanding of marine biology through his study of coral reef formation during the period from 1831 to 1836.

A Briton, Edward Forbes, and an American, Matthew Maury, share the honor of being named the "Father of Oceanography." Forbes theorized that marine life decreased in numbers at each succeeding depth zone. He believed that marine life ceased to exist at a depth of 300 **fathoms**. Forbe's error was accepted. Sir John Ross had discovered worms in sea mud from 1,050 fathoms some twenty years earlier, but he was unable to publicize his findings properly. Forbes was a skillful writer and his observations contained thought-provoking scenes, which stimulated further scientific inquiry into marine biology.

Matthew Maury was a naval officer who charted winds and currents in the North Atlantic. His work saved ocean commerce millions of dollars because of shortened passage routes. Furthermore, in 1854 he mapped the Atlantic to the depth of 4,000 fathoms.

The first research expedition. The three-year voyage of HMS *Challenger* was the first full-scale oceanographic research expedition. Her crew of sailors and scientists covered over 140 million square miles of ocean. The expedition's chemist, J.Y. Buchanan, is credited with founding chemical oceanography by his analysis of water samples taken throughout the voyage. His observations set the pattern for other scientists aboard. All were congratulated for their precision, devotion, and efficiency in drawing up their reports, which filled fifty volumes.

Close-of-century investigations. During the last twenty years of the 1800s, oceanography was given a big boost through the efforts of a number of distinguished men. German scientist, Victor Hansen, was the first to name **plankton**. A Russian admiral, S.O. Makarov, made detailed temperature and density readings in the North Pacific. Prince Albert of Monaco was an oceanographer who outfitted a group of oceanographic vessels and founded the marine museum and laboratory at Monte Carlo.

The Woods Hole Laboratory started in 1875 in Massachusetts. It has become one of the two great oceanographic research institutions in the United States. The other is the Scripps Institution of Oceanography at La Jolla, California, which was founded in 1905. The Marine Biological Association Laboratory in Plymouth, England, since 1879 has been a center for marine research.

A number of other marine laboratories were also established at such places as Helgoland, Germany; Viña del Mar, Chile; Recife and Sao Paulo, Brazil; Nanaimo and St. Andrews, Canada; and Kochi and Tokyo, Japan.

Commercial fisheries. During the latter 1800s, marine biologists became interested in commercial fisheries. As a result, another branch of oceanography was started, named fishery science. Alexander Agassiz in the United States, W. C. McIntosh of Scotland, and Frank Buckland

in England did much to improve fish harvesting and to pioneer research in fish migration, growth, and life cycles.

The Danish scientist, C.G.J. Petersen, invented the first practical fish tag and led the effort for prevention of overfishing.

Johan Hjort, a Scandinavian, contributed greatly to the knowledge of trawling and deepwater dredging. He also discovered that fish change colors with depth: They are blue or transparent near the surface, silvery or gray at depths from 450 to 1,500 feet, and black or red at deeper zones.

In 1925 the famous Antarctic explorer, Captain Robert Falcon Scott, studied the biology of the antarctic whales in the *Discovery* which was especially designed for the rugged mission.

Even though the German scientist Fritz Haber was unsuccessful in finding an economic means for recovering gold from seawater, his data on salt-nutrient distribution in relation to plankton proved to be very beneficial.

Deep-ocean research. A Swedish vessel, the *Albatross,* dug deep-sea cores from depths of 25,900 feet in the Atlantic in 1947. In 1950 the Danish ship *Galathea* brought up fish from 23,100 feet below the surface and anemones from as deep as 32,800 feet.

The "scuba" (self-contained underwater breathing apparatus) was invented in 1943 by Jacques Cousteau and Emile Gagnan. Another very useful device was developed by Dr. John Swallow; he made a float that could be sunk to any predetermined depth and then be used to transmit data on water densities to tracking vessels. Through such a device a current was found moving southward at speeds of 2 to 8 miles a day at a depth of 6,500 feet.

Later studies undertaken by Townsend Cromwell found a major current for the Pacific system, now bearing his name, that is at least 3,500 miles long, only 65 feet deep in places, and is centered exactly on the equator.

Multinational oceanographic research. Starting with the International Geophysical Year of 1957, many nations began to cooperate on ocean research. From 1959 to 1965, the collective efforts of scientists from twenty-two nations produced much valuable data for fishery development in the Indian Ocean.

The United States, the Soviet Union (U.S.S.R.), France, and Brazil undertook surveys of the tropical Atlantic off the west coast of Africa, which were called the "Equilant" cruises of 1965-66.

Since 1965 the concept of *global tectonics* has been widely accepted. This concept holds that the earth's crust is divided into approximately eight major plates that move relative to each other. In 1971 the General Assembly of the United Nations adopted a treaty banning nuclear weapons testing or use beyond a 12-nautical-mile coastal zone. This treaty was designed to keep a large portion of the ocean available for the benefit of all people.

Many nations have continued to cooperate in the collection of data on ocean currents, submarine geology, deep-sea marine life, and huge fish populations.

Match these items.

1.1	_____	Hansen	a. start of deep-sea oceanographic research
1.2	_____	Scott	b. one of the fathers of oceanography
1.3	_____	scuba	c. first practical fish tag
1.4	_____	Cromwell	d. coral reef formation
1.5	_____	HMS *Challenger*	e. International Geophysical Year
1.6	_____	*Galathea*	f. current in Pacific at equator
1.7	_____	first multinational cooperative oceanic research	g. antarctic whale research
1.8	_____	Darwin	h. Cousteau and Gagnan
1.9	_____	Maury	i. plankton
1.10	_____	Petersen	j. anemones at 32,8000 feet
			k. fish eggs

Complete these activities.

1.11 Describe Benjamin Franklin's contribution to oceanography.

_____

_____

_____

_____

1.12 List the accomplishments of the voyage of H.M.S. *Challenger.*

a. _____ ,

b. _____ ,

c. _____ , and

d. _____ .

1.13 Use an example to explain how a person may fail in one scientific effort only to be successful in another with unanticipated results.

_____

_____

_____

_____

TEACHER CHECK _____ initials _____ date

TECHNIQUES FOR INVESTIGATION

Special scientific equipment and techniques have aided in the development of oceanography.

Specially designed equipment. During the *Challenger* voyage, a current drag was developed to measure the currents beneath the surface. Looking very much like a box kite, the drag measured the under-surface currents independently of the surface float, which was affected by surface winds and currents.

Another innovation was self-registering thermometers. They record only the maximum and minimum temperatures to which they are exposed during a submersion. A series of these thermometers at certain intervals provides the temperature profile of a location.

The Radio Direction Finder was one of the first electronic applications to aid sea navigation (1907). It was followed by an echo sounder developed in 1922 and by radar, in 1937. Other navigational systems developed for oceanic excursions were *Loran* and *Decca.*

Wave and tide measurement. A problem that plagued oceanographers for many years was tidal prediction solely from the positions of the earth, moon, and sun. Irregular coastlines, varying slopes of the ocean floor, and tidal refraction prevented adequate mathematical solution. Then, in 1844, William Ferrel of the U.S. Coast and Geodetic Survey, developed his tide-prediction machine.

In the early 1900s Stevenson and Cornish developed empirical formulas that related wave height to wind velocity, duration, and **fetch**.

During World War II, our amphibious operations made necessary an understanding of wave theory. Sverdrup and Munk introduced the "significant wave" forecasting method in 1947. Their concept was that the average height of the highest third of the waves in any wave group approximated the period of maximum wave energy.

Acoustic devices. Underwater sonars were developed in 1916. These devices produced sound pulses and received back the reflected echoes at distances up to 600 feet. In another two years their range was extended to 4,650 feet. A variety of acoustic devices have been developed since, such as "pingers," which give a ship its precise distance from the bottom, and subbottom profiles, which determine the configuration of rocky shoals lying beneath the sea.

"Sofar" (sound fixing and ranging) was also developed in World War II to aid in the location of survivors at sea.

Airborne sonars. Airborne wave meters using electromagnetic radiation record the profiles of

waves in much greater detail than can be done aboard ship.

Satellite-mounted sensors are one of the latest pieces of oceanographic equipment. These sensors contact buoy-mounted systems that remain unmanned on station for months at a time, recording valuable data on currents, tides, and waves.

Complete these sentences.

1.14 One of the earliest electronic devices developed to aid navigation was the _____

_____ .

1.15 The configuration of rocky shoals is determined by _____ .

1.16 The range underwater sonars was extended to _____ by 1918.

Complete this activity.

1.17 Describe the characteristics of a current drag.

_____

_____

_____

MAJOR DISCOVERIES

Many of the historical events concerning oceanography proved to be landmark investigations. A number of these major discoveries will be discussed in this section.

Topographical features of ocean floor. Three distinctive areas divide the ocean floor: the continental *shelf,* the continental *slope,* and the sediment covered ocean floor itself, sometimes called the *abyssal plain.*

The continental shelf has a number of ridges, terraces, and canyons comparable to the Grand Canyon. The average width of the shelf, which comprises about 7 percent of the ocean area, is 30 miles. Its slope is generally gradual, about 2 to 3 degrees.

The continental slopes have a more pronounced drop-off. Their angle ranges from 100 to 500 feet per mile.

Deep trenches are abundant, especially in the Pacific. Many mountains rising from the floor are higher than Mt. Everest. All the oceans are divided by an almost continuous system of mountains; the largest system is the mid-Atlantic ridge. Along much of the ridge's length is the rift valley, which may extend as much as 2,400 miles across and rise no more than 1½ miles above the surrounding sea floor.

The mid-ocean ridges are broken by numerous fractures that frequently are the locations of shallow earthquakes.

Seamounts are undersea mountains of at least 1000 meters that rise from the ocean floor, but do not rise above the surface of the water. They are found in the Pacific, Atlantic, and Indian Oceans. Once a seamount has risen above the surface of the water it is redefined as an oceanic island. The Hawaiian Islands are one example.

Small extinct volcanos of more than 500 meters, but less than 1000 meters dot the ocean floor. Collectively, they are known as abyssal hills.

Discovery of life in deepest depths. Mention has already been made of the marine life findings by the Galathea as deep as 32,800 feet. In 1960 Jacques Picard and Don Walsh reported seeing a flatfish at the depth of 35,800 feet.

Undersea habitation by men. In extending his search of the ocean, man has sought to prolong his stay beneath the water. Jacques Cousteau established *Conshelf Two* in 1963, 33 feet beneath the surface of the Red Sea. *Conshelf Two* was the first human colony on the sea floor ever tried with success. Some of his crew remained as long as 31 days, carrying out various underwater investigations and recording descriptions of living and working for such an extended period underwater.

Future source for mineral supplies. Many billions of tons of boron, copper, manganese, uranium, silver, and gold are present in the oceans. Even diamonds have been extracted from the ocean floor; estimates place their values at $4 million.

"Billion of tons" sounds like a tremendous amount. All these minerals, however, are spread out in such vast areas that recovery of most may prove unprofitable. Nonetheless, technology is advancing at such a rapid pace that critical shortages could develop in the foreseeable future. Therefore, greater efforts may be made to extract significant amounts of these minerals dispersed under the ocean. As of 1964 the United States had recovered in solution about $100 million worth of sodium chloride, magnesium, and magnesia bromine and about $15 million worth of sulfur.

Match these items.

1.18	_____	Picard and Walsh	a. extends along the mid-Atlantic ridge
1.19	_____	rift valley	b. covered by sedimentation
1.20	_____	underwater mountains	c. comprises 7 percent of ocean area
1.21	_____	abyssal hills	d. saw marine life at 35,800 feet
1.22	_____	abyssal plains	e. small, extinct volcanoes
1.23	_____	continental shelf	f. seamounts
			g. hot spots

Complete these sentences.

1.24 All oceans are divided by an almost continuous system of mountains, the largest being the _____ .

1.25 Undersea habitation by men for extended periods was pioneered by a. _____ at a station called b. _____ .

1.26 Some of the more important minerals occurring in the ocean are boron, copper, manganese, a. _____ , b. _____ , and c. _____ .

SUBMERSIBLE RESEARCH

Some of the most exciting oceanographic research has been carried out through the use of submersible vessels. The *Conshelf Two* habitation experiment was mentioned earlier. The mission was actually carried out in an underwater research station composed of four main buildings and eight satellite structures. At the 40-feet depth was the Starfish House, a servicing and docking station for the *Diving Saucer,* a small submarine. The eight outlying structures were antishark cages and stock pens for fish captured in the reef. The main building was Deep Cabin, anchored 90 feet down the reef. In this building the Cousteau crew performed their missions.

A research submarine. The *Alvin* is a 22-foot research submarine from the Woods Hole Oceanographic Institution, which had been given the task to recover a "lost" H-bomb. The bomb had plunged seaward just before the crash of a B-52 bomber near Palomares, Spain, on January 17, 1966.

After two months of frustrating searches, the *Alvin* finally spotted the bomb entangled in its chute at a depth of 2,550 feet. During its first recovery attempt, the nylon hoist line was cut and the bomb settled back down on the slope, some 300 feet deeper. Another attempt failed, and the *Alvin* itself was almost lost when the strong parachute canopy started to fall around it like a circus tent.

On April 7, the H-bomb was finally brought to the surface intact. The rescue operation remains one of the more dramatic and complicated missions in the annals of Naval history. The *Alvin* itself had to be rescued in 1968 when it was lost in a deep-water dive. A year later, it was recovered from a depth of 5,000 feet and is now back in service. Her recovery is the deepest ever accomplished to date.

Nuclear submarines. The *Nautilus* and *Skate,* United States nuclear submarines, sailed beneath the North Pole in 1958 gathering important data on the Arctic Sea and the icecap.

Sealabs I and II. Between 1964 and 1968, U.S. Navy men occupied *Sealab I* for eleven days at a depth of 192 feet, former astronaut and Commander Scott Carpenter resided in *Sealab II* for 30 days at a depth of 205 feet.

A third Sealab experiment was to have been conducted at 600 feet, but the tragic death of one of the earlier Sealab divers caused an indefinite postponement.

French and Russian undersea efforts. What are the limits? No one can say for sure. Scientists do know that prolonged underwater submergence can bring about physiological and psychological changes in personnel similar to that experienced by United States astronauts and Russian cosmonauts. The French have successfully sent men down in a pressurized chamber to a depth of 17,000 feet. The Soviets lost a team of divers at a depth of more than 1,000 feet when the tremendous pressures caused a structural failure that led to a fatal pressure reduction inside the cabin.

A bathyscaphe. In 1960, Jacques Picard and Don Walsh descended to a depth of seven miles to the bottom of the Challenger Deep, in the Mariana Trench, to observe the marine environment. Their vessel was the bathyscaphe *Trieste.* It was at this depth that they encountered the flatfish, resembling a sole, 1 foot long and 6 inches wide.

A rescue vehicle. In 1971, the *DSRV-1* (Deep Submergence Rescue Vehicle) made the first submerged mating with its mother submarine in a simulated rescue operation. The *DSRV* is designed to rescue up to twenty-four men at depths of 3,500 feet.

Match these items.

1.27 _____ *Trieste*
1.28 _____ *DSRV-1*
1.29 _____ *Alvin*
1.30 _____ *Nautilus*
1.31 _____ *Sealab II*
1.32 _____ French

a. a research submarine
b. have successfully sent men to an ocean depth of 17,000 feet
c. undersea residence of Commander Scott Carpenter for thirty days
d. lost a team of divers at 1,000 feet
e. a bathyscaphe
f. a nuclear submarine
g. a submergence rescue vehicle

Review the material in this section in preparation for the Self Test. The Self Test will check your mastery of this particular section. The items missed on this Self Test will indicate specific areas where restudy is needed for mastery.

SELF TEST 1

Complete these sentences (each answer, 3 points).

1.01 Sverdrup and Munk introduced the concept of _____ which related wave energy with the average height of the highest third of the waves in any wave group.

1.02 The two submarines which sailed under the North Pole in 1958 were the a. _____ and b. _____ .

1.03 A source of mild earthquakes originating undersea are the numerous _____ , which break the mid-ocean ridges.

1.04 A "pinger" gives a ship its precise distance _____ .

1.05 Airborne wave meters use _____ to record the profiles of waves.

Match these items (each answer, 3 points)

1.06 _____ bathyscaphe *Trieste*
1.07 _____ *Conshelf Two*
1.08 _____ echo sounder
1.09 _____ Sofar
1.010 _____ Hjort
1.011 _____ Forbes
1.012 _____ continental shelf
1.013 _____ fetch
1.014 _____ *Alvin*
1.015 _____ satellite mounted sensors

a. distance of open water over which wind flows
b. locates survivors at sea
c. averages 30 miles wide
d. developed in 1922
e. Cousteau
f. query buoy-mounted systems
g. Picard and Walsh
h. established varying fish colors with depth
i. believed marine life ceased at 300 fathoms
j. rescued at 5,000-foot depth
k. temporary undersea residence of Commander Scott Carpenter

Complete these lists (each answer, 3 points).

1.016 List the two "Fathers of Oceanography."

a. _____ b. _____

1.017 List the three marine biologists who in the late 1800s did much to improve knowledge on fish migration, growth, and life cycles.

a. _____ b. _____

c. _____

Complete this activity (each answer, 4 points).

1.018 In the following chart write the appropriate research vessel for the oceanic mission listed.

Oceanographic Mission	Research Vessel
a. Occupied by 4 men for 11 days, 192 feet depth	a.
b. Makes first submerged mating with mother submarine	b.
c. Observed marine life at bottom of Challenger Deep	c.
d. Lived in by Scott Carpenter for 30 days at depth of 205 feet	d.

63/79 **SCORE** _____ **TEACHER** _____ initials _____ date

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