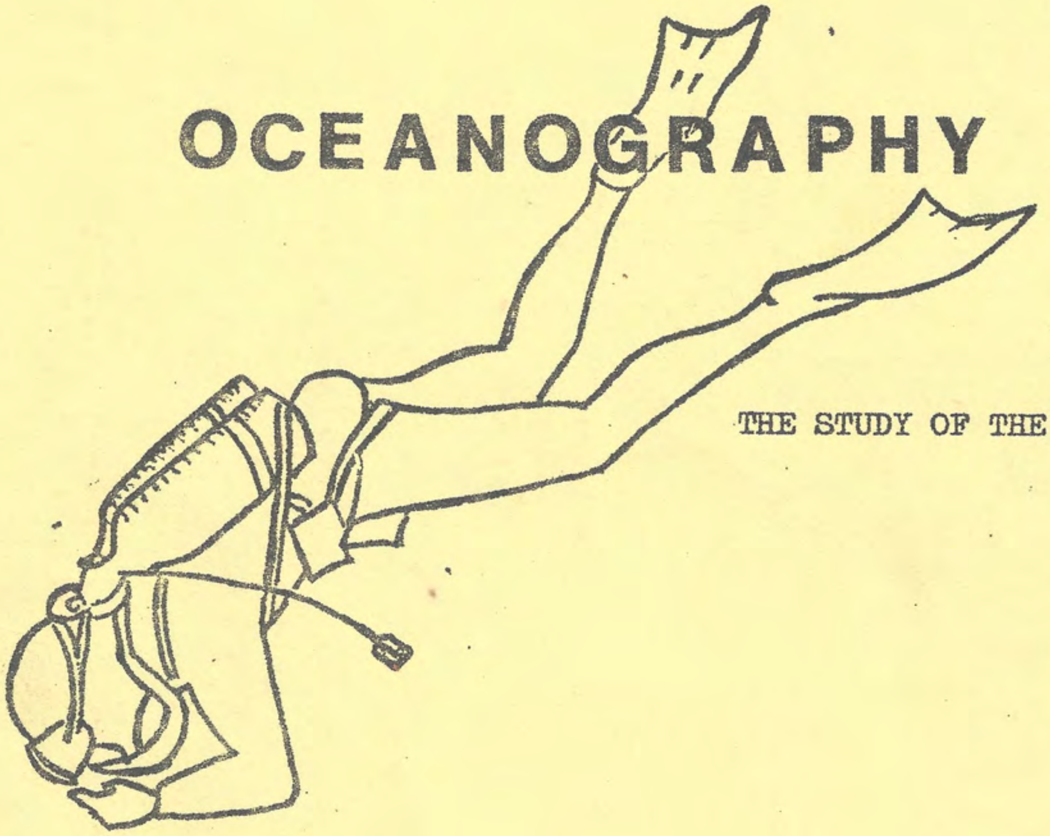
GRADE 11 MULTISTRAND SCIENCE

UNIT 1. THE OCEANS

GOSP GLADSTONE OCEANOGRAPHIC STUDIES PROGRAM

OCEANOGRAPHY



THE STUDY OF THE SEA.

R. D. MOFFATT

+1980

OCEANOGRAPHY

(1)

GRADE 11 MULTISTRAND SCIENCE

"THE OCEANS"

R. Moffatt

Acknowledgements

To R. Jenkins from F.U.S.E. (Australia) for permission to copy the following pages and ideas from "OCEANOGRAPHY" pages 1,8,17, 24,31,35,39,40,41,43,46,47,48,49,51.

To J. Oxenhorn and B. Goldfield from the book "OCEANOGRAPHY - OUR FUTURE" Chapters 4,5,6,8,9,11,14,15,16 - Copied for the purpose of private study for students enrolled in this course.

To A. Martin of the Tasmanian Marine Studies Centre, my thanks go for many of the practical methods for collecting marine organisms and the units on navigation.

To A. Kenny who has persevered with me and the course from its conception, and G. Mitchell for many of the original drawings.

To the Schools Commission Innovation Grants and the Central Queensland Branch of the State development committee for the funds necessary to get the course off the ground.

NOTE TO TEACHERS:

If copying Please Acknowledge the Source.

OCEANOGRAPHY

Why Study The Unit

R. Jenkins
(F.U.S.E. Australia)

The sea is a source of food and minerals; for use as a recreation ground, and serves as a vast highway for the ever increasing traffic between nations. As the world's population increases so do the demands on the sea. To assume that man can continue to make such demands and treat it as a dumping ground for the waste products of its industries and urban communities is NIAVE. Concern and understanding needs to be shown by all who use the sea if its riches are to be safeguarded. All nations, friend or foe, need to comprehend its mystery in terms of the basic processes that explain its past and will determine its future. Hopefully this will lead to a better understanding of its limitations.

I hope this parcel of work will clarify some of the fundamental processes and so enable citizens of the future, in some small way, to make informed opinions and judgements with regard to the future of two-thirds of the surface of this planet.

This unit is the first of two and deals with the following:-

****

MULTISTRAND SCIENCE

O C E A N O G R A P H Y

This unit has the following components:-

1. Unit objective statements - Content/Knowledge
2. Review exercises - at the end of each chapter
3. Assignment - separate study sections
4. Library and resource material
5. Oceanographic skills - Practical exercises to supplement the chapter material

WHAT AND HOW TO STUDY FOR THE EXAM

The objective statements are CRUCIAL. If you are able to write complete and correct answers to these you will do well in this course. All EXAM questions are written from these objectives. We will give you the answers throughout the course - it is up to you to keep an accurate and complete record of your daily work

ONE MODULE IS REQUIRED FOR THIS

WHAT ABOUT PRACTICAL WORK

This will be worth approximately half of the course. A separate module is required for this. In addition, a LABORATORY RESULT book will be required. So that each person gets an individual mark and there can be no advantage to any student by copying, the best ten (10) practical experiments will be chosen for assessment and the following rules will apply:-

1. Both teacher and students to decide on how many days shall elapse before the practical due date. Once decided, this shall remain in force for the Semester.
2. All practical work must be kept in a laboratory module and should contain the following write-up procedure:-
   (a) Title______________ Date / /
   (b) Introduction: Why do this Practical - Aim
   (c) Methods
   (d) Results
   (e) Discussion
3. Your Laboratory Result Sheet must be handed in with the completed Practical
4. If you are absent from a practical you will receive no mark, and so will not be required to write the Practical up. However, you will then have your "best 10 chances" reduced and there is a minimum of 10 Practicals that have to be completed per Semester

These rules are to ensure everyone gets a fair go. RM 29/1/80

Chapter 1. Studying the Oceans

Objective Statement - CONTENT -

You are making good progress if you can:

1. Relate some of the statistics associated with the oceans with their immense size and distribution.
2. Explain the significance of the Challanger's Voyage.
3. State the ratio of area of sea to land.
4. Explain the hydrologic cycle.
5. Write a definition for oceanography
6. Read a passage of work independently.

Objective Statement - PRACTICAL WORK -

You are making good progress if you can:

1. Clean glassware for use in this course with a chromic acid solution.
2. Distill 25 mls. of sea water.
3. Realize what is required for the practical work in this course in terms of:
   a) Safety procedures.
   b) excursion details.
   c) due dates.
   d) how to write up practicals.
   d) distinguishing results from conclusions and methods.

Read About the Sea: TOWN LIBRARY Check out the 500.9 's.

Girl on the Ocean Floor. General Reading.	500.92	
The opean Sea, A. Hardy	574.92	Har.
Oasis in space, J. Ccusteau	574.92	Cou.
A guide to the Seashores, P. Ingle	574.92	Ing.
Life on the Australian Seashore, McKeon	574.92	Mke,
The Great Barrier Reef, I. Benrett	574.92	Ben
Australian Sea shores , Dakin	574.92	Dak.

Wanta Finda Job ??

Oceanography has 3 job areas,

(a) Professional in the fields of Marine Biologist, Marine Scientist: (See Mr. Hersey for details or write to any of the following Uni. of Q., J.C.Uni., C.I.A.E. or to the Marine Sciences Institute in Townsville)

(b) In the Technical Fields of Sea Going Personell - The T.A.F.E. has 4 courses to qualify you for jobs ranging from deck hand to Ships Master

(c) As a decki, with no formal qualifications other that your certifiwate from school. This course may make you realize or discover a love of the sea that never once before existed.

UNIT 1 THE OCEANS

WHAT'S IT ALL ABOUT?

Seventy-one percent of our earth, almost three-quarters - is covered by water. No wonder our oceans have been the subject of a lot of study and interest.

Scientists are pretty sure that all life began in the sea. Early man wondered at the nature of the sea. The roar of the ocean, the power of crashing waves and vast sights "without end" made for mystery and fear for him. In early times, the sea was man's "highway," and much of our early history was made on or near it.

Man's first trips to the sea were made close to shore in small, crude ships. Mostly he searched for fish, which were precious food. Later, he developed larger boats and took to the seas for adventure. His explorations brought him to new lands - lands of strange people, unheard-of plants and animals, precious metals, and gems. His travels also changed his whole idea of geography. The early explorers took a scientist with them. Joseph Banks came with the Endeavour.

But it was not all adventure and romance. The hardships of the seas brought death and destruction. Also, mighty warships were used in bloody sea battles in long wars among nations.

Now there is a new day in history. Our explorations are made not only on the ocean but also in the ocean-deep down and on the bottom. It is no longer enough to know how to handle a ship. It is a complicated business of science and engineering; of experiments and tests and data. Nations are still rivals, but their search in the oceans is now friendly and co-operative.

And so we turn to the science of OCEANOGRAPHY. In our first Unit, we shall study the oceans, explore their depths, and their currents, and look at some of the methods oceanographers use to study the Oceans and it's Chemistry. (Kem - is - tree)

1-1 THE LOST ATLANTIS

The stories of the early Greek writers tell us that a great island was once located in the Atlantic. The island, which was called ATLANTIS was inhabited by a very strong and proud people who wished to conquer all of Europe. The Greeks wers supposed to have saved the Europeans from the invading armies of this ocean kingdom. For its wickedness, the island was struck by an earthquake which lasted a day and a night. The island disappeared into the sea - never to be seen again.

Is this just a tale? Is there really a lost city lying somewhere in the Atlantic? We may never know. But this story does serve to point out our early interest in the sea. Today more than ever, the seas and oceans are being studied and talked about. Let's find out...

1-2 WHO STUDIES THE OCEANS?

A lot of people have been studying the oceans for a great many years. There are NAVIGATORS who are concerned with ocean travel. There are map makers, direction finders, and place locators. There are

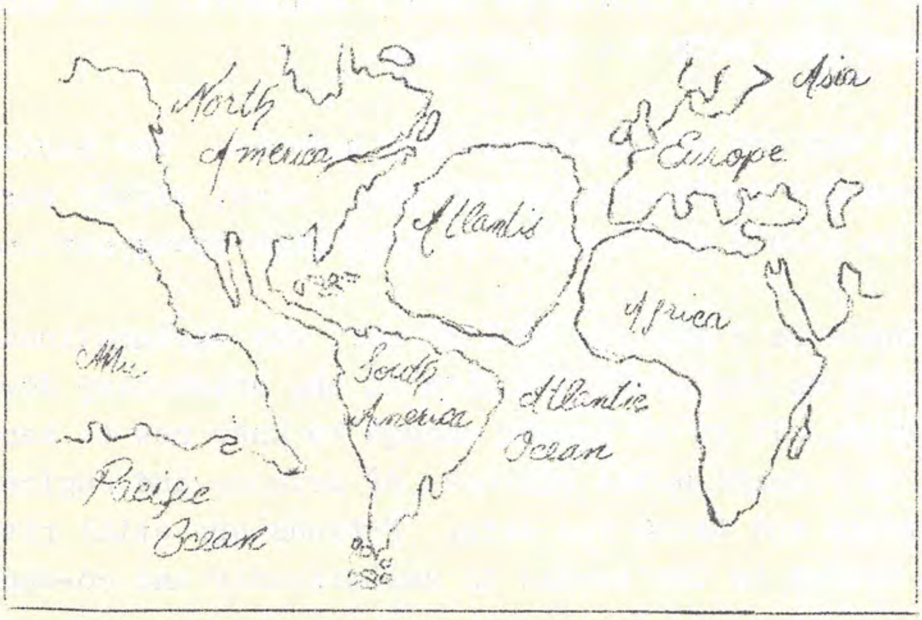


Fig 1. Atlantis, the "lost island" of an ancient legend.

GEOGRAPHERS. More recently, there are the new scientists, the OCEANOGRAPHERS (o-shu-NOG-ruh-furz).

What is oceanography the study of? The answer is: anything and everything about oceans. To give you a better idea of what this means, let's look into the work of some of the early oceanographers.

Matthew Fontaine MAURY (MAW-ree), an American naval officer, is known as the "Father of Oceanography." He was most interested in the PHYSICS of the sea. He studied currents, depths, climates, and temperatures for many years. From his observations, he developed charts of winds and currents month by month. Later in his life, he published the first real textbook about oceanography.

Edward FORBES was a Scotsman who studied living things found in the sea. His interest was in BIOLOGY. He investigated how far down in the sea life could exist.

The oceans have been called the "largest water solution in the world." Many chemicals, both elements and compounds, are dissolved in the oceans. Oceanographers must therefore study the CHEMISTRY (KEM-is-tree), or composition, of ocean water.

The oceans are also really a part of the earth - the water over the crust of the earth. Therefore, oceanographers study rocks and rock movements. That part of their study is called GEOLOGY (jee-OL-uh-jee).

1-4 THE GREAT VOYAGE

December 21, 1872, was a cold rainy day. The 2,300-ton ship was ready to set out from England. What a strange ship! It had chart rooms, microscopes, bottles, tanks, and nets. The 223 crew members and scientists stood at attention on the deck as the ship slipped away. It was the research ship CHALLENGER - the greatest ocean studying vessel of its time.

It sailed around the world's oceans for 3½ years. Scientists aboard collected all sorts of information. They drew maps of the ocean bottom. They took bottm-of ocean temperatures. They located the exact positions of many islands and rocks. Many new animal groups were discovered.

The results of these studies were published in 50 large books.

As we shall see later, today's ocean research ships are very complicated floating laboratories.

Learned so far -

* Oceanography is a combination science of the physics, chemistry, geology, and biology of the oceans.
* Maury and Forbes were early oceanographers.
* The Challenger was a nineteenth-century ocean research ship.

1-5 THE EARTH AND ITS WATERS

The outer surface, or CRUST, of the earth is made of rock. The CONTINENTS lie on GRANITE (Gran-it). Granite is rock formed millions of years ago by the slow cooling of liquid minerals. The oceans lie on BASALT (buh-SALT).. Basalt is rock formed when the LAVA (LAH-vuh) of ancient volcanoes cooled rapidly.

Almost three-quarters of the earth's surface (71 percent) is covered by water. This part of the earth is called the HYDROSPHERE (HY-druh-sfeer). The hydrosphere is really one big ocean. Sticking up out of the water are the various large masses called CONTINENTS and smaller masses called ISLANDS. For purposes of geography, we call different parts of the ocean by separate names. There are 4 oceans and 21 seas. Some geographers now speak of one ocean: The World Ocean.

Examine Fig. 1-2 below. This shows how the waters of the earth are distributed. You can now understand why we refer to a "water hemisphere" and to a "land hemisphere."

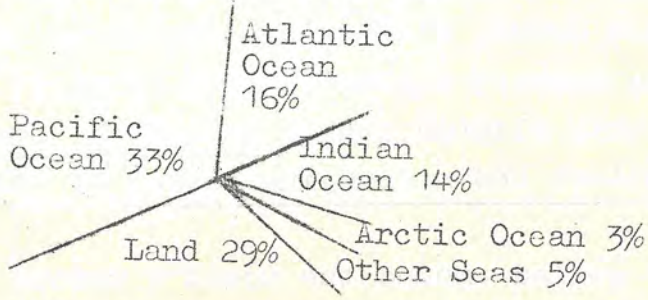


Fig. 1-2 Where is most of the land? Where is most of the water? Add the percentage of water in the three smallest oceans. How does this compare with the Pacific Ocean?

1-6 WHERE DID THE WATERS COME FROM?

Let's imagine we have a special time machine that can take us back billions of years to the earth's beginning. We set the dials of our time machine for 4½ billion years. Away we go!

What does it look like? Everywhere we see hot rocks with huge open cracks. These cracks lead to active volcanoes. We see vapor (steam) oozing out of the cracks. The vapor escapes into the atmosphere to form clouds.

If we returned a billion years later, we would find that the earth had begun to cool and had formed huge amounts of liquid water from the clouds. This is the process of CONDENSATION (kon-den-SAY-shun). The waters began to collect in the ridges and valleys to form the early oceans.

There was a time when the water kept changing to vapor as it touched the hot rocks. Then it condensed again. When the rocks finally cooled, the great ocean basin was formed.

Why doesn't the water leave the oceans now? Or does it? Follow the water cycle in Figure 1-3 below. Its scientific name is the HYDROLOGIC (hy-druh-LOJ-ik) cycle. Start with the ocean.

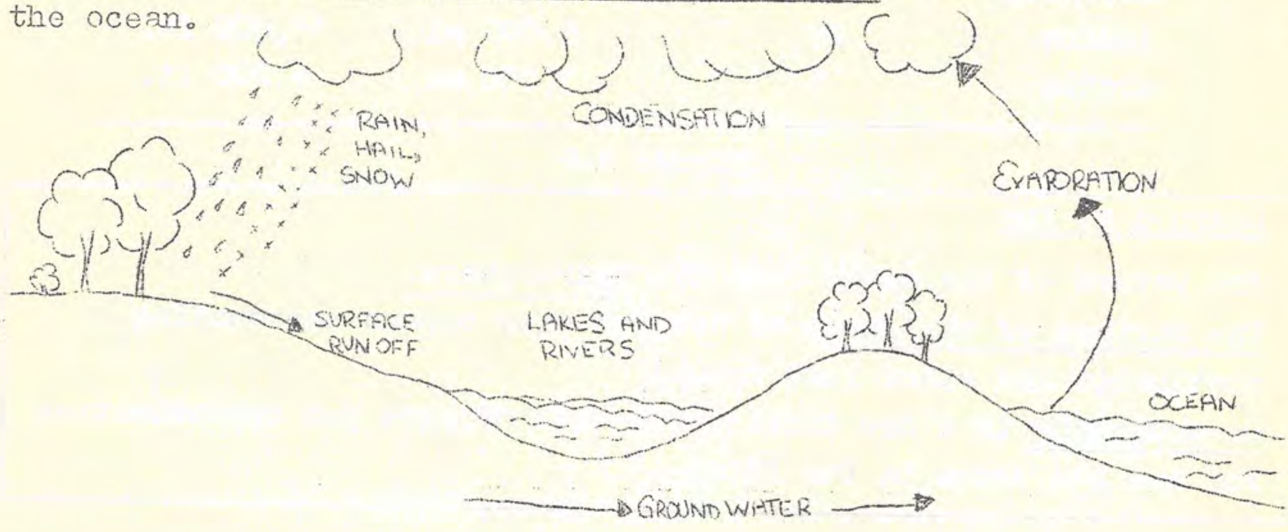


Fig. 1-3. The hydrologic cycle. What happens to rain, snow, and hail? Does the water from rivers and streams always enter the ocean immediately? Explain your answer.

1-7 OCEANOGRAPHY AND YOU

The oceans are part of our environment. They have a great influence on our weather and climate. They give us a means of transportation. They provide food. Eighty-five percent of the world's oxygen is produced in the oceans. They are rich in minerals and oil. They are a source of great wealth for the future of humanity.

Is there a future for you in oceanography? With the sudden burst of interest in oceanography, many people will find new careers. Some will become oceanographers as scientists. Some will be skilled workers on ships. Some will work in shore plants or laboratories. We will visit the Fish Board to learn more about the fishing industry, and discuss careers in Marine Science and courses in the Navy and in the fields of technical and further Ed.

OCEANS OF THE WORLD

Ocean	Millions of Square Miles	Width	Average Depth
Pacific	64	10,000 mi.	14,000 ft.
Atlantic	32	3,600 mi.	12,800 ft.
Indian	28	6,000 mi.	13,000 ft.
Arctic	5	3,000 mi.	4,000 ft.

Figure 1-4

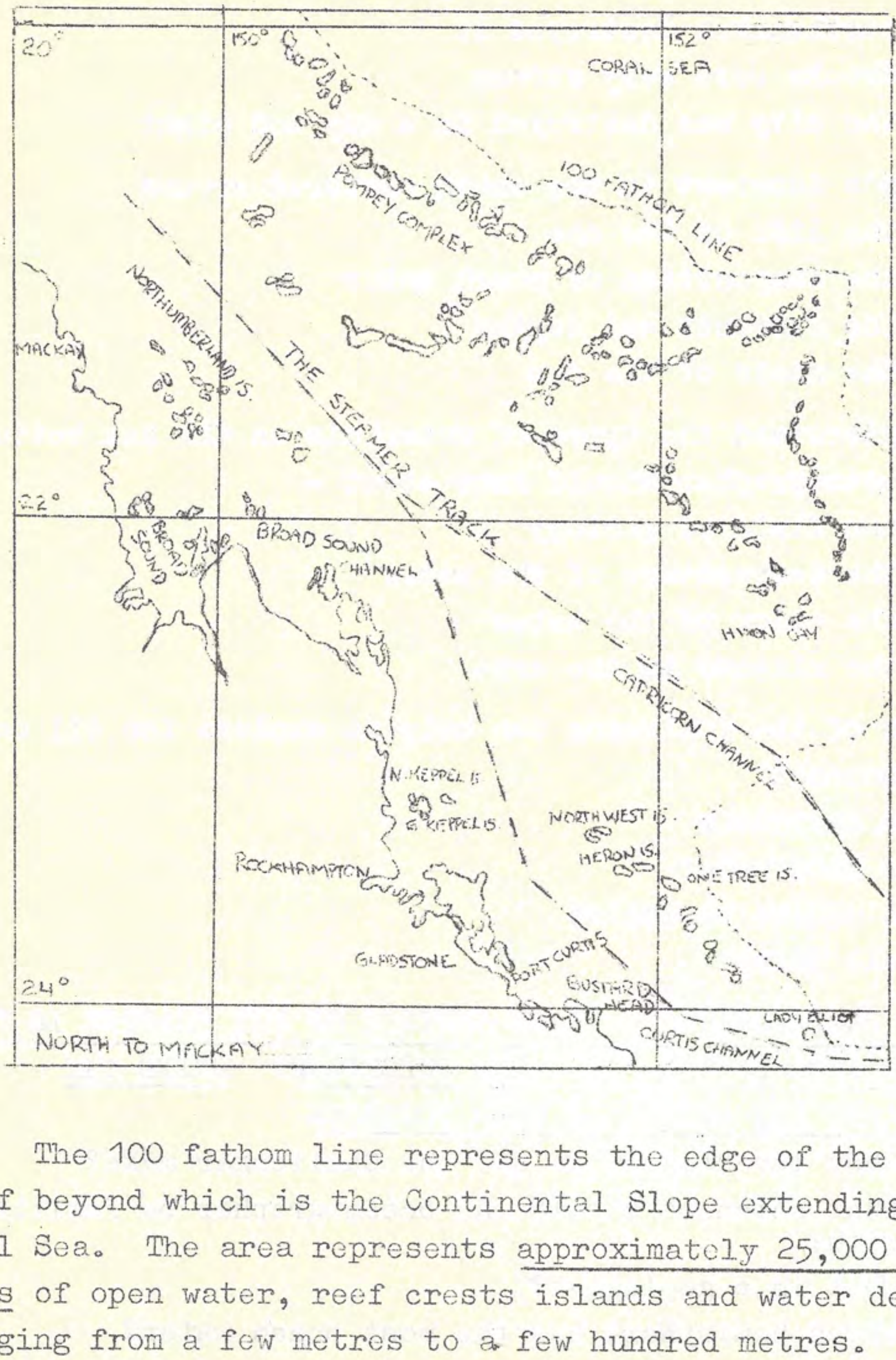
Learned so far

The waters of the earth form the hydrosphere.

The surface of the earth is covered with oceans surrounding continents and other land forms.

Oceanography is a new field which will provide job opportunities for men and women in the future.

1-8 THE OCEAN ADJACENT TO GLADSTONE



The 100 fathom line represents the edge of the Continental Shelf beyond which is the Continental Slope extending into the Coral Sea. The area represents approximately 25,000 square miles of open water, reef crests islands and water depth changing from a few metres to a few hundred metres.

Any Oceanographic (O - cheno - graphic) study of this area requires knowledge of three things, namely:

(a) how deep the water is
(b) how far from land
(c) how far from reef

We will study this in chapter 2; and other methods that Oceanographers use to study the sea.

I REVIEW EXERCISES

I. FIND THE ANSWER. WRITE IT IN YOUR NOTEBOOK

1. The tale of the lost city of Atlantis reminds us that
   - a. civilization had an early interest in the sea
   - b. earthquakes destroyed it
   - c. Greeks were very strong
   - d. the city was destroyed in a day and night
2. Maury's interest in the ocean centered around
   - a. the life of the sea
   - b. the composition of ocean water
   - c. the currents and depths
   - d. the rocks of the sea
3. To understand the types of materials on the sea bottom, an oceanographer should know about -
   - a. the field of geology
   - b. the temperature of the water
   - c. the color of the water
   - d. the climate in the area
4. Which of the following can help us explore for oil under the oceans?
   - a. a navigator
   - b. a geographer
   - c. a marine biologist
   - d. all three

II. FIND THE EXPLANATION IN WHICH SECTION OF THE CHAPTER IS THE ANSWER TO EACH OF THE FOLLOWING QUESTIONS? WRITE THE QUESTION AND THE ANSWER IN YOUR NOTEBOOK

1. What investigations did the Challenger make?
2. What sciences should the oceanographer be familiar with?
3. What is a geologist?
4. Which hemisphere has the most ocean water?

III. TRUE OR FALSE? IF THE STATEMENT IS TRUE, WRITE TRUE. IF THE STATEMENT IS FALSE, GIVE A WORD TO BE USED INSTEAD OF THE CAPITALIZED WORD, SO THAT THE STATEMENT WILL BE TRUE

1. Matthew Maury was interested in the BIOLOGY of the sea
2. The ATLANTIS made a famous oceanographic voyage
3. The study of the oceans is known as OCEANOGRAPHY
4. the HYDROSPHERE forms seas, bays, and oceans

II RESEARCH ACTIVITIES

I. Read Science for Secondary Schools extract Book 2. Pages 262 - 267, up to wind, waves and currents

II. Read In Search of Science extract Book 2 Pages 274 - 276.

III. Answer: "It has been suggested that our planet, the earth, would have been better named the OCEAN. What reasons would you give to support this suggestion?"

IV. Answer Q 3 In search of Science Book 2 Page 283

III PRACTICAL ACTIVITIES

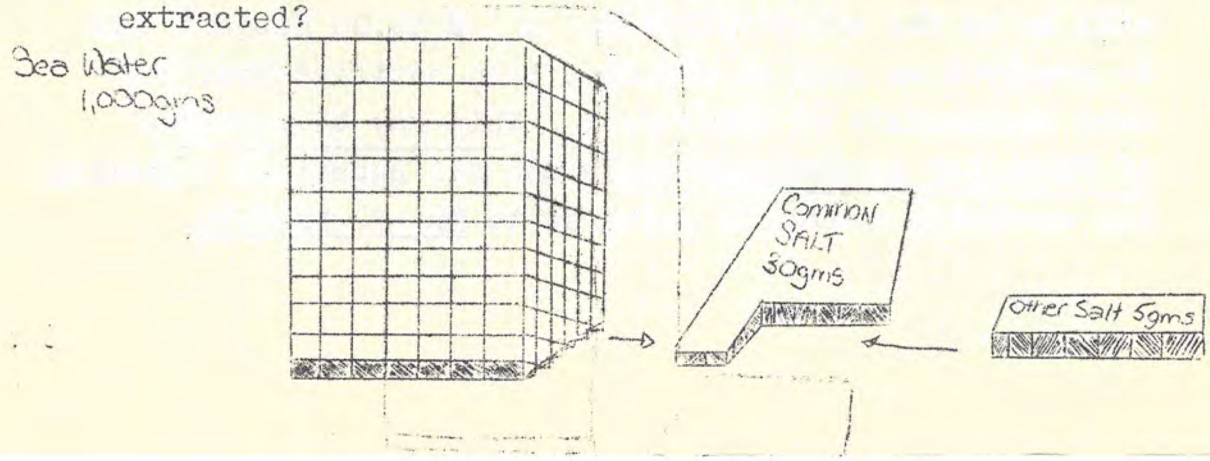
I. The cleaning of laboratory glassware - see P. 1 Lab. Manual

II. The distillation of sea water - see P. 2 Lab. Manual

IV STUDY ASSIGNMENTS.

Use any reference material to assist your answers

1. The distribution of the ocean in relation to the land masses has changed over the years
   (a) How did they appear 250 million and 50 million years ago?
   (b) How can scientists account for these changes?
2. Find a map that indicates the contour of the oceans depths (Reader's Digest Atlas or National Geographical)
   Compare the height of the seas mountains with those found on the land
3. Read Kon-Tiki or Ra III and write about Thor Heyerdahl's discoveries and his respect and concern for the sea
4. Draw up a chart of 'Facts about the Earth's Oceans'. Illustrate, if possible, for classroom display
5. Prepare a model of one area of an ocean's floor -
   Gladstone Harbour } of plaster of Paris
   Boyne River
6. Elements in the Sea. Use chemistry reference books to find out if the following elements are in sea water: mercury, silver, lead, gold, platinum. Why aren't these metals extracted?



Chapter 2. Oceanographic Methods

CONTENT OBJECTIVES

You are making good progress if you can:

1. State that (a) Oceanography as a Science depends on observation to develop theories
(b) Theories are tested by experiments
(c) Oceanographers work in the field and in the laboratory

2. Draw the following pieces of equipment:

(a) A Nansen bottle
(b) A Secchi disc
(c) A plankton net
(d) a dredge
(e) a corer

3. Explain how a sounder works and explain its significance.

PRACTICAL OBJECTIVES

You are making good progress if you can:

1. Recognise the main symbols on a chart of Port Curtis 224.

2. ****Plot a safe course from Auckland Creek inlet to Heron Is and Masthead and Navigate in 8Hrs. Lab 3.

3. Measure the transparency of sea water Laboratory Excercise 6

4. Measure the temperature of a sea water sample Lab Ex 4.

****

Special Note:

At the conclusion of Unit I, and in the first Week in May, there will be a 5 Day excursion to Masthesd Is for 30 students . To qualify for this excursion we want good students who are interrested in the subject with a personal drive and the love of doing a job as well as it can be done. As the amount of effort to get us to the reef will be extremly high we want people who demonstrate that they can and will get the maximum benifit from such a trip. The excursion is open to all and selection will be on the above criteria. A Ø 50.00 deposit will be required as soon as you have been notified that you were successfull in selection. This may be refunded if financial hardship prevails and all questions regarding the excursion should be referred to Mr. R. Moffatt.

CHAPTER 2: METHODS OF OCEANOGRAPHIC STUDY

2-1. HOW DO WE STUDY OCEANOGRAPHY?

Oceanography is a science. As in other sciences, the most important method of learning is by observation. Observation means careful watching. Observation uses all senses, not only sight. For example, an oceanographer listens to echoes in the ocean. He may smell a sample of water. He feels the rocks, the seaweed, and the sea animals with his fingers.

As the oceanographer makes his observations or collects DATA, he keeps careful notes. From his observations, he develops a "hunch" or HYPOTHESIS (hy-POTH-uh-sis) as a temporary explanation. As he gathers more facts, his hypothesis may become a THEORY (THEE-uh-ree), which is a stronger explanation.

Like other scientists, the oceanographer performs investigations or EXPERIMENTS to test the truth or error of his hypothesis or theory. Some theories hold up and are accepted; others are found to be wrong and are thrown out.

2-2. WHERE DO WE STUDY OCEANOGRAPHY?

Your first answer might be, "In or on the oceans." A better answer is "Indoors, outdoors, everywhere."

The oceanographer travels to distant places to study special areas of the ocean. He goes below the surface of the oceans, sometimes to the very bottom. Often he works at the seashore.

Can you study oceanography indoors? Of course.

Indoors, the oceanographer studies his samples, arranges his data, and sets up his experiments. He works in a modern, well-equipped LABORATORY.

Like other scientists, the oceanographer is often in the library, reading about the data and the experiments of other oceanographers. Sometimes he meets with other oceanographers at conventions to discuss problems with his fellow scientists.

2-3. TAKING MEASUREMENTS IN OCEANOGRAPHY

Science is precise. The scientist cannot always trust his senses. He therefore uses instruments to get his measurements.

As a scientist, the oceanographer uses well-known instruments. For example, he uses thermometers to measure temperature. He uses barometers to measure pressure. He uses tapes and rulers to measure distances. He uses scales to measure the mass of objects (measured as weight).

The units of his measurements may be either English or metric. But in addition to the usual scientific instruments, oceanographers use very special equipment. We shall learn about it in the section that follows.

LEARNED SO FAR

- Oceanography, as a science, depends on observation to develop theories
- Theories are tested by experiments
- Oceanographers work outdoors (in the field) and indoors (labs, libraries and conventions)
- Oceanographers use instruments for precise measurements.

2-4. LIMITS IN THE DEEP WATER

When you dive to the bottom of a pool, do you feel your ears get stuffy? This is because water pressure becomes greater, the deeper you go. There is a limit to how far down we can go into the sea. The limit for a diver using the COMPRESSED air unit for breathing is about 450 to 600 feet. Of course, divers have gone to greater depths in special chambers. One such dive took two men to a depth of 38,000 feet. In this ch. we shall learn more about deep diving. and in Lab Excercise 7.

2-~~5~~. FLOATING LABORATORIES

To transport tools to the sea, the oceanographer uses well-equipped research vessels. These vessels are outfitted with laboratories for advanced work at sea. Usually, the ships are run by a university or government organization.

The Atlantis II is a vessel operated by the Woods Hole Laboratory in Massachusetts. It is 210 feet long and can carry 25 scientists and 28 crew members. The ship has a controlled-temperature aquarium, a fully equipped machine shop, and an underwater observation chamber. There are four large laboratories on board.

2-6 TRAPPING A WATER SAMPLE

Today, the oceanographer uses an instrument known as the NANSEN BOTTLE (NAN-sun). A special tube traps water at a certain depth and records its temperature. It is more accurate than the bucket and line, since the temperature of ocean water changes as you go deeper. Back on board ship, scientists perform further tests on the water. For example, they may check the amount of OXYGEN (OX-uh-jin) or test its salt content.

NANSEN BOTTLE

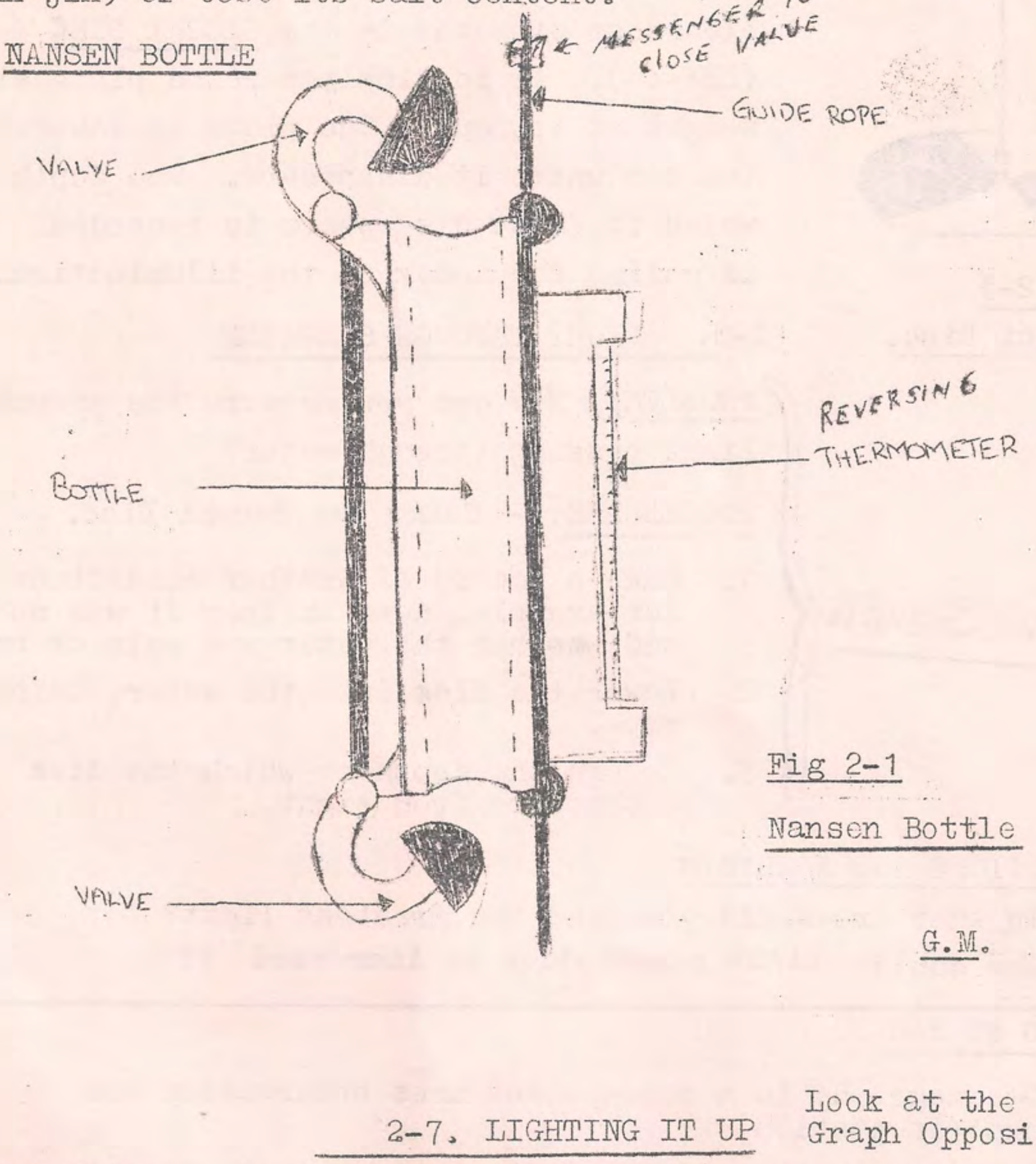


Fig 2-1

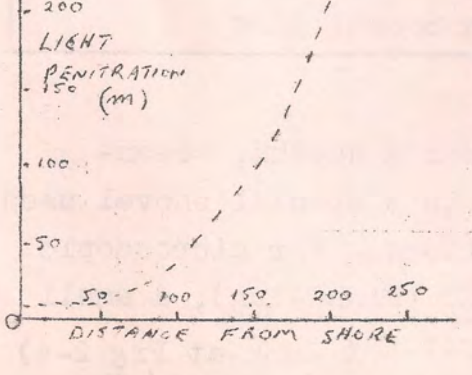
Nansen Bottle

G.M.

2-7. LIGHTING IT UP

Look at the Graph Opposite

Fig 2-2 Light Penitration...



It has been said that the sea is a dark, silent world. This is true in the deeper parts of the ocean. But in the shallow coastal regions, light does go through. Marine biologists are interested in how far into the sea light can reach, since plants can grow only where there is light. The depth to which light can reach depends upon the clearness of the water.

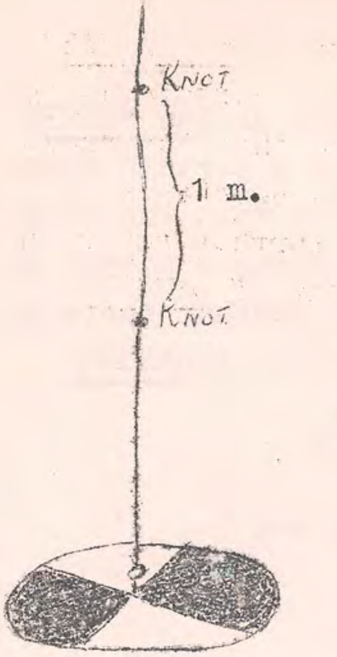


Fig 2-3
Secchi Disc.

What makes one body of water clear and blue and the other green and cloudy? We will learn that MICROSCOPIC plants and animals are found in seawater. When they are present in great numbers, the water can become green and cloudy. Light could not pass very far into such water.

A simple instrument to measure the clearness of water is the SECCHI DISK (SEK-ee). It is simply a round plate with a weight at its end. The plate is lowered into the sea until it disappears. The depth at which it first disappears is recorded. This is called the index of the illumination.

2-8. LIGHT THROUGH SEAWATER

CONSIDER

PROBLEM: How can you measure the amount of light passing through water?

PROCEDURES: - Using the Secchi Disc.

1. Make a record of weather conditions. For example, note whether it was sunny, and whether the water was calm or rough.
2. Lower the disk into the water, using the rope.
3. Record the depth at which the disk disappears from sight.

OBSERVATIONS AND ANALYSIS.

1. In what areas did you find the greatest light?
2. How could light penitration be increased ??

LEARNED SO FAR

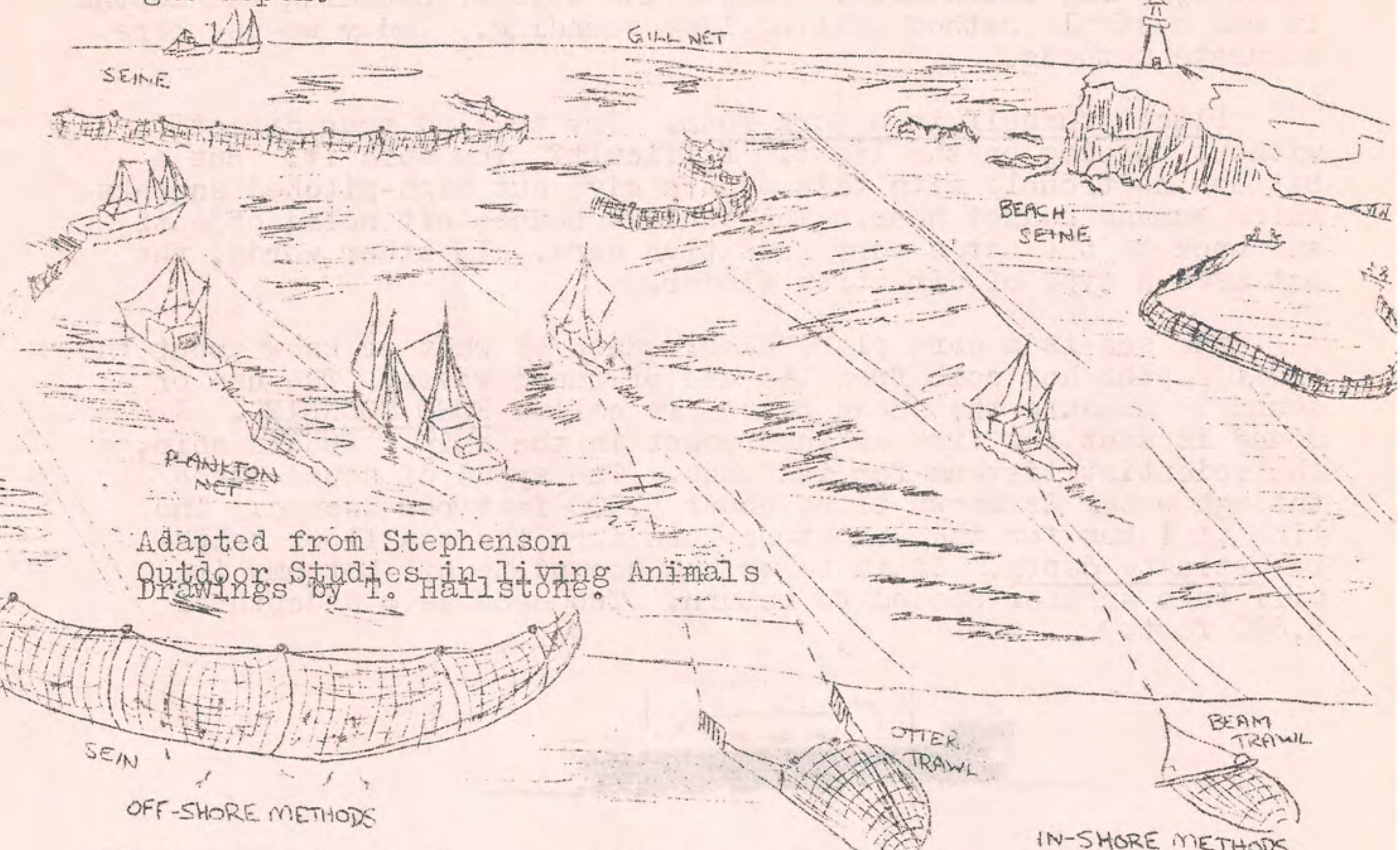
- Oceanography is a science and uses observation and experimentation
- Oceanographers must use instruments to make precise observations of the sea
- To trap water samples, scientists use Nansen bottles
- Light penetration is measured with a Secchi disk

2-9. A DEEP-SEA SAFARI

To collect animals and plants from the ocean's depths, oceanographers use NETS and DREDGES. A dredge is a special shovel used to scoop up material from river or sea bottoms. For microscopic animals and plants, they use a PLANKTON NET (PLANK-tun), a small cone-shaped net which is towed behind a boat. (Look at Fig 2-4)

......./ 19

To collect fish, the scientist uses the MIDWATER TRAWL. This is a large net which uses a weight to keep it at the right depth.



Adapted from Stephenson
Outdoor Studies in living Animals
Drawings by T. Hailstone.

Strange as it may seem, a story may be told from a mud sample taken from the ocean floor. A sample from the sea may give the geologist a clue to the age of the earth. To obtain these samples, a CORER is used. It is simply a long tube which is pushed into the sea bottom. A small cylinder of mud is then trapped inside the tube. We shall learn more about the corer in a later chapter. In some cases a sediment sampler is used to bite into the ocean floor. This is then pulled to the surface with a winch and samples are analysed and looked at on the boat.

SEDIMENT SAMPLER

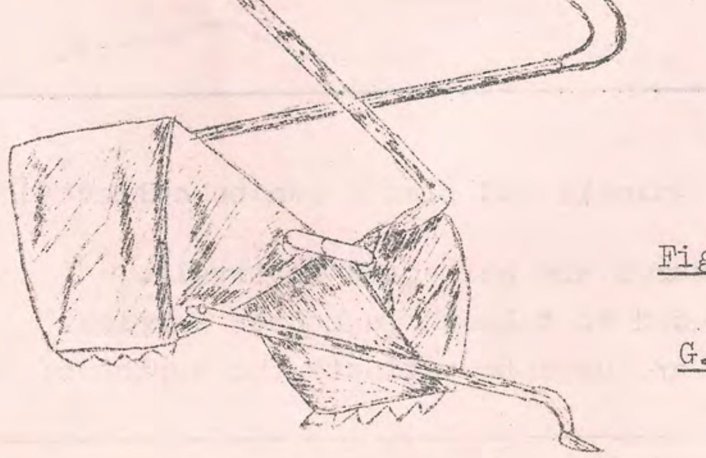


Fig 2-5.

G.M.

2-11 PROBING THE DEPTHS

How deep is the ocean? This was one of the first questions asked by early scientists. They found ways of sounding the depths It was a simple method calling line sounding. Today we use more accurate methods.

Place yourself in a dark room. Try to find your direction without turning on the light. Difficult? You said it! But a bat has no trouble with this. Bats give out high-pitched squeaks which humans cannot hear. The squeaks bounce off solid objects and back to the bat's very sensitive ears. In other words, the bat uses a type of direction finder.

The sea is a dark place also. Much of what we know about the great depths has come from the use of sound waves. The use of sound to measure the ocean bottom is called ECHO SOUNDING. A sound is sent out from an instrument in the ship. Aboard ship, the scientist listens for its echo. The speed of sound waves through water is known to be about 5,000 feet per second. The time it takes for the echo to return from the sea floor helps to estimate depth. If it takes one second to hit bottom, it will take another second to return. Two seconds = a depth of 5,000 feet.)

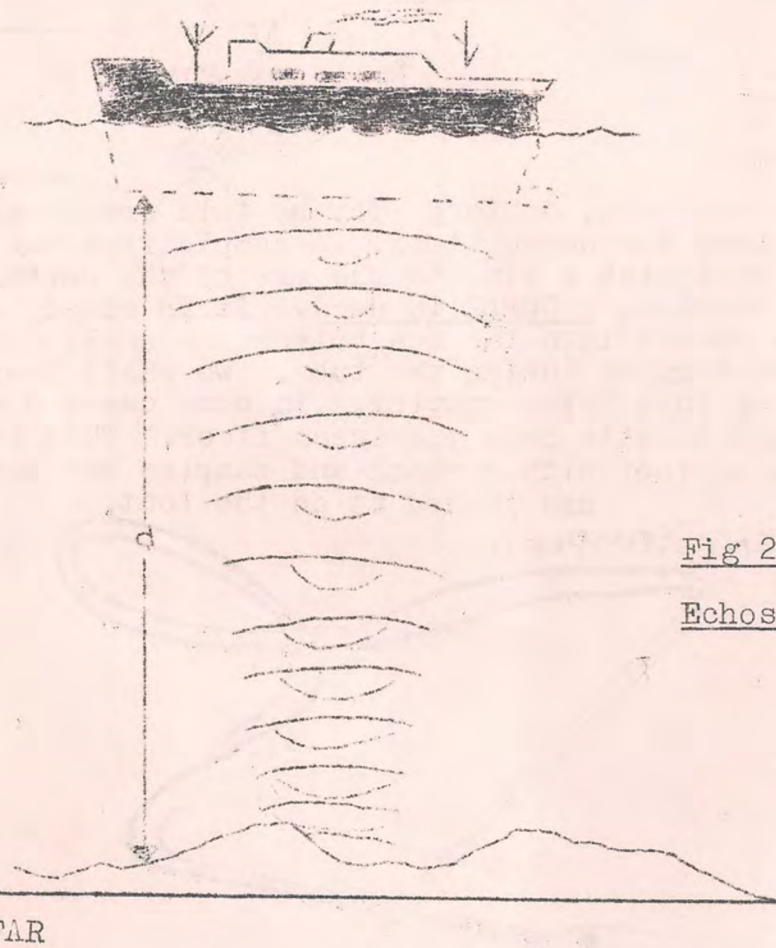


Fig 2-6.

Echosounding.

6 M.

LEARNED SO FAR

- Microscopic animals and plants can be collected in special nets.
- Larger creatures are collected in trawls.
- A corer is used to take whole bottom samples.
- Sound waves are used to estimate the depths of the ocean.

I. REVIEW EXCERCISES.

1. FIND THE EXPLANATION. IN WHICH SECTION OF THE CHAPTER IS THE ANSWER TO EACH OF THE FOLLOWING QUESTIONS? WRITE THE QUESTION AND THE ANSWER IN YOUR NOTEBOOK.

   a. How can our senses be used to study science?

   b. Why is it important to know the speed of sound waves when using the echo sounder?

   c. What could cause water to lose its clearness?

   d. Where is oceanography studied?

2. FINISH THE STORY. USE THE WORDS FROM THE LIST BELOW. WRITE THE STORY IN YOUR NOTEBOOK.

   An Oceanographic ship is travelling out to sea. The scientists plan to study the depth of the ocean. They will use (1) ______________. To study water clearness they will make use of the (2)________________. The scientists plan to collect some microscopic life. They will use the (3) ________________. Some scientists are interested in the age of the earth. They plan to take some (4)________________.

plankton net	core samples
echo sounding	Nansen bottle
dredges	research vessel
	Secchi disk

3. a. What is one of today's biggest problems in studying oceanography? Why?

   b. Why should every experiment be written up clearly?

   c. How is scientific research like detective work?

   d. Why is there so much talk about changing the United States's system of measurement to themetric system? Do you approve? Why?

4. ONE WORD DOES NOT BELONG WITH THE OTHER THREE, WRITE THE WORD.

   1. Depth, echo, color, sound.

   2. Color, light, clearness, core.

   3. Net, trawl, dredge, Secchi disk.

II PRACTICAL ACTIVITIES

1. Looking at the GLADSTONE OCEANOGRAPHIC STUDIES PROGRAM'S EQUIPMENT. Arrange for the boat and gear to be brought to the school or walk over to the opportunity school and examine the equipment there.

2. Chart Reading and NAVIGATION - Lab. Exercise 3.

3. Using a Secchi Disc - Lab. Exercise 6.

4. Measuring the temperature of Sea Water - Lab. Exercise 4.

III AUDIO VISUAL

1. View the Video tape on Marine Studies B. & W. at the Boyne River - See David Kopelke.

2. View the Video tape on the Marine Studies Centre from Tasmania.

3. View the slide set on the GLADSTONE OCEANOGRAPHIC STUDIES PROGRAM.

4. View the film - "PLANKTON AND THE OPEN SEA" Cap. Ed. Centre. (This may be better left till the Unit on the Chemistry of Sea Water is completed.)

Chapter 3. Exploring the Deep

Content Objectives

You are making good progress if you can:

1. Recall that
   - (a) Diving depth is limited by temperature pressure and lack of O_2.
   - (b) Diving suits solve some problems, but the diver is not "free".
   - (c) Scuba frees the diver by giving him an air supply.
   - (d) Diving suits are a new form of protection.
   - (e) Face masks protect the diver's face and swim fins help increase speed under water.
   - (f) Underwater spheres and submarines can bring scientists to great depths for research and study.
   - (g) Submersibles are equipped with many scientific instruments for underwater research.

2. (a) Explain that pressure in liquids increases with depth and density.
   - (b) Explain why density of liquids varies with temperature.

3. (a) Explain how engineers have designed means of controlling depth of immersion.
   (b) Describe some of the machines used by explorers.

4. (a) List some reasons why humans explore the oceans.
   (b) Discuss the types of resources which might be obtained from the oceans.

Chapter 3. Exploring the Deep.

3-1 LOOKING BACK...

If you've ever tried diving, you know that you can stay under water for less than a minute. Some professional divers are able to last for a little over two minutes. The record for a breath-holding dive is 217½ feet in 40 seconds. How, then, can a person stay under water for longer lengths of time?

The first way was with the "old-fashioned" diving suits. Later, breathing devices or "underwater lungs" were developed. The most modern way is the underwater research vehicle or U.R.V.

3-2 EARLY DIVING METHODS

Early diving equipment used the diving suit, heavy helmet, and heavy weights. Compressed air was fed to the helmet through a long coiled tube. The diver could communicate to the surface through a telephone.

3-3 BREATHING UNDER WATER

History books tell us that man's first venture under water for long periods of time was using air bags made of animal skins. These bags were taken to the bottom by divers. When the air was used up, men on board ships lowered down new bags. It was not until 1943, however, that Jacques Yves Cousteau and Emile Gagnon developed the AQUALUNG or SCUBA (SKOO-buh; Self-Contained Underwater Breathing Apparatus). With the scuba, a diver could swim under water without a connection to the surface. He could stay submerged for an hour or more, depending upon the air supply in his tanks.

In the scuba, tanks of compressed air are strapped to the diver's back. The high-pressure air from the tanks is changed to regular breathing pressure by a special automatic regulator attached to the tank. Scuba divers are called "free divers" since they are not anchored by tubes and lines. Today a diver can reach an average depth of about 135 feet. Scuba is a new tool of science. It is also a new sport.

A well-dressed diver wears a face mask and swim fins. Where the water is extremely cold, a special diving suit is worn.

The face mask covers the nose as well as the eyes. It provides an air space between the eyes and the water. This permits the diver to see clearly under water. Flippers or swim fins help the diver to move easily through the water. Only the diver's feet are then required for swimming, leaving the diver's hands free to do other work.

Along with these developments came the dry suit and the wet suit. These inventions protect the diver against cold water. Dry suits keep the water away from the body. The rubber of the suit forms an airtight seal over the diver's body. Woollen underwear beneath the suit gives extra warmth. The wet suit is made of foam rubber. Tiny air bubbles in the rubber provide insulation. A little bit of water is allowed to seep in. The water is next to the diver's body and is quickly heated by the body heat.

3 -5 TO BREATHE UNDER WATER...

Will there come a time when humans will breathe the way fish do? One development is the SILICONE (SIL-uh-kone) membrane, with which a hamster was kept alive breathing under water. The membrane works on the same principle as the fish gill. Oxygen passes into the membrane and to the hamster. Carbon dioxide produced by the hamster passes out of the water. Perhaps a special membrane will be produced for humans. Imagine, breathing under water!

Another very exciting possibility is liquid breathing. A scientist has been able to get mice and dogs to become "liquid breathers." He placed the animals in a weak salt solution containing large quantities of oxygen, which was pumped in under pressure. The same experiment was tried on a human. He was able to take seven breaths when his lungs were filled with this liquid. Perhaps someday we shall all be able to breathe under water.

LEARNED SO FAR

- Diving depth is limited by temperature, pressure and lack of oxygen
- Diving suits solve some problems, but the diver is not "free"
- Scuba frees the diver by giving him an air supply

- Diving suits are a new form of protection
- Face masks protect the diver's face and swim fins help increase speed under water

3-6 HALF A MILE DOWN!

"August 11, 1934: At 11:12 A.M., we came to rest gently at 3,000 feet." These were the words of Dr. William Beebe, the famous oceanographer. After many earlier dives, he made a record dive in a steel chamber called a BATHYSPHERE (BATH-uh-sfeer). Dr. Beebe had reached a point at the bottom of the ocean where no man had every been before.

The sphere was attached to the ship by a wire cable. The men inside could not control the movement. That was forty years ago. New vessels have been built; new diving methods have been developed. Our knowledge has increased.

Scientists needed a vessel that was not attached by a cable - a vessel that could dive and come up on its own. Now we have such vessels!

3-7 DEEP-SEA DIVING VESSELS

Take a large steel sphere; place into it all the modern conveniences (electricity, telephones). Then attach it to a large HULL filled with gasoline. What do you have? A BATHYSCAPHE (BATH-uh-skaf). This is essentially what scientists Auguste and Jacques Piccard (pee-KAR) did when they built the bathyscaphe. They called it the Trieste. The float of the bathyscaphe has 13 tanks, 11 of which are filled with 30,000 gallons of petrol. The petrol is lighter than water and this makes the craft light enough to float. One tank at each end is left empty until just before the dive. Then the tanks are opened and seawater flows in. The bathyscaphe begins to sink. As the vessel goes deeper, the petrol is compressed in the tanks. This leaves some empty space. Seawater can then enter to occupy this space.

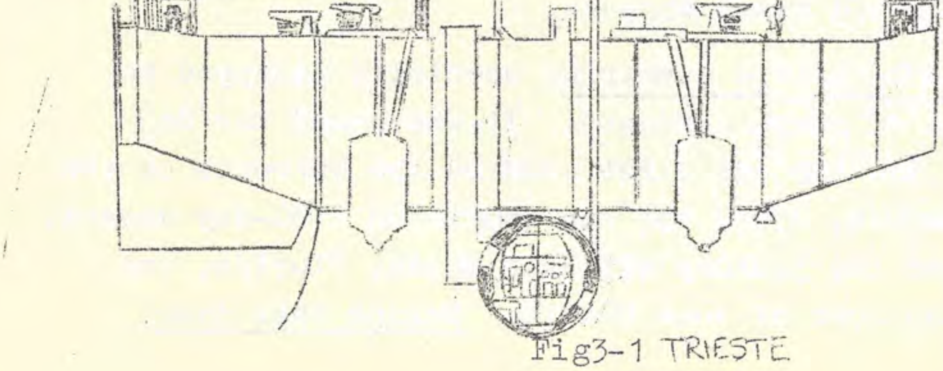


Fig3-1 TRIESTE

Look at ; page 25 and in particular, (26)

FIG. 3-1 The Trieste made one of the deepest dives in history over 38,000 feet down. How does this craft differ from a bathysphere?

The trieste also carried 10 tons of small steel pellets. By releasing some of the pellets, the boat becomes lighter, and it slows down. To rise to the surface, the pellets are released rapidly. This makes the craft lighter, and so it floats.

The men in the Trieste reached a depth that no one had ever reached before - over 38,000 feet down.

3-8 THE RESEARCH SUBMARINES

When most people think of submarines, they think of a massive undersea boat used in times of war. In the past few years, submarines have been developed to carry a few people in the exploration of the sea. These subs are very useful because they need no attachment to the surface ship.

The first of these vessels to be developed was the diving saucer called Denise. Built by Jacques Cousteau, the saucer is operated by two people. One of its drawbacks is that it can be used only in the shallow waters of the continental shelf.

After the Denise came a whole line of craft called DEEP-STAR SUBMERSIBLES (sub-MUR-suh-bulz). The first one produced was called DS-4000. The four digits stand for the depth it can reach. The submarine is designed to carry a crew of three and is driven by electric motors

Then came the ALUMINAUT (uh-LOO-muh-nawt). It is built of high-strength aluminium alloy. It can reach a depth of 15,000 feet.

3-9 RESEARCH SUBS IN ACTION

The date was January, 1966. A B-52 bomber carrying an H-bomb crashed near the Spanish Coast. A research sub just large enough for two was used to recover the bomb. This sub, nicknamed ALVIN, could reach a depth of 6,000 feet. It had a mechanical arm in front which could grasp objects.

Scientists have built a submarine specially equipped to study the mysteries of ocean currents. It was named the Ban Franklin, to honor the man who first studied the currents of the Gulf Stream. In August, 1969, the sub completed a 30-day voyage. The Franklin started its journey off Palm Beach, Florida, and finished it near the cost of Noca Scotia. During this time, scientists aboard measured the course and speed of the Gulf Stream.

The speed of the current was sometimes measured at 4.5 miles per hour - almost twice as fast as had been expected. The scientists on board found marine life to be pretty scarce. But they did sight some sharks, a 30-foot jellyfish, a squid, and a pair of swordfish! One of the most interesting discoveries was that the stream has strong waves.

3-10 A SHIP THAT STANDS!

Just think, a 355-foot ship that can stand on its end with 35 feet of it sticking out of the water! This is the vessel named FLIP or Floating Instrument Platform. The upper part of the vessel contains the living and working quarters for the scientists and crew. When the crew wants the lower half to submerge, they flood the BALLAST TANKS (BAL-ust). The stern of the ship then sinks under water. FLIP is then free to float with the ocean current and is hardly affected by waves. In this position, scientists can take many measurements.

LEARNED SO FAR -

Underwater spheres and submarines can bring scientists to great depths for research and study

Submersibles can stay under water a long time

Submersibles are equipped with many scientific instruments for underwater research.

The spirit of adventure

I Review Excercises

1. Scuba gear permits the divèr to remain underwater because

(a) on air line is connected to the surface
(b) tanks of air are carried with him
(c) he breathes through membranes
(d) he holds his breath

2. The water in a diver's wet suit

(a) is heated by the diver's body temperature
(b) is cooled by outside temperature
(c) provides oxygen for the divèr
(d) is warmed by the air

3. In order to make a bathyscaphe descend, the operator must

(a) release steel pellets
(b) release petrol
(c) let sea water enter the hull
(d) remove sea water from the hull

4. What is the function of a skin diver's regulator?

5. How does a wet suit protect the diver from cold water?

II Practical Activities

1. Lab Exercise 5
Pressure & Density
Pressure:Activity 1 and 3
Density:Activity 3 and 4

or

2. Science of Secondary Schools Book 3 Activity 13.1, 13.2, 13.3, 13.4

3. Estimating the total suspended solids - Lab Exercise 7

4. Measuring the total dissolved solids - Lab Exercise 8

5. Arrange for a local Skin Diver to try his gear. You may want to join a local diving club. ?

III Audio Visual

1. Slide set "the Oceans"

2. Chart set "the Sea" McMilliam.

IV Study Assignments

1. Why was decompression a problem to early divers?
How did staying underwater help?
How does a decompression chamber function?

2. What is an aquanaut? Find out more about the American Aquanaut programme

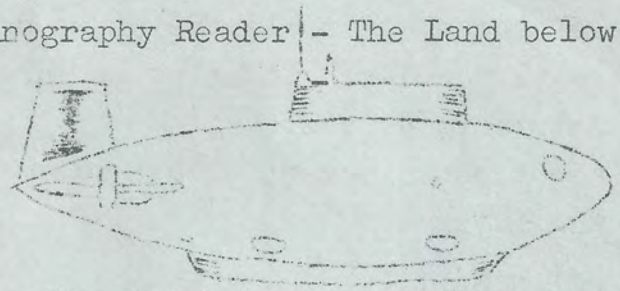
3. What is the purpose of a Plimsoll line on an ocean-going ship? Go to the harbour and draw one. Visit the local harbour master and ask him why these lines are important.

4. What is a Bathysphere and Bathyscope?
Find out all you can about these machines and give a brief history of their performance

5. What gas mixtures do divers breathe? Why can't they breathe on ordinary air mixture?
What effect do these new gas mixtures have on communication?

6. Who was William Beebe?
   What contribution did he make to the study of the oceans?
7. State how the pressure in a liquid depends on
   (a) the depth of the liquid
   (b) the density of a liquid
8. Outline a history of the development of diving aids
   Illustrate your answer and comment upon their effectiveness and limitations

V <u>Reading</u> - Oceanography Reader - The Land below the Oceans



<u>Chapter 4</u> <u>The Chemistry of Sea Water</u>

<u>OBJECTIVES - CONTENT</u>

You are making good progress if you can:

1. (a) State why the sea is salty and what salinity is
   (b) Describe how a hydrometer can be used to measure salinity
   (c) State that sea water is 3½% salt or
   (d) State that sea water is heavier than fresh water because of dissolved salts
   (e) Describe how oxygen and carbon dioxide come to be present in the sea
   (f) Explain why cold water is heavier than warm water
2. (a) Explain some of the methods an oceanographer uses to measure
   1. Temperature   3. Dissolved oxygen
   2. Salinity   4. Dissolved carbondioxide
   (b) Explain why the Red Sea is more salty than average ocean water

<u>OBJECTIVES - PRACTICAL</u>

You are making good progress if you can:

1. Determine the alkanity of sea water
2. Determine the dissolved oxygen in a sample of sea water
3. Calculate the biological oxygen demand of a sea water sample
4. Estimate the carbon dioxide content of a sea water sample
5. Calculate the salinity % of sea water
6. Graph salinity with latitude

4-1 HOW SHALL WE DESCRIBE OCEAN WATER?

We have talked about the forces and motions of the water. We can also study its composition - its <u>chemistry</u>. The <u>physics</u> of ocean water involves the study of other natural forces such as temperature, pressure, light and sound.

These things are important to us because ocean water affects ocean life. The study of plants and animals in relation to their environment is called ECOLOGY (ee-KOL-uh-jee).

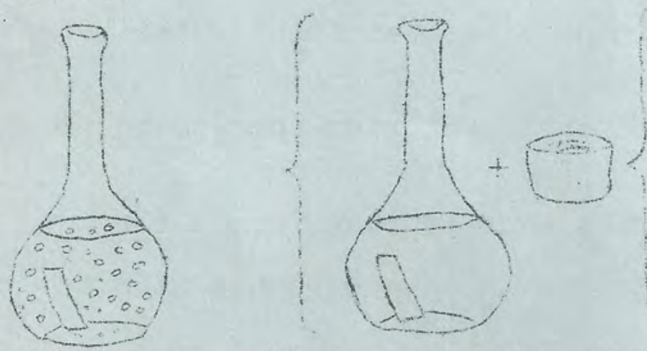
A knowledge of ocean water also helps us design ships, bridges, and underwater cables. It helps us find ways to choose and preserve the materials we use.

If we know about ocean water, we can plan to make good use of the oceans in the future.

4-2 WHY IS THE OCEAN SALTY?

The oceans are water, H_2O, but not "pure" water. Where does the salt come from?

Rivers carry minerals from the land to the sea. The ocean is, therefore, a "catch-all" basin for land materials. So the ocean is a <u>solution</u>. Other materials are <u>dissolved</u> in it and are invisible.



67.0% sodium chloride $NaCl$
14.6% magnesium chloride $MgCl_2$
11.6% sodium sulfate Na_2SO_4
2.2% potassium chloride KCl
3.5% calcium chloride $CaCl_2$
1.1% miscellaneous

100 grams seawater — 96.5 grams pure H_2O + 3.5 grams solid salts

FIG. 4-1. The solid part taken from ocean water contains many compounds. Look up the word <u>salt</u> in a good chemistry book. What kind of element is found in every salt?

Was the ocean always salty? There is a theory that millions of years ago, the ocean water was "fresh" or nonsalty. We also know that the ocean grows saltier at a steady rate as time goes by.

The chief mineral or compound in the sea is common table salt. This is <u>SODIUM CHLORIDE</u>, a compound of sodium and chlorine. The chemical formula is $NaCl$. How much of the water is $NaCl$? Look at the Figure above.

4-3 OTHER SALTS: HOW MUCH?

The amount of dissolved salts in water is called its SALINITY (suh-LIN-uh-tee).

From careful experiments, scientists know that dissolved chemicals make up 35 parts per 1,000 of seawater. Look at the percentages in Figure 4-1. Sodium chloride is the most abundant. The other salts are found in only small amounts. Another way to say this is that the average salinity of the ocean is 3½ percent.

LEARNED SO FAR

We study the characteristics of ocean water to understand marine ecology, to solve marine engineering problems, to remove useful products from the ocean.
Ocean minerals are brought from the land by rivers.
Salinity refers to the amount of dissolved salts in the sea.
Seawater is 3½ percent salt.

4-4 SALINITY AND THE WEIGHT OF SEAWATER

How do dissolved salts change the "weight" of seawater? Because of the dissolved minerals, seawater is "heavier" than fresh water. To put it another way, the DENSITY (DEN-suh-tee) of water has increased. To measure the higher density of the water, we use an instrument known as a HYDROMETER (hy-DROM-uh-tur). A hydrometer is a hollow glass tube that is weighted at one end so that the tube will float upright. Hydrometers sink less in seawater than in fresh water. Can you explain why?

4-5 DISSOLVED GASES IN THE SEA

So far, we have mentioned the solids dissolved in the sea. Chemical tests show that the ocean also contains dissolved gases. What are these gases? Where do they come from?

All gases in the atmosphere are also dissolved in ocean water. The two chief gases are carbon dioxide (CO_2) and oxygen (O_2). These gases are found in greater amounts at the surface than at deeper levels.
Some of these gases are simply dissolved from the atmosphere into the ocean's surface. Rain, falling into the ocean, brings large amounts of these gases into the sea.
Floating green plants in the sea produce oxygen during the process of PHOTOSYNTHESIS (fo-tuh-SIN-thuh-sis). This will be discussed in a later chapter. (see page 47 a.)

Fig 4-2
Salanometer

4-6 DIFFERENCES IN SALINITY

Everyone can float in the Dead Sea in Israel! Everyone can float in the Great Salt Lake in Utah! As you can guess, this can be explained by salinity.

If you wanted to find the salinities of the world's oceans, you would first have to collect samples and test them with a hydrometer. An average of the different readings would fall between 34 and 37 parts per 1,000. But in the warmer parts of the world (tropics), readings may be as high as 40 parts per 1,000. Why such high salinities?

Take a jar of salt water and heat it gently. The water will begin to EVAPORATE (ee-VAP-uh-rate). But the salt remains in the bottle. The same thing happens in the ocean. Warm climates speed up evaporation, which leaves salt behind. As a result, the density of the water increases. In the tropics, for example, air temperatures can exceed 100 degrees, causing a very high evaporation rate. Salinities can get very high. Near the poles, evaporation is lower; therefore salinity is lower. LOOK BACK at your ANSWER TO #3 P.28?

High rainfall and a source of fresh water can lower the salinity. This occurs along the coasts wherever rivers enter the sea. Water with a lowered salinity is called BRACKISH (BRAK-ish). In addition, melting icebergs and snow bring fresh water into the ocean. This also reduces salinity.

4-7 TEMPERATURES OF THE OCEAN

Try diving into a lake or bay. When you are near the bottom, the water may be a little cooler. What is the reason for this temperature difference? The warmer region of any body of water is always near the surface. As we move to the depths below, sunlight does not penetrate. It is much colder there. Warmer water is lighter and floats on top. Colder water is heavier and sinks. The point between warm and cold regions is known as the THERMOCLINE (THUR-mo-kline).

Look at Figure 4-3. You will see that the North and South Poles have temperatures well below the freezing point of water. If salt lowers the freezing point of water, why do we find ice floes in this part of the world? The ice above is actually made up of water that has evaporated from the seawater below and has very little salt. Below this ice, the water is not frozen.

SAMPLE TEMPERATURES OF THE OCEAN

Equator and tropics	30°C
North and South Poles	- 2°C
Red Sea	32°C
Indian Ocean	27°C
Pacific Ocean near Tasmania	9°C
Pacific Ocean near Gladstone	20°C

FIG. 4-3. Ocean temperatures differ in many parts of the world. Why is the water warmer near the tropics?

4-8 LIGHT IN OCEAN WATERS

Ocean water is transparent. It allows light to go through it. The light that enters the ocean is made up of various colors. We can easily see this if we pass sunlight through a PRISM (PRIZ-um). The light is broken down into the colors of the SPECTRUM (SPEK-trum). The red end of the spectrum is made up of long waves, while the blue and violet ends are made up of shorter waves. Long waves of light are absorbed by the surface waters. Shorter-wave light - such as green, blue, and violet - penetrates to greater depths.

How far does light go down into the ocean? The chart below shows that light reaches about 180 m., below the surface. The brightest light is near the top. There is no light below 180 m.,

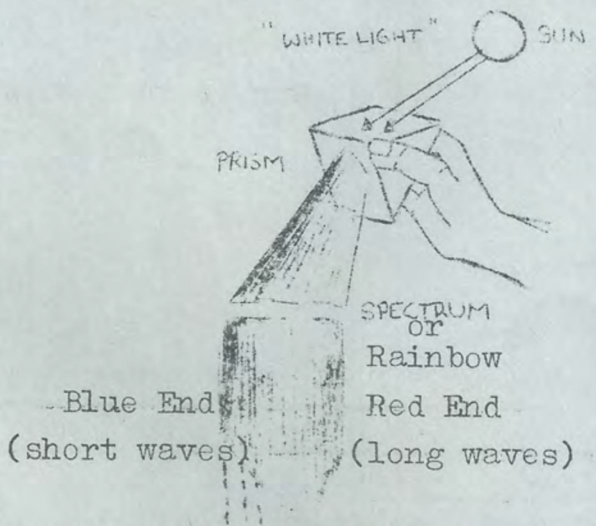


FIG.4-4 Light is made up of many colors. What colors make up the spectrum? R.O.Y.G.B.I.V. This is important to algae as we will see later in the next unit.

LIGHT ZONES IN OCEANS

Surface to 75 metres	Good light for plant growth
75 metres to 180 metres	Dim light - no green plant growth
180 metres to sea bottom	Darkness - no plants

4-9 THE COLOUR OF OCEAN WATER

Light also gives the ocean its colour. Actually, the water itself has no color. The colour is due to the reflection of sunlight by the sky or by the dissolved minerals. Thus, the Red Sea is not red; the Yellow Sea is not yellow; the Black Sea is not black.

LEARNED SO FAR

Seawater is heavier than fresh water because of its dissolved salts.
The chief gases in the sea are CO_2 and O_2
Warmer waters have a higher salinity than colder waters
Cold water is much heavier than warm water
Ocean water is transparent and allows light to penetrate it

I Study Guide : REVIEW EXCERCISES.

(a) KNOW AND UNDERSTANDING. FIND THE ANSWER.

1. The ocean became salty because
   a. rainwater contains salts
   b. salts come from bottom sediments
   c. salts were washed from the land by rivers
   d. salts were always present in the oceans
2. If salts were added to fresh water, the salinity
   a. would increase
   b. would decrease
   c. would not be affected
   d. would cause the temperature to change
3. A hydrometer would tend to float higher in a solution with
   a. low salinity
   b. fresh water
   c. high salinity
   d. much dissolved oxygen

(b) FIND THE EXPLANATION. IN WHICH SECTION OF THE CHAPTER IS THE ANSWER TO EACH OF THE FOLLOWING QUESTIONS? WRITE THE QUESTION AND ANSWER IN YOUR NOTEBOOK.

1. Why is seawater heavier than fresh water?
2. Why do you find colder water near the ocean bottom?
3. How does the nature of ocean water help us to understand ecology?
4. How far does light go down into the ocean?

(C) WRITE THE FOLLOWING STATEMENTS IN YOUR NOTEBOOK. CHOOSE THE CORRECT NUMBER OR PHRASE FROM THE PARENTHESES TO COMPLETE THE SENTENCE

1. The average salinity of seawater is about (20,35,10) parts per 1,000

2. A (thermometer, hydrometer, barometer) is used to measure the salinity of seawater
3. Warmer water is (heavier, wetter, lighter) than cold water
4. In warmer parts of the oceans, salinities are (higher, lower) than they are in temperate parts
5. Salt (lowers, raises) the freezing point of water
6. The red end of the light spectrum is made up of (long, short) waves

(d) PUT ON YOUR THINKING CAP.

1. Are the oceans less salty or more salty near areas of much rainfall? Explain your answer
2. Why is the Red Sea far more salty (40 percent) than average ocean water?

II Practical Activities

1.***INVESTIGATION: How can we identify some common salts in ocean water?

PROCEDURES

1. Moisten solid sodium chloride with a drop of hydrochloric acid. Pick up some of the moistened crystals on a nichrome wire loop. Hold the loop in a Bunsen flame.
2. Repeat with calcium and with potassium
3. Repeat these tests with seawater

OBSERVATIONS AND ANALYSIS

1. What colors result from each pure chemical?
2. What colors result from seawater?
3. Can this experiment tell you about quantities? Explain

2.	The alkanity of sea water	- Lab. Ex. 9
3.	Measuring dissolved oxygen content	- Lab. Ex. 10
4.	Measuring biochemical demand BOD	- Lab. Ex. 11
5.	Measuring carbon diozide concentration	- Lab. Ex. 12
6.	Measuring chloride concentration	- Lab. Ex. 13
7.	Graphing salinity with latitude	- Lab. Ex. 14

III Audio Visual

Plankton and the Open Sea - Capricornia Education Centre
Audio Tape - Tasmania Marine Studies Centre

*** See S.T.A.Q. Journal article on, "Tripping the Light Fantastic " by Bill Simpson.

CHAPTER 5 THE SEA IN MOTION

OBJECTIVE STATEMENTS

At the end of this section you should be able to:	You are making good progress towards these objectives if you can:
1. Understand the size and effect of ocean currents.	1.(a) Draw on a world map the major ocean currents.
2. Understand the causes of ocean currents and their directions.	2.(a) Explain how variations in density due to changes in temperature and salinity cause currents. (b) Describe how land masses and winds affect ocean currents.
3. Understand the cause and effect of tides.	3.(a) Explain the effects of the sun and the moon on tides by means of diagrams or words. (b) Describe how often the tides ebb and flow daily.
4. Understand the cause of waves.	4.(a) Describe the effect of wind, tide and earth movements on water. (b) Explain the movement of wave using the terms: (i) wave velocity (ii) wave amplitude (iii) wavelength (c) Explain how the individual particles of a wave move up and down (oscillate).
5. Describe and understand some of the problems associated with particular currents and wave formations.	5.(a) Illustrate problems encountered in the design of harbours and breakwaves.
6. Be aware of the possibility of using the seas motion as a source of energy.	6.(a) Describe devices which uses wave, tidal or current energy. (b) Discuss future possibilities of the use of the sea as an energy source.

CHAPTER 5 THE SEA IN MOTION

5 - 1 SURFING AT THE SHORE

To the confirmed surfboard addict, there is nothing in life that can compare with sitting out in the surf in a patch of the Pacific ocean near a Rocky headland, waiting for the big Rollers to come in. With a light offshore brease and a long even swell of 2 metres wrapping around the headland, the surfer is convinced that this sport is the greatest.

What is it about a powerful wave that gives the surfer his ride? Let's study the causes and movements of the waves.

5 - 2 WHAT IS A WAVE?

Visit a pier or dock on a windy day. If possible, bring a pair of binoculars with you. Look at some of the waves. All waves have some common features. The top of the wave is called the CREST (KREST). The low point is known as the TROUGH (TRAWF). The height of the wave is the distance between the crest and the trough. See if you can find these points. If the day is windy, you may see waves of different shapes and sizes.

If we had a special camera with which to look into a wave, we would find that each particle of water moves in a circular pattern called an ELLIPSE (ee-LIPS). Let's use a piece of rope to describe this action. Tie a piece of rope (about 15 feet long) to a door handle. Shake the free end of the tope up and down. A wave will be formed along the rope. The wave moves along the rope, but the rope is still attached to the door handle.

Water waves are like rope waves. It is the wave that moves, not the water. As the wave moves along, the water particles move in a circular fashion. One way to observe this is to watch a boat bobbing on the waves. The boat is actually lifted toward the crest. Once over the top, it appears to slide down the trough. When the wave has passed, the boat will not have moved very far.

5 - 3 CAUSES OF WAVES

How are waves started? Most ocean waves are produced by winds. As the wind blows against the surface of the water, the water begins to rise and fall. This is a regular movement, as in the rope experiment.

How can the rope show bigger waves? Well you can apply more energy. It is the same for ocean waves.

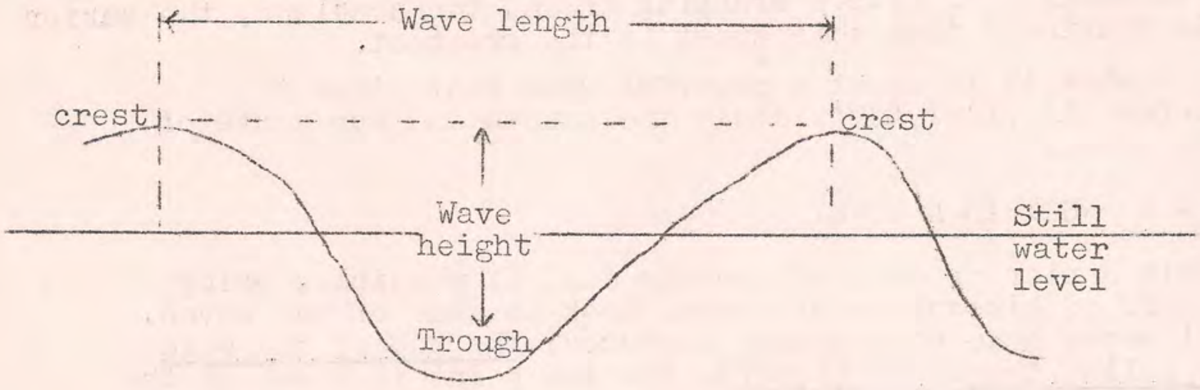
What other factors control the size of waves? Examine the chart below.

Waves in the Atlantic reach about 12 m., in height; Pacific waves rise to about 15 m.. In big storms, waves may rise to 30 m., One of the largest waves ever seen was reported in the Pacific at 33 metres !

5 - 4 THE FORM OF A WAVE

Examihe Figure 5 - 1 below. As you can see, the length of the wave is measured from crest to crest. The height is measured from crest to trough.

Fig. 5-1. Length and height are important wave measurements. Can you think of a third measurement?



5 - 5 WHITECAPS AND FOAM

If you're ever near the ocean on a windy day, look out over the water for WHITECAPS. These are powerful, wind-driven waves. They start breaking before they reach the shore. When the wind force is more than 18 Km., per hour, some of the smaller waves grow. The height of the wave is greater than its length. The crest moves faster than the main body and it topples over.

What do you think the whitecap is caused by? If you said "foam," you are right. Foam is made of air bubbles that bounce off one another. It's similar to a roomful of balloons hitting one another.

Learned so far -

Waves are rhythmic movements of water in the ocean.
Waves are caused by winds.
Strength and speed of waves depend on strength, speed, and distance of the winds.
In waves, the wave energy moves, the water does not.

5 - 6 GIANTS OF THE SEA

The Japanese have a word for it: TSUNAMI (soo-NAR-ee). Not all waves are caused by winds. Some arise when an undersea earthquake "acts up." Such a quake forms a huge crack or FAULT on the sea bottom. Water then rushes into the crack, causing waves to form on the surface. These tsunamis may produce only three or four waves. But when they approach the shore they rise very high. They also travel very far, possibly as much as 3.000 Tsunami waves sometimes extend almost 170 Km from crest to crest.

The waves that hit Hawaii in 1946 killed 173 people and destroyed $25 million worth of property. After this disaster, a warning service was set up in the Pacific Ocean. By estimating the speed and time of arrival, this service can give people on land time to move to safer areas. Since tsunamis are caused by earthquakes, the most useful instrument in this service is the SEISMOGRAPH (SIZ-muh-graf).

5 - 7 AT THE SHORE

On a windy day, you can see the way waves break on the beach. When the wave leaves deeper water, it undergoes changes. Churned up by the winds, it has stored a great deal of energy. When the wave reaches shallow water, this energy is released. As the bottom; it is slowed, But the top part of the wave keeps going at the same speed. Thus, it "rolls over" and crashes onto the shore. These crashing waves are called BREAKERS. Look for the SPILLING breakers; they fall on shores with a gentle slope. One way to recognize them is to look for a long line of foam tumbling down the front. These are the waves that surfers love to ride. Where the bottom rises very steeply, as on rocky coasts, waves hit rocks with loud booms. These are known as PLUNGING breakers.

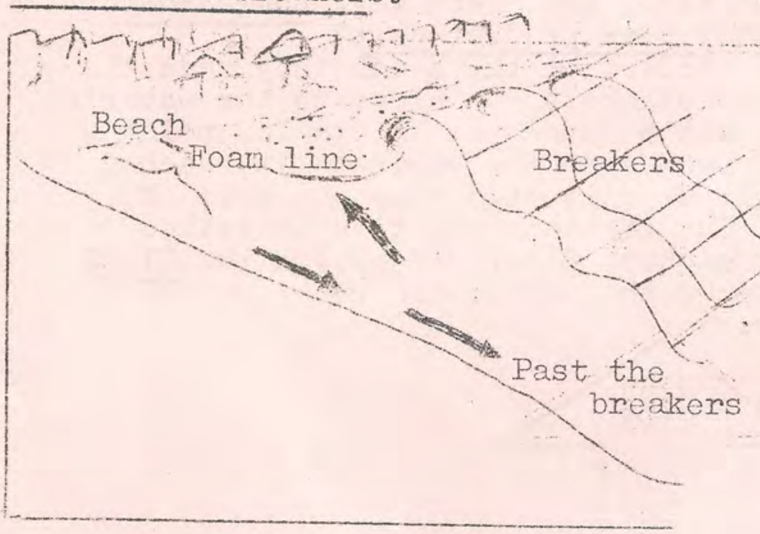


Fig. 5-2. Spilling breakers release a great deal of energy when they hit the shore. On what type of coastline would you find this type of wave?

5 - 8 LONGSHORE AND RIP CURRENTS

Do you know why lifeguards permit swimming only in certain areas? Why they blow their whistles when you swim out too far? As waves break along the beach, a lot of water accumulates near the land. Since the incoming breakers prevent the water from moving out again, it travels along the shoreline. It is now called a LONGSHORE CURRENT. The water heads out to sea again wherever the incoming waves are weaker. In this area, it is called a RIP CURRENT or UNDERTOW. A swimmer caught in this current can be swept out to sea.

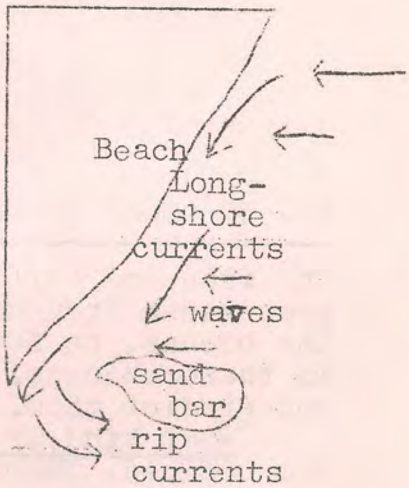


Fig. 5-3. Why do you think a rip current is commonly called an "undertow"?

Learned so far -

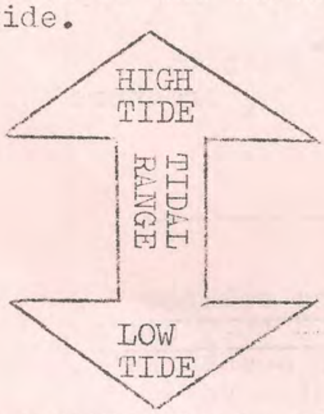
Crashing waves are called breakers.
Spilling breakers fall on shorelines that have a gentle slope; plunging breakers are found on rocky coastlines.
Longshore currents move along the shore; a rip current or undertow heads out to sea again, where the waves are weaker.
Tsunamis are caused by undersea earthquakes.

5 - 9 HIGH WATER, LOW WATER

The class arrived at the beach, spread their blankets, and prepared for a day of fun. After spending an hour in the water, they decided to return to the blankets to lie in the sun. To their surprise, they found their blankets almost covered by the rising water. What caused this rapid movement of water onto the shore? The students in our story learned about tides the "wet" way. Could they have timed it? Could they have predicted it?

When the students arrived at the beadh they made the mistake of spreading the blankets too close to the water's edge. At that time the water level was at its low point or EBB. When the water rose over the blankets it reached its high or FLOOD level. We call this rise and fall of ocean water the TIDES. The distance the tide travelled between its lowest and highest points is called the TIDAL RANGE. In certain parts of the world, the range may be 60 feet above low tide.

Fig. 5-4



5 - 10 SOME SIMPLE OBSERVATIONS ABOUT TIDES

The rise and fall of tides from the ebb to the flood has been known from ancient times. Long ago, as man watched the oceans, he found that there was a regular time or rhythm in these changes. By careful observation, he could time them and predict them.

What kind of timing was observed? First, a daily change was noticed. There were two high tides every day; there were two low tides every day.

But that's not all. It was also soon discovered that there were two specially high tides eadh month and two specially low tides each month.

Finally, careful observation showed that the timetable for tides was very much like the timetable for the changes or PHASES (FAY-ziz) in the light patterns of the moon.

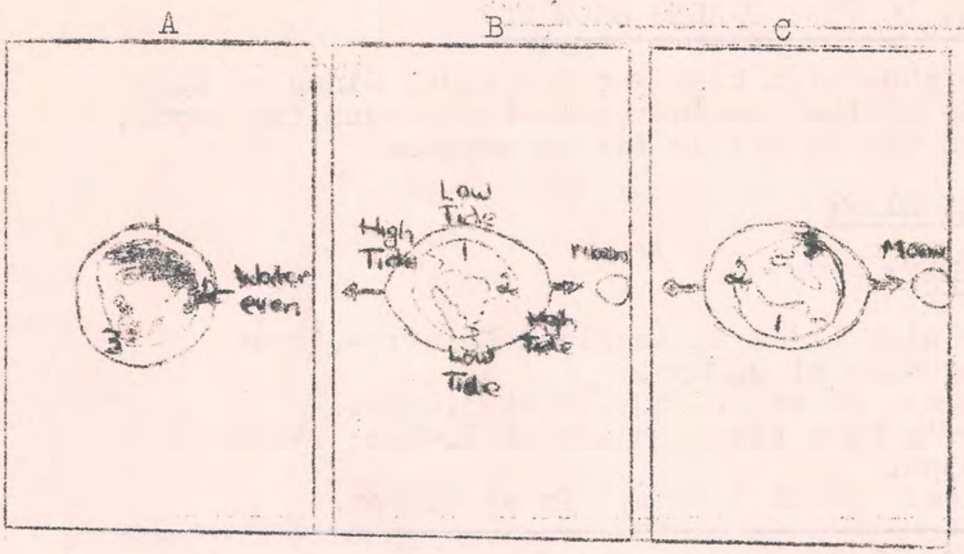


Fig. 5-5.
A. If there were no gravity pull of the moon, the water would be evenly distributed all around the earth.
B. The moon pulls on the earth at point 2. The water rises to high tide at point 2. The water on the opposite side also rises as the earth is pulled away from it. At points 1 and 3, the water falls for a low tide.
C. Exactly 6 hours and 13 minutes later, the earth has rotated under its waters. Points 1,2,3, 4 are in new positions. Points 2 and 4 had low tides. Now, 12 hours and 26 minutes later, points 2 and 4 have their second high tide.

5 - 11 What CAUSES THE DAILY TIDES?

Let's imagine that we are observing the earth from outer space. Our mission is to watch the movements of the moon and sun and how they affect the oceans. The side of the earth that is closer to the moon "feels the pull" of the moon's gravity more. As a result, the ocean water on the side of the earth facing the moon bulges. A bulge also develops on the opposite side. At any one time. there are two high tides and two low tides.

As the earth spins (rotates), the water tends to "jump off." The pull of the earth-gravity-"holds" the water on.

At the same time, the moon's gravity pulls the water. The moon rises 52 minutes later each day. Thus, every 24 hours and 52 minutes there are two high tides and two lows. This is the actual length of the moon's day. Each day, the tides are about 52 minutes later.

5 - 12 WHAT DO TIDE TABLES SHOW US?

Tide tables show high tide and low tide. Since we know the schedule of the moon's revolution around the earth, these tables can be set up far in advance.

DAILY DIARY

TIDE TIMES:

Today's high tides at Auckland Point: 4.1m at 8.58 am; 4.5m at 9.20pm.
Low tides: 2m at 2.52am; 2m at 3.01pm.
Tomorrow's high tides: 4.2m at 9.45cm; 4.4m at 10.05pm.
Low tides: 1m at 3.35am; 2m at 3.46pm.

Learned so far -

Tides are the rhythmic rise and fall of ocean water.
There are daily high tides and low tides; there are monthly high tides and low tides.
Tides are caused mainly by the pull of the moon.
Every 24 hours and 52 minutes, there are two high tides and two low tides.
Tides may be predicted on convenient tables.

5 - 13 THE MOON'S HELPER - THE SUN

As we said before, there are unusually high and unusually low tides at certain times of the month.

Farther out in space, the sun also pulls on the earth's waters by its gravity. Is this pull stronger than the moon's or weaker? Although the sun is very much larger, the moon is nearer the earth. Therefore, the pull of the moon is more than twice as strong. Let's see how this works.

5 - 14 DOUBLE PULL: SPRING TIDES

When the sun and moon are in a direct line, the tidal range is high. At this time, there are very high tides and very low tides. They are called SPRING TIDES. They come twice a month: at full moon (full face) and new moon (face not visible).

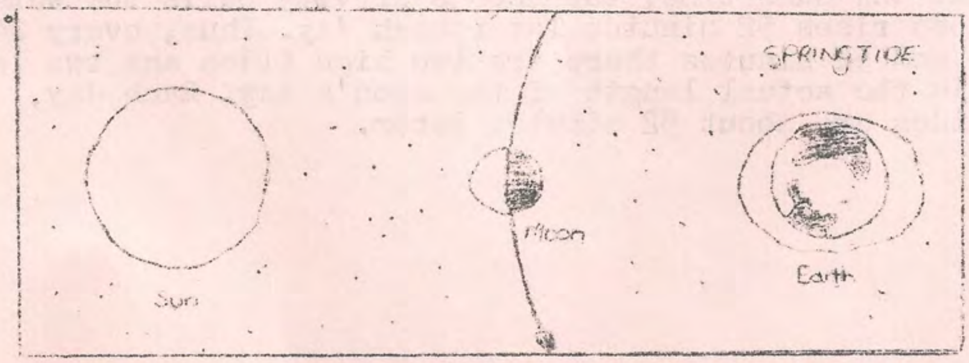


Fig. 5-6 Spring tides are produced when the sun and moon are in a direct line. Why are there such high tides?

5 - 15 RIGHT-ANGLE PULL: NEAP TIDES

When the moon and sun are at right angles, they work against each other. This happens when the moon is in its first and last quarters. Now the tides are not quite so high nor quite so low. We call these NEAP TIDES (NEEP). This also happens twice during the month.

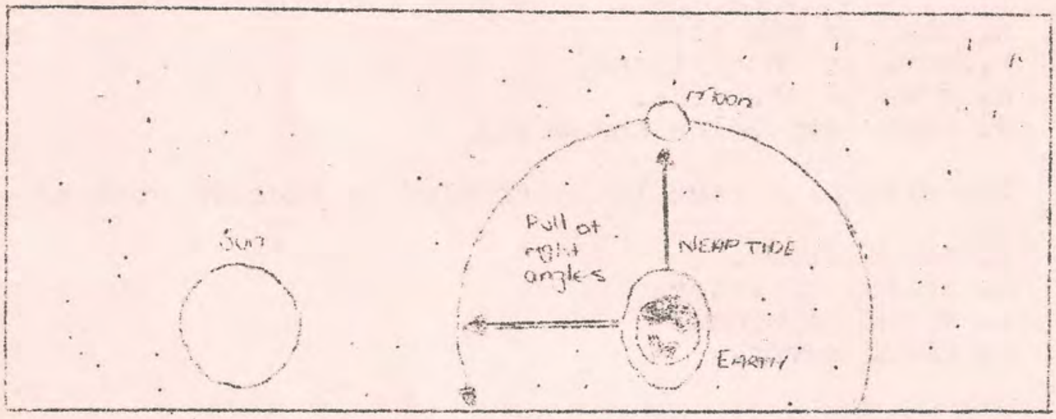


Fig. 5-7. At first quarter and last quarter, the moon and sun are at right angles. The face of the sun and the face of the moon work against each other. Now the tides are not quite so high and not quite so low. This is the neap tide.

5 - 16 DEPENDS ON WHERE YOU LIVE

A friend of yours lives 20 miles south of your town. The time of high tide on his table is 10 minutes earlier than yours. Why do we find such differences? We must remember that coastlines are not straight. Adding to this is the roughness of the ocean bottom. This slows the waters down and results in differences in tides.

In the Bay of Fundy, near New Brunswick, Canada, a narrow channel changes the shape of the incoming tide. The water has a steep front as it moves upstream. This is called a TIDAL BORE. TIDAL NODE.

5 - 17 TIDES AND OUR ACTIVITIES

We watch the tides to time our sailings. Tugboat captains examine the tide tables to begin pulling giant freighters out of the shallow harbors. Are you going fishing? Then you will watch the tides to find the kind you want. Tides are surely important in our lives.

SUMMARY OF TIDES

Daily tides	High Low High Low	6 hours, 13 minutes between each
Spring tides (2 each month)	Full moon New moon	About 14 days apart
Neap tides (2 each month)	First quarter Last quarter	About 14 days apart

1. REVIEW EXCERCISES.

PART A: WAVES

(a) KNOWING AND UNDERSTANDING. FIND THE ANSWER.

1. When a wave mass moves along, the water particles

   a. stay in one place
   b. move in an ellipse.
   c. move to the side.
   d. move down below the wave.

2. The size of a wave is controlled by factors such as -

   a. temperature.
   b. colour of water.
   c. speed of wind.
   d. cloud cover.

3. Rip currents are caused by -

   a. water moving in from the sea.
   b. water moving out to sea.
   c. the movement of waves toward shore.
   d. water being pulled to the bottom.

4. When large sections of the sea floor drop,

   a. continents move into the crack.
   b. water rushes in.
   c. wind-generated waves are produced.
   d. rip currents are formed.

(b) FIND THE EXPLANATION, IN WHICH SECTION OF THE CHAPTER IS THE ANSWER TO EACH OF THE FOLLOWING QUESTIONS?

1. How can observations of a boat demonstrate that it is the wave shape rather then the water itself that moves?
2. Why are longshore currents formed?
3. What can happen when a portion of the sea floor caves in?
4. What causes a wave?

(c) STUDY THE DIAGRAM IN FIGURE 5-1 P38 CHOOSE THE WORD THAT BEST APPLIES TO EACH QUESTION. WRITE IN YOUR NOTEBOOK.

1. What do we call the top of a wave?
2. How is the length of a wave measured?
3. The height of a wave is measured from .... to ....

(d) CAUSES AND EFFECTS. IN THE LIST BELOW, ONE GIVES CAUSES AND THE OTHER EFFECTS. MATCH THE CORRECT CAUSE AND EFFECT IN YOUR NOTEBOOK.

Causes	Effects
1 Faulting of the sea bed	a Breaker
2 Waves approaching shallow water	b Erosion
3 Waves hitting a rocky coast	c Tsunami
4 Current moving away from beach	d Undertow
5 Hawaiian waves of 1946	e Tsunami warning service
	f Plunging breakers

(e) During your Excursion or when you are next at the Beach.

Visit a beach at low tide and make a study of any erosion going on. Is there any indication that the waves and currents are sweeping away the sands? Look for an area where beach grasses are growing. Is there less erosion here?

(f) STATE THE DIFFERENCE CLEARLY IN YOUR OWN WORDS

1 What is the difference between ripples and waves?
2 What is the difference between and undertow and a breaker?
3 What is the difference between a bar and a causeway?

PART B: TIDES

(a) KNOWING AND UNDERSTANDING. FIND THE ANSWER.

1 High tides come 52 minutes later each day because
  a the sun and moon pull at the same time.
  b of a friction against the earth's surface.
  c the sun interferes.
  d the moon rises 52 minutes later each day.

2 When it is low tide on our side of the world, the side opposite us has
  a a spring tide.
  b a low tide.
  c a high tide.
  d a flood tide.

3 Spring tide
  a are stronger than neap tides.
  b are caused by bores.
  c come with every spring.
  d are not related to gravity.

4 A neap tide is formed when
  a the moon and sun form a straight line.
  b the waves are high.
  c the weather is cold.
  d the moon is at right angles to the sun.

(b) FIND THE EXPLANATION. IN WHICH SECTION OF THE CHAPTER IS THE ANSWER TO EACH OF THE FOLLOWING QUESTIONS? WRITE THE ANSWER IN YOUR NOTEBOOK.

1 Why are there two high and two low tides each day?
2 Why do we have different tide schedules for the same part of the world? FIND OUT ABOUT TIDAL NODES.

4

3 What causes the spring tide?
4 What causes the neap tide?

(b)WORD PLEASE. WRITE THE WHOLE SENTENCE IN YOUR NOTEBOOK.

1 Each tide lasts about hours and minutes,
2 Each high tide comes about minutes later each day.
3 The length of a moon or lunar day is .
4 Every month there are spring tides.

(d) WHAT'S THE DIFFERENCE? COMPARE THE WORDS. STATE THE DIFFERENCE BETWEEN WORDS IN EACH PAIR.

1 Flood tide -- ebb tide.
2 Tidal range -- tidal bore.
3 Neap tide -- spring tide.

(e)ROUNDING OUT YOUR KNOWLEDGE.

1 What is meant by tideland?
2 What are tide pools?
3 How are tidelands and tide pools important for marine life

II PRACTICAL ACTIVITIES

1 ASEP Seashores Activities 1, 2 & 3 Lab Ex 15
2 ASEP Seashores Option 3 Lab Ex 16
3 ASEP Seashores Option 4 Lab Ex 17
4 ASEP Seashores Option 5 Lab Ex 18
5 Spring and Neap tides -- when not to launch your boat at Boyne Island Lab Ex 19

III AUDIO VISUAL

V.C.R. Surfing Waves

IV READING ACTIVITIES

Chapter 6 and 7 Oceanography and our future Pages 46-64 or Science for Secondary Schools Page 271-273; 267-270.

There are many books and magazines about surfing:
The ammerican "Surfer" , The Australian, "Surfing World"

Check out the Phys Ed. section of the Library for other Books. Grab hold of a tide book and read the first feww pages.

OCEANOGRAPHY

GRADE 11 PRACTICAL WORK

compiled by

R.D.Moffatt

Laboratory Activities

Contents

GRADE 11 OCEANOGRAPHY LAB EXERCISE 1

THE CLEANING OF LABORATORY GLASSWARE

Aim: To clean the glassware in your laboratory kit.

1. Preparation of chromic acid cleaning solution.

Warning!

Chromic acid solution can be very dangerous if it is used incorrectly. If any is spilled, the area must be immediately washed with a solution of sodium bicarbonate. Any acid that is spilled on your clothing or skin must be washed off with large quantities of water.

You will need:

distilled water
potassium dichromate
concentrated sulphuric acid
1 litre beaker
glass rod
600 ml bottle with glass stopper
measuring cyliner

Procedure

1. Add 10 ml of distilled water to a 1 litre beaker.
2. Weigh out about 7 g of potassium dichromate and dissolve this in the distilled water.
3. Carefully add 500 ml of concentrated sulphuric acid to the beaker.
4. Stir in the solution carefully, making sure that all of the potassium dichromate dissolves.
5. Carefully pour the chromic acid solution into a suitable container and seal with a glass stopper.
6. Label this bottle "Caution! Chromic acid".

---

2. Using the chromic acid cleaning solution.

You will need:

chromic acid solution
detergent
distilled water
sampling bottle

Procedure

1. Transfer about 15 ml of the chromic acid solution into the sampling bottle.
2. Slowly swirl the liquid in the bottle so that the chromic acid solution covers the inside of the bottle with a thin film.
3. Leave the bottle for about 2 minutes and then wash it out with a large quantity of water.
4. Wash out the bottle with hot water and detergent.
5. Rinse again with cold water and finally with distilled water. Your bottle is now ready for sampling.

THE DISTILLATION OF SEA WATER

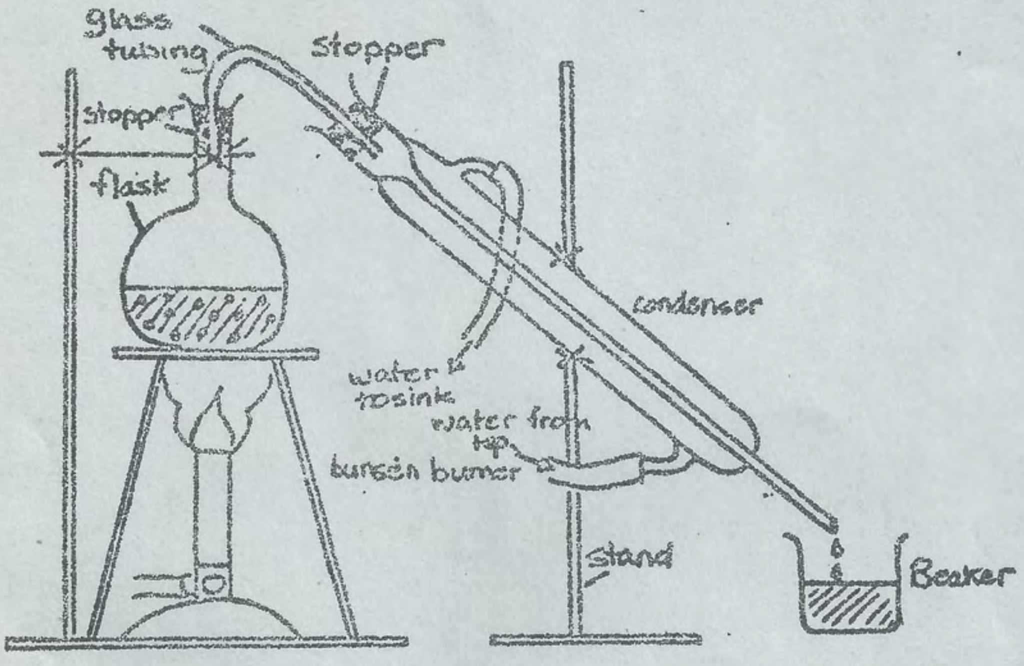
Aim: To collect 5 mls of pure water from 25 mls of Sea Water

You will need:

a bunsen burner
a distilling flask
a -10°C -110°C thermometer
a condenser
a trip oil stand
a gauze mat
a 50 ml beaker
250 mls of sea water
a graduated cylinder
a 250 ml beaker
2 retort stands
stopper with tubing

IF QUICKFIT APPARATUS IS AVAILABLE USE THIS

Procedure: 1. Set up your apparatus as follows:



2. When this is done, heat the sample of until it boils and then turn on carefully, the water from the sink tap

3. Collect a water sample from A and measure the temperature, then collect a water sample from B, as indicated in the diagram. RECORD

4. Collect 5 mls of distillate and taste it. RECORD

YOUR EXPERIMENT IS NOW COMPLETE

GRADE 11 OCEANOGRAPHY

LAB EXERCISE 3

HOW TO READ A CHART OF GLADSTONE HARBOUR AND BASIC NAVIGATION SKILLS

Aim: To recognize the symbols on a chart and plot a safe course from Auckland Creek to South End

You will need: A chart of Gladstone harbour

A parallel Rule

MEASURING THE TEMPERATURE OF A SEA WATER SAMPLE

Introduction:

Many people think that the temperature of a water sample has little or nothing to do with its pollution, but an increase in the heat content of a water body can have serious effects on the aquatic life.

A number of power stations and industrial plants use vast quantities of water for cooling machinery; after absorbing the heat, this water is returned to the river or lake and causes the temperature of the water body to increase over a period of time. Such an increase in temperature may have these effects:

1. Fish die or move elsewhere, since different species exist at different optimum temperatures, for example:
   rainbow trout 15°C
   perch 24°C
   carp 32°C

Each of these species can tolerate a temperature rise of only 5°C.

2. The warmer water tends to lie on top of the cooler water because it has a lower density. Consequently, the cooler water is prevented from coming into contact with the atmosphere and so cannot dissolve oxygen from the atmosphere; lack of dissolved oxygen reduces the ability of the water body to support aquatic life.
3. Poisoning by any chemicals dissolved in the water body is greatly accelerated by an increase in the temperature of the water, since an increase of 10°C usually doubles the rate of chemical reactions.
4. The availability of oxygen to aquatic life is lessened substantially by an increase in water temperature, since the amount of oxygen that can be dissolved in water decreases as the temperature rises. Consider the following data:

Temperature (°C)	Dissolved O_2 (parts per million)
0	13
5	10
10	8
15	6
20	5
25	4

Plot a graph of this data and you should clearly see how the amount of dissolved oxygen is determined by the water temperature.

There are a number of ways in which thermal pollution can be overcome and already several industries are running pilot schemes to combat or utilize this excess heat.

Cooling towers allow air to enter at the base; the heated water runs down over baffles and loses heat to the air. In other types of towers, air is forced by large fans over pipes containing the heated water, and heat is exchanged by radiation and convection from these pipes. There is an increasing use of cooling ponds or lakes, which act as ice-free winter reserves for wildlife, particularly water-birds.

As yet there has not been any significant use of waste heat for heating buildings, although it is a possibility that may well be developed in the near future.

Aim: To measure the temperature of a Sea Water Sample and see the effects of adding various chemicals to it.

You will need:

water samples	dilute sulphuric acid
sodium chloride	thermometer
bleach	sampling bottles
iron filings	Maximum-minimum thermometer (if available)

Procedure

Select a water sample and record the highest temperature obtained when the bulb of the thermometer is placed about 5 cm below the surface. After this reading, you should collect samples from the outside laboratory and quickly record their temperature. Repeat the procedure for a sample taken halfway down, using the same thermometer. (You may be able to obtain a maximum and minimum thermometer, which will "stick" at a particular temperature and so give you ample time for recording.)

Compare these readings and note any variations and possible reasons for them, but at the same time, be prepared to take regular readings to make sure that any temperature changes over a reasonable period are being observed.

Now, collect samples of water from these sites and find out if any additives cause a temperature change in them. Try adding to it, bleach, iron filings and dilute sulphuric acid to the different samples, as these are types of pollutants that could be entering a waterways that could well alter the water temperature.

Results: Draw up the following data table like the one below in your practical note book and complete it for the temperatures that you record.

Table 1: The Temperatures of Water Samples at Various Locations around the Laboratory.

Location of Water Sample	Temperature			
	T1	T2	T3	Average T.

Table 2: The Temperatures of Water Samples with Various Additives

Additive	Temperature			
	T1	T2	T3	Average
Sea Water Sample				
Sea Water Sample + Bleach				
Sea Water Sample + Sulphuric Acid				
Sea Water Sample + Iron Filings				

Discussion:

1. The reasons why the temperatures around the laboratory are different
2. The effects of adding different substances to the sea water sample
3. What recommendations would you make to the C.E.B. with regards water discharge from the Powerhouse.

GRADE 11 OCEANOGRAPHY

LAB EXERCISE 5

PRESSURE AND DENSITY

You will need: ASEP Pressure and Density Booklet

Core: Complete "Pressure" Activities 1 and 3

Complete "Density" Activities 3 and 4

Aim: For you to understand the concepts of Pressure and density

Option: If time permits we will do the entire booklet. This will not need to be written up as a practical exercise.

GRADE 11 OCEANOGRAPHY LAB EXERCISE 6

MEASURING THE TRANSPARENCY OF SEA WATER

Aim: To measure the TURBIDITY of a Sea Water Sample

Introduction:

If you look at a beaker of tap water, you will see that light easily passes through it: we say that the water is transparent. But if you stir a sample of muddy water and observe it, you will find that it is difficult to see through the sample: we say that it has a high turbidity. The turbidity is due to the presence in the water of suspended material, which is scattering and absorbing light.

Turbidity prevents light from reaching green plants below the surface. It is only in the presence of sunlight that green plants are able to build up food material by the process known as photosynthesis; if light is prevented from reaching them, photosynthesis stops. Since photosynthesis produces oxygen as well as plant food, the oxygen level in the water falls.

We must also realize that fish rely on their eyesight to locate food. It can only be concluded that the less transparent the water, the less able it is to support an animal and plant population.

You will need:

- a Secchi disc
- Some string
- a glass vessel (an old pneumatic trough will do)
- a sinker
- a sample of dirty sea water

NOTE: You will need to keep 1L of Sea Water Sample for the next 2 Lab Exercises

Procedure:

A Model turbidity disc (often called a secchi disc) can be made from a circle of wood or metal 5 cm in diameter. The circle is marked out in black and white quarters. Four lowering strings are attached to the disc (figure ℓ) so that it remains parallel to the water surface. These strings are attached to a cross of wood above the water surface, puppet-like. One of the lowering strings should be marked at 5 cm intervals, so that the depth of readings can be measured. (A meter rule may be used instead in many cases.) If wood is used, the disc should be weighted with nuts and bolts inserted in suitable holes - these can be used to attach the lowering strings.

Lower the secchi disc into the water until the white quarters completely disappear from sight.

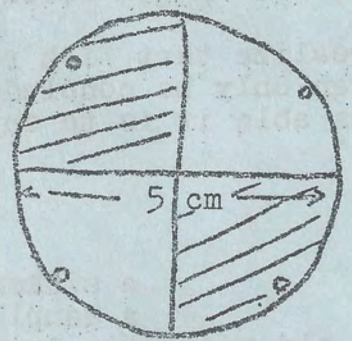
When the turbidity disc disappears from view, note the depth from the marked string and record it. Repeat twice and average your results. RECORD

The next practical topic tells you how to measure the actual quantity of suspended material in water. In the meantime, you can relate your secchi disc records to the quantity of suspended material in the following way:

Depth disc disappears	Water condition
0.25cm	very muddy
1.5 cm	much suspended matter
10.0 cm	very clear

FIGURE 1

Four holes are made in the disc so that strings can be attached



Secchi disc

MEASURING THE TOTAL SUSPENDED SOLIDS (T.S.S.)

Introduction:

In the secchi disc practical we discussed two of the ways in which suspended solids can be harmful to aquatic life. It appears that some water bodies have received more sediment because of man's activities than from any other cause. Natural erosion of the land has always washed a certain amound of solid material into rivers and lakes, but man has accelerated this process by clearing vegetation, so that tree and grass root systems no longer bind the topsoil. Both water and wind transport this loose material into the waterways. Sewage and industrial effluent discharged into rivers also add to the suspended material in the water.

You will need:

water samples (NOTE: Use the same water sample as for the previous experiment)
filter papers
500 ml beaker
filter funnel
balance - we will try a triple beam balance but one group will need to use the Anylitic balance

Procedure:

We can measure the total suspended solid content of our samples by the technique of filtering: the sample is passed through a filter paper so that water (the filtrate) passes through the system, leaving the suspended solids (the residue) trapped in the filterpaper.

It is important that the mass of the filter paper is recorded before filtering. Carefully filter a 250 ml sample. After the operation, dry the filter paper overnight and then reweigh it. Subtract the mass of the filter paper to give the mass of suspended solids present per 250 ml sample of water.

Results:

Your data should be presented like this:

Mass of filter paper = xg
Mass of filter paper + residue = yg
$\therefore$ Mass of residue = (y - x)g

Your results should be expressed in parts per million (p.p.m.) and this can be worked out as shown below:

250 ml of sample yields 0.005 g
$\therefore$ 1 litre of sample yields 0.020 g
The mass of 1 litre of water is 1000 g, so if we multiply the mass of solid by 1000 we will obtain the number of grams of solid in a million grams of water, i.e., the result in parts per million. For example:

0.020 g per 1000 g of water
= 20 g per million g of water
i.e.,
Total suspended solids (T.S.S.) = 20 p.p.m.

Repeat this experiment at least twice for each sample taken. It may be of value to compare your T.S.S. findings with your turbidity disc results.

If possible, you might like to examine any solids on your filter paper with a hand lens or microscope to try to determine the types of particles that are polluting the water body under investigation.

Discuss:

1. The mass of residue in relation to your secchi disc readings.

2. The effects of suspended matter on animals and plants that live in the sea.

MEASURING THE TOTAL DISSOLVED SOLIDS (T.D.S.)

Aim: To calculate the total dissolved solids in a sea water sample

Introduction:

A number of compounds dissolve in water to the extent that they will pass through the pores of a filter paper and so cannot be separated by filtering. However, they can be separated and measured by evaporating the water and accurately weighing the remaining material.

It is to be expected that all water bodies will contain a certain amount of dissolved material, since chemical compounds are constantly being weathered out of rocks and soils, and the T.D.S. content of a river increases significantly as that river approaches the sea, because of sea-water contamination. The natural T.D.S. level of our waterways can, however, be increased by industrial effluent, sewage disposal, and irrigation, which washes salts from the land into the lakes and rivers.

Salinity of water bodies is certainly not uncommon, since about 97% of the world's water is found in seas and oceans in the form of salt water. The less than 1% that occurs as "fresh water" on land can frequently become saline to some degree. Factors that can contribute to increasing salinity include:

1. Industrial effluent such as inorganic salts, which are produced in acid-base reactions, used in a number of industrial processes.

2. Salt brines from mines, oil-wells, etc., which may be inadvertently released into bodies of fresh water.

3. Highway salting, where salt used on icebound highways is allowed to percolate into groundwater supplies and rural wells.

4. Irrigation, a process that dissolves vast quantities of minerals from the soil and carries them down into groundwater bodies.

5. Ocean inundation, which may occur when rivers decline because of a reduction in runoff during periods of drought. Such rivers may then be overcome by strong tidal flows that carry saline water many kilometres upstream. In extreme cases the tidal advance may threaten a city's freshwater supply.

It has been realized for many years that a number of inorganic salts have toxic properties once certain concentrations in water are reached. This is particularly true of salts of some of the heavier metallic elements (e.g. mercury, lead, zinc, cadmium). The increasing use of materials that contain these elements has led to their introduction, either intentionally or otherwise, into areas of the environment where they were not previously found. The continuing detection of heavy metals in water in concentrations that have reached toxic levels is a cause for concern.

You will need:

water samples
balance
desiccator

3 evaporating basins
water bath

NOTE: Use the same water sample as for the previous two exercises.

Procedure:

Take three clean, dry evaporating basins and accurately weigh each one to the nearest milligram (0.001g).

Add 100 ml of filtered sample to each of the evaporating basins, and heat them on top of a water bath until all of the water in the basins has been driven off.

Place the evaporating basins inside a desiccator overnight. On the following day, record the mass of each basin to the nearest milligram.

Results:

Tabulate your data using the following information.

Mass of basin 1 = ag
Mass of basin 1 + T.D.S. = bg
∴ Mass of T.D.S. = (b - a)g

Find the average T.D.S. value by adding the three results together and dividing by three. This will give you the number of grams of total dissolved solids per 100 ml of sample.

Again your results should be expressed in parts per million. For example:

100 ml of sample gave 0.025 g
This represents 0.25 g per litre
∴ Total dissolved solid content = 250 p.p.m.

Note that the generally accepted T.D.S. level for drinking water is 200 p.p.m., although many water authorities make their maximum permissible level 500 p.p.m. You may like to ask your local water authority what T.D.S. level they accept.

Discuss:

1. The total dissolved solids in relation to your secchi disc readings

2. The effects of dissolved particles on animals and plants in the sea.

MEASURING THE ACIDITY OR ALKALINITY OF SEA WATER

Aim: To measure the pH of a sea water sample

Introduction:

In this topic we use the pH value to indicate whether or not a water sample is acidic or basic. Neutral samples have a pH of exactly 7.0; acidic solutions have a pH less than 7.0; alkaline solutions have a pH greater than 7.0. If a body of fresh water has a pH value outside the range 6.0 - 8.0, it is possible that pollutants are entering the water at some point. Common materials that can easily disturb the natural pH of water are fertilizers, industrial effluent, detergents and insecticides.

The most productive fresh natural waters contain concentrations of the carbonate and bicarbonate ions that result in a pH of between 6.5 and 8.5. Such a system can readily absorb small quantities of acidic or basic materials without significant changes in pH. However, if large amounts of strong acid or base are allowed to enter the system, then the natural "buffering" ability of the water is overcome, resulting in drastic changes of pH. Consider some of the possible consequences:

1. A water body with a pH as low as 6.0 can cause excessive corrosion of plumbing, boats and metal structures in the water, such as piers.

2. All vertebrates, most invertebrates and the majority of microorganisms die at pH values below 4.0. In fact, only bacteria and a few species of algae can tolerate such levels of acidity.

3. Agricultural crop damage will almost certainly result if the pH of irrigation water falls below 4.5. This level of acidity in water causes iron, aluminium and magnesium salts to dissolve more readily than usual and the resulting high concentrations can become toxic to crops.

You will need:

water samples
pH paper
universal indicator
phenolphthalein solution
0.02 M sodium hydroxide solution
0.01 M sulphuric acid
pH meter (if available)
burette
3 x 250 ml conical flasks
25 ml pipette

Procedure:

Approximate measurements of pH can readily be obtained using inexpensive pH paper or universal indicator solution. It would be an excellent idea to test the pH of a number of household detergents, insecticides, etc. before going on to test your water samples.

A pH meter will give a more accurate result, though not all students may have access to this relatively expensive piece of equipment.

Alternative method: YOUR TEACHER WILL SHOW YOU HOW TO USE A BURETTE.

We can determine the alkalinity of a sample of water by using a burette, a 25 ml pipette and phenolphthalein indicator. Note that phenolphthalein is colourless in the presence of acids but gives a pink colour in alkaline solution.

Measure 25 ml of your water sample into a 250 ml conical flask and add about two drops of phenolphthalein solution so that a pink colour develops. Titrate to a colourless end point by adding 0.01 M sulphuric acid from the burette.

In this technique we use 0.01 M sulphuric acid to give a direct measure of the alkali concentration of your water sample as parts per thousand in a 25 ml sample. Multiplying by 40 gives the result in parts per million alkali.

If the volume of sulphuric acid added to the 25 ml sample is x ml, then:

alkalinity = x X 40 (p.p.m. alkali)

This technique is useful to compare sample pH values that are too close to be distinguished using universal indicator solution.

It is possible to use a similar method and the same apparatus to determine the acidity of a water sample. The titration is carried out with 0.02 M sodium hydroxide solution, using phenolphthalein as indicator, until a faint pink colour appears.

For a 25 ml sample:

acidity = number of ml NaOH added X 40 (p.p.m. acid)

Results:

Tabulate your results for yours and the class data - and estimate the average pH of the class sample

Discuss:

The possible effects of low and high pH values on animals and plants in the sea.

GRADE 11 OCEANOGRAPHY LAB EXERCISE 10

MEASURING THE DISSOLVED OXYGEN (D.O.) CONTENT OF SEA WATER

Aim: To calculate the amount of oxygen in (p.p.m.) of a sea water sample

NOTE: The sea water sample will have to be collected FRESH OR part of this experiment will have to be done for you. If it is not possible we will run an artificial experiment with the water + 35 g of salt.

Introduction:

Although some forms of bacteria can live in water that contains no dissolved oxygen, no other animal life can survive in these conditions. Obviously, it is very useful to be able to measure the oxygen levels of water samples. The following guide relates oxygen levels to possible life forms.

Less than 1 p.p.m. of oxygen:
This water would not support any life other than anaerobic bacteria. It is bacteria of this type that release the gases that may be detected in swampy areas, such as methane and hydrogen sulphide.

Between 1 p.p.m. and 5 p.p.m. of oxygen:
A few animals, such as worms and shrimps, may survive in this water, although there is not enough oxygen for fish.

More than 5 p.p.m. of oxygen
A large variety of animal life can live in this water

Oxygen dissolves in water to only a slight extent. It usually enters the water from the atmosphere or by being released by green plants growing beneath the surface. The amount of dissolved oxygen depends on water temperature and altitude (that is, atmospheric pressure). At 20°C and 1 atmosphere pressure, a value as high as 9 p.p.m. can be expected, whereas high mountain lakes may contain up to 40% less dissolved oxygen at the same temperature. The dissolved oxygen content falls with increase in temperature

We will classify water as polluted when the D.O. content falls below the level that is necessary to support the complement of aquatic life that is normal for that particular water body.

The main cause of water de-oxygenation is the presence in the water of substances known as oxygen-demanding wastes, that is, materials that are readily broken down in the decaying process produced by bacterial activity, with resulting depletion of dissolved oxygen. Most oxygen-demanding wastes are organic compounds, which commonly occur in sewage, industrial wastes from food-processing plants, paper mills and tanning plants, and slaughterhouse effluents. Since the characteristic element in these organic materials is carbon, an obvious reaction (and one encouraged by bacterial activity) is the oxidation of carbon to carbon dioxide: $C + O_2 \longrightarrow CO_2$. Any available carbon will require almost three times its mass of oxygen to react. For example, one drop of oil will react with all the dissolved oxygen in 4.5 litres of water.

YOU WILL NEED:

water samples	0.62g sodium thiosulphate FRESH
15 g starch	5ml chloroform
distilled water	4 x 100ml volumetric flasks
concentrated sulphuric acid	storage bottle
48g manganese (11) sulphate	beaker
50g sodium hydroxide	burette
15g potassium iodide	pipette
	3 x 500ml conical flasks

PROCEDURE

Before starting the actual measurement, it is necessary to make up several solutions to be used in the measurement. It is important that these solutions be made up as carefully as possible.

1. Starch solution

Weigh out 0.5g of starch and dissolve this in 100ml of distilled water in a volumetric flask. It is important that the meniscus is exactly on the 100ml mark. Label the flask clearly.

2. Concentrated sulphuric acid

This is not a solution to make up; rather, a bottle is used to hold about 30ml of the acid. Note that sulphuric acid can be very dangerous if spilled and so must be treated with great respect. Label this bottle very clearly.

3. Manganese (11) Sulphate solution

Weigh out 48g of manganese sulphate and add a few ml of distilled water to make up a solution of the solid. Transfer this solution to a 100ml volumetric flask and add distilled water up to the 100ml mark. The manganese sulphate should be completely dissolved and the bottom of the meniscus should be on the 100ml mark.

4. Alkaline iodide solution

Weigh out 50g of sodium hydroxide and (separately) 15g of potassium iodide. Add both samples to a beaker containing a few ml of distilled water to make up a solution. Transfer to a 100ml volumetric flask and add distilled water until the meniscus is on the 100ml mark.

Note that sodium hydroxide must never be touched because it will burn the skin on contact. This material must also be weighed rapidly since the solid absorbs moisture from the atmosphere (sodium hydroxide is a deliquescent material).

5. Sodium thiosulphate solution

Weigh out 0.62g of sodium thiosulphate and make the solution up to 100ml in a volumetric flask, as described before.
Measure out 5ml of chloroform and add it to the sodium thiosulphate solution, mixing well. Chloroform has anaesthetic properties and therefore the stopper must be placed on the bottle as soon as possible after use. If any chloroform is accidentally spilled, windows nearby should be opened and everyone moved away from the area until the odour has disappeared.
This solution must be used within three weeks of being made up.

The method about to be described (called the Winkler Method) is very similar to the method used in analytical laboratories. If it is to be used correctly, all samples must be returned to the laboratory for analysis within a few hours of collection. The sample bottle must not have any air space above the water surface because even slight shaking can cause more oxygen to dissolve in the water. A good deal of care is necessary if reliable results are to be obtained.

At the sampling site, the sampling bottle should be filled with water and this initial sample discarded. The sampling bottle should then be held horizontally and allowed to fill very slowly. Stopper the bottle and check that it contains no air bubbles.

Remove the stopper and, into the space made available, pipette 1ml of the manganese sulphate solution, with the end of the pipette beneath the surface of the water sample.

A clean pipette should then be used to transfer 3ml of alkaline iodide solution to the water sample, again making sure the pipette discharges beneath the surface. The bottle should then be stoppered (all air excluded) and shaken vigorously for 15 seconds, or until a precipitate settles out on the bottom of the bottle.

When the precipitate has settled out, measure out 2ml of concentrated sulphuric acid, using a measuring cylinder, and pour it into the sample bottle, which is then shaken again.

At least two samples must be taken at each site and treated in the same way at the site before being returned to the laboratory, within a few hours of collection, for the remainder of the experiment.

In the laboratory, set up a burette and a 500ml conical flask. Fill the burette with sodium thiosulphate solution. Transfer 200ml of the water sample to the 500ml conical flask and allow slightly less than 1 ml of solution to run from the burette into the water in the flask. When the liquid in the flask is swirled, a faint yellow colour should appear: if it does not, a little more sodium thiosulphate solution should be added from the burette, until the yellow colour becomes visible.

Add a few drops of starch solution to the flask contents, until a blue colour appears.

MEASURING THE BIOCHEMICAL OXYGEN DEMAND (B.O.D.)

Aim: To measure the B.O.D. of a Sea Water Sample.

YOU WILL NEED:
the same materials and equipment as in the last practical water samples and an oven.

INTRODUCTION
Water that contains organic waste usually also contains bacteria, which break down the waste material and in the process consume dissolved oxygen. The amount of oxygen that is used up in this process is a good measure of the amount of organic waste in the water sample and is known as the biochemical oxygen demand.

SOME TYPICAL B.O.D. LEVELS

Source of sample	B.O.D. (p.p.m.)
Untreated municipal sewage	100 - 400
Runoff from farmyard	100 - 10 000
Food-processing wastes	100 - 10 000

SOURCE: C.H. Wadleigh, Wastes in Relation to Agriculture and Forestry; U.S. Department of Agriculture miscellaneous publication no. 1065 (Washington D.C.: U.S. Gov. Printing Office, 1968) pp. 41-44

Aerobic conditions	Anaerobic conditions
C - CO_2	C - CH_4
N - NH_3 + HNO_3	N - NH_3 + amines
S - H_2SO_4	S - H_2S
P - H_3PO_4	P - PH_3

SOURCE: L. Klein, River Pollution. vol 2 (London: Butterworth, 1962) pp. 37-38

Aquatic life may disappear when oxygen is removed from water, because it has died of oxygen starvation or because it has moved to more favourable areas. A further result of oxygen depletion is an increase in the number of anaerobic organisms, which, in contrast to aerobic organisms, thrive in the absence of oxygen. Some products of decomposition may be summarized as in the table.

Methane (CH_4), often called "marsh gas", is odourless and flammable. Amines have a fishy smell. Hydrogen sulphide (H_2S) is evil smelling and toxic. Some phosphorus compounds also have unpleasant odours. Obviously, a change from aerobic to anaerobic conditions is most undesirable where water is to be used for human consumption, and also where water is used for recreation.

PROCEDURE

First analyse a number of water samples from one site for their oxygen content (as in practical topic). Then keep the samples at 20°C for five days and after this time again measure their oxygen content. Ideally you should collect 4-6 samples from each site for this test.

A comparison of samples taken from various sites could prove very interesting.

RESULTS

Look at these sample results:

B.O.D. =

$$\left[\begin{array}{c}\text{initial oxygen}\\ \text{content}\end{array}\right] - \left[\begin{array}{c}\text{oxygen level after}\\ \text{5 days at 20°C}\end{array}\right]$$

= 6p.p.m. - 4p.p.m.
= 2 p.p.m.

A B.O.D. of 2 p.p.m. or less suggests clean water containing little organic waste. Water if of doubtful purity when the B.O.D. value reaches 5 p.p.m.

Tabulate as follows:-

Sample No.	O_2 content		
	Day 0		Day 5
1.			
2.			
3.			
4.			

DISCUSS 1. The relationships between samples

2. The B.O.D. values

MEASURING THE CARBON DIOXIDE CONCENTRATION

Aim: To calculate the CO_2 concentration in p.p.m. for a sea water sample.

Introduction:

Water bodies tend to contain dissolved carbon dioxide because this gas dissolves in rain droplets as they fall through the atmosphere. The amount of carbon dioxide present in a water sample will affect the pH because the product of carbon dioxide solution in water is carbonic acid:

$$CO_2 + H_2O \rightarrow H_2CO_3$$

You will need:

Water samples
0.0227 M sodium carbonate solution
Phenolphthalein indicator
distilled water
burette
3 X 250 ml conical flasks
pipette

Procedure:

A standard 0.0227 M solution of sodium carbonate is made up by dissolving 2.406 g of sodium carbonate in 1 litre of distilled water that has been boiled and cooled immediately before preparing the solution.

Using a pipette, transfer 100 ml of water sample to a conical flask. Add about ten drops of phenolphthalein indicator solution. Then run the sodium carbonate solution from a burette into the water sample, until the solution in the flask turns from colourless to pink.

Take care to avoid excessive shaking of the water sample, since this could easily lead to more carbon dioxide dissolving. Because of this possibility, the analysis should be carried out as soon as possible after sampling.

Calculate the carbon dioxide concentration using this formula: 1 ml of 0.0227 M sodium carbonate used ≡ 10 p.p.m. carbon dioxide.

Results:

Present yours similar to those below

Sample No. 1
Initial burette reading 0.00 ml
Final burette reading 2.50 ml
Volume of 0.0227 M sodium carbonate used
= final reading - initial reading
= (2.50 - 0.00) ml
= 2.50 ml
1 ml sodium carbonate ≡ 10 p.p.m. CO_2
∴ 2.5 ml ≡ 25 p.p.m. CO_2
∴ carbon dioxide concentration in sample No. 1 = 25 p.p.m.

Your results will be more meaningful if you compare the results from your collected water samples with results obtained from prepared samples. One of the prepared samples should be distilled water, or recently boiled water, which contains no carbon dioxide. To make a second sample, pass carbon dioxide (from a Kipp's generator) through a sample of distilled water to saturate it with carbon dioxide. In this way you can obtain upper and lower limits with which to compare the results from the samples you have collected from natural water bodies.

Discuss:

The effect of CO_2 on pH.

Your results in relation to class results.

GRADE 11 OCEANOGRAPHY LAB EXERCISE 13

MEASURING THE SALINITY OF A SEA WATER SAMPLE

Aim: To measure the chloride concentration in p.p.m. of a sea water sample.

Introduction:

Through weathering and erosion, chloride compounds in rocks and soils eventually find their way into streams and rivers, and therefore we would expect all natural waters to contain some chloride ions. However, we should realize that aquatic life cannot exist if the chloride concentration becomes too high. (For example, freshwater species cannot survive if the water becomes saline.)

The chloride concentration of water may increase significantly where industrial wastes containing chlorine compounds enter the water body, or where certain mining projects allow rain and wind to move chloride-bearing wastes into nearby waterways.

Irrigation dissolves chloride compounds from the topsoil and transports them into rivers and lakes. Evaporation may concentrate the dissolved salts to extremely high levels in some lakes in dry areas - for example, the Dead Sea and Lake Eyre.

You will need:

- Water samples
- 4.97g silver nitrate
- Distilled water
- 5 g potassium chromate
- 1 litre volumetric flask
- brown glass storage bottle
- 250 ml beaker
- storage bottle
- burette
- 3 X 250 ml conical flasks

Procedure:

It is necessary to first make up two solutions for use in the analysis of the water samples.

1. Silver nitrate solution CARE

Weigh out 4.97 g of dry silver nitrate crystals and make up one litre of solution in a volumetric flask. It is very important that these solutions are made up accurately.

When the solution has been made up, a clean, dry, brown glass bottle should be labelled suitably and the solution transferred to it, since direct sunlight tends to break down silver nitrate solution.

2. Potassium chromate indicator

Weigh out 5 g of potassium chromate and dissolve this in 90 ml of distilled water in a 250 ml beaker. When all of the potassium chromate has dissolved, add a few drops of silver nitrate solution until a red precipitate forms. The solution is then filtered into a clean, suitably labelled bottle.

Fill a burette with silver nitrate solution and put 100 ml of filtered water sample in a 250 ml conical flask. Add 1 ml of potassium chromate indicator to the water sample and then run the silver nitrate solution into the sample from the burette, taking care as you approach the end point of the titration, which is indicated by a red colour.

The procedure should be repeated about three times for each water sample, or until consistent results are obtained.

Each milligram (0.001 g) of chloride in the water sample uses 1 ml of silver nitrate solution from the burette.

Results:

Present these as follows:

Sample No. 1
Initial burette reading 0.00 ml
Final burette reading 70.00 ml
Volume of silver nitrate solution used
= final reading - initial reading
= (70.00 - 0.00)ml
= 70.00 ml
= 70 X 0.001 g of chloride
= 0.07 g per 100 ml of water sample
= 0.7 g per litre of water sample
∴ Chloride concentration in sample No. 1
= 700 p.p.m.

Discussion:

Compare the chloride concentrations of all your samples, remembering that you can expect the chloride concentration to increase as a river approaches the sea. You should watch for any dramatic increases not attributable to natural causes.

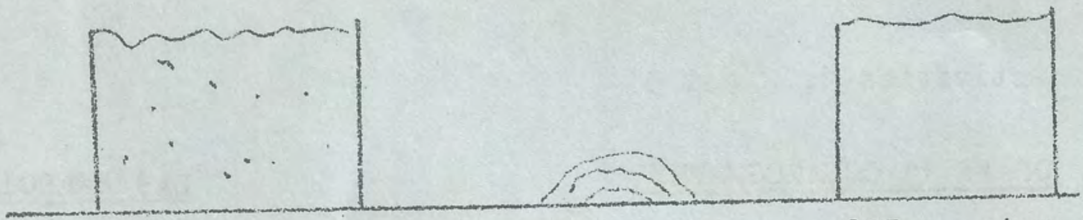
GRADE 11 OCEANOGRAPHY LAB EXERCISE 14

GRAPHING SALINITY WITH LATITUDE

Aim: To prepare a graph of the salinity of sea water with the ocean's position

Introduction:

Salinity or S^{o}/oo can be thought of as follows:



1 kg Sea Water - 35 g Salt = 965 g water

A kilogram of sea water which contains 35 grams of dissolved salts has a salinity of $35^{o}/oo$

Procedure:

Obtain a sheet of graph paper and graph S^{o}/oo (Y axis) versus latitude (X axis). Make sure 0^{o} is in the middle of the GRAPH.

SALINITY $^{o}/oo$	LATITUDE
32.0	80° N
33.0	70° N
32.6	60° N
33.5	50° N
35.0	40° N
35.8	30° N
35.3	20° N
34.5	10° N
35.0	0°
35.5	10° S
35.7	20° S
35.5	30° S
34.5	40° S
34.0	50° S
33.9	60° S
33.9	70° S
34.0	80° S

Results:

Paste your graph into your Lab. Book

Discussion:

1. The relationship between Northern and Southern hemisphere
2. The area of the ocean with the highest and lowest S^{o}/oo and any reasons for this difference.

GRADE 11 OCEANOGRAPHY LAB EXERCISE 15

ASEP SEASHORES

Activities 1, 2 and 3

GRADE 11 OCEANOGRAPHY LAB EXERCISE 16

WAVE PROBLEMS FOR ENGINEERS

ASEP Seashores OPTION

Aim:

GRADE 11 OCEANOGRAPHY LAB EXERCISE 17

BEACH EROSION

ASEP Seashores OPTION

GRADE 11 OCEANOGRAPHY LAB EXERCISE 18

CYCLES IN COASTAL EROSION

ASEP Seashores OPTION

SPRING AND NEAP TIDES

Aim: To plot the tidal variation of a harbour for a month

Introduction:

The tides for the month are mainly caused by the pull of the moon. However, there are very high tides caused by the combined pull of the moon and the sun called SPRING TIDES and lower tides caused by the sun and moon pulling at right angles. We can summarise these tides as follows:

DAILY TIDES	HIGH, LOW, HIGH, LOW	6 hours 13 minutes apart
SPRING TIDES	FULL MOON NEW MOON	about 14 days apart
NEAP TIDES	FIRST QUARTER LAST QUARTER	about 14 days apart

You will need:

A sheet of graph paper

Procedure:

1. Select a month from the table given
2. Plot the highest tide for the day and the lowest tide for the day.
   (Y AXIS) V's the date in the month
   (X AXIS) onto a sheet of graph paper

Discuss: 1. The dates of the full, half and quarter moons.

2. The dates of the Spring and Neap tides.

27

GLADSTONE

Lat 23° 50' S — Long 151° 15' E

TIME ZONE -1000 — TIMES AND HEIGHTS OF HIGH AND LOW WATERS — YEAR 1980

JANUARY

Day	Time	M	Day	Time	M
1 Tu	0215 [illegible] 1458 2054	0.7 4.4 0.8 3.5	16 W	0133 0810 1410 2022	0.6 4.3 0.9 3.8
2 W	0256 0924 1539 2133	0.7 4.4 0.9 3.5	17 Th	0220 [illegible] [illegible] [illegible]	0.6 4.8 [illegible] [illegible]
3 Th	[illegible] 1001 [illegible] [illegible]	[illegible] 4.[illegible] [illegible] 3.5	18 F	[illegible]	[illegible]
4 F	[illegible] 1037 [illegible] [illegible]	0.9 3.9 1.0 [illegible]	19 Sa	0342 1023 1613 2241	0.5 4.[illegible] 0.[illegible] 3.8
5 Sa	[illegible] 1109 1718 2313	1.0 4.1 1.1 3.3	20 Su	[illegible] [illegible] 1725 2319	0.5 4.5 0.6 [illegible]
6 Su	0452 1139 1746 2345	1.1 4.0 1.2 3.2	21 M	0527 1158 1813	0.7 4.[illegible] 0.[illegible]
7 M	0526 [illegible] 1820	1.2 3.8 1.3	22 Tu	[illegible] [illegible] 1245 [illegible]	[illegible] [illegible] 4.[illegible] [illegible]
8 Tu	0021 [illegible] 1226 1901	3.1 1.3 3.6 1.4	23 W	[illegible] [illegible] 1377 1950	[illegible]
9 W	0115 0706 1337 1958	3.3 [illegible] 3.4 1.6	24 Th	0218 0016 1427 2103	[illegible] 1.6 [illegible] [illegible]
10 Th	[illegible] 0612 [illegible] 2103	3.[illegible] 1.8 3.2 1.5	25 F	0326 0942 1550 2118	3.5 1.6 3.4 [illegible]
11 F	0307 0850 1546 [illegible]	3.[illegible] 1.8 3.2 1.6	26 Sa	0446 1109 1709 2344	3.7 1.5 3.4 1.2
12 Sa	0452 1103 1654 2306	3.3 [illegible] 3.2 1.3	27 Su	0554 [illegible] 1810	[illegible] 1.4 [illegible]
13 Su	0552 1203 1754 2358	[illegible] [illegible] 3.3 1.1	28 M	[illegible]	[illegible]
14 M	0541 1254 [illegible]	[illegible]	29 Tu	[illegible] [illegible] [illegible] [illegible]	[illegible]
15 Tu	[illegible]	[illegible]	30 W	[illegible] [illegible] [illegible] 2041	[illegible]
			31 Th	[illegible] [illegible] [illegible] 2118	[illegible] 4.[illegible] 0.[illegible] [illegible]

FEBRUARY

Day	Time	M	Day	Time	M
1 F	0316 0941 1554 2153	0.9 4.3 0.9 3.6	16 Sa	0256 0926 1643 2143	0.5 4.8 0.4 4.1
2 Sa	[illegible] [illegible] [illegible] 2212	0.9 4.3 1.0 3.6	17 Su	0343 1008 1625 2228	0.4 4.8 0.4 4.2
3 Su	[illegible] [illegible] 1646 2246	0.9 4.2 1.0 3.6	18 M	0428 1054 [illegible] [illegible]	0.4 4.8 [illegible] 4.2
4 M	0437 1107 [illegible] 2315	1.0 4.[illegible] 1.1 3.5	19 Tu	0511 1127 1749	0.5 4.5 0.6
5 Tu	0505 [illegible] 1737 2346	1.1 3.9 1.2 3.4	20 W	0006 0558 1222 1831	4.1 0.8 4.2 0.8
6 W	0537 1206 1809	1.3 3.7 1.3	21 Th	0045 0648 1309 1922	4.0 1.1 3.9 1.1
7 Th	[illegible] [illegible] [illegible] [illegible]	3.3 [illegible] 3.[illegible] [illegible]	22 F	0145 0752 1407 2024	3.6 1.5 3.5 1.3
8 F	[illegible] [illegible] 1333 1946	3.2 1.5 3.2 1.6	23 Sa	0252 0916 1530 [illegible]	3.6 1.7 3.2 1.5
9 Sa	[illegible] 0842 1447 [illegible]	3.2 1.9 3.0 1.6	24 Su	0415 1054 1652 2302	3.6 1.7 3.1 1.4
10 Su	0345 1016 1603 2215	3.2 1.9 3.0 1.5	25 M	0537 1206 1811	3.7 1.5 3.2
11 M	0505 1130 1720 2320	3.4 1.7 3.1 1.3	26 Tu	0009 0639 1303 1905	1.3 3.9 1.3 3.4
12 Tu	0600 1230 1821	3.7 1.4 3.2	27 W	0103 0728 1348 1945	1.2 4.0 1.1 3.6
13 W	[illegible] [illegible] 1322 1910	1.1 [illegible] 1.1 3.[illegible]	28 Th	0148 [illegible] 1424 2024	1.0 4.2 1.0 3.7
14 Th	[illegible] [illegible] 1411 2001	[illegible] [illegible] 1.8 3.8	29 F	[illegible] [illegible] 1458 2058	0.9 4.2 0.9 2.7
15 F	[illegible] [illegible] 1458 2006	0.6 4.6 0.6 4.0			

MARCH

Day	Time	M	Day	Time	M
1 Sa	0258 0915 1526 2126	0.9 4.2 0.9 3.8	16 Su	0243 0905 1520 2126	0.4 4.7 0.3 4.5
2 Su	0326 [illegible] 1550 2154	0.8 4.2 0.8 3.8	17 M	0330 0950 [illegible] 2211	0.2 4.7 0.[illegible] 4.4
3 M	0352 1009 [illegible] 2222	0.9 4.1 0.9 3.8	18 Tu	[illegible] 1034 [illegible] 2255	[illegible] 4.6 [illegible] 4.[illegible]
4 Tu	0416 1035 1637 2248	0.9 4.0 0.9 3.8	19 W	0458 [illegible] 1722 2341	0.5 4.4 0.6 4.3
5 W	0446 1101 1701 2318	1.0 3.9 1.0 3.7	20 Th	0543 1158 1803	0.7 4.0 0.9
6 Th	0516 [illegible] 1730 2352	1.2 3.[illegible] 1.1 3.6	21 F	0025 0630 1245 1848	4.[illegible] 1.1 3.6 1.1
7 F	0550 1203 1800	1.4 3.4 [illegible]	22 Sa	0118 0730 [illegible] 1945	3.9 1.4 3.2 1.4
8 Sa	[illegible] 0635 1246 1843	[illegible] [illegible] 3.2 1.5	23 Su	0220 0851 1454 2107	3.8 1.6 3.0 1.6
9 Su	0130 0746 1350 1950	3.3 1.8 3.0 1.6	24 M	0335 1030 [illegible] 2235	3.5 1.8 2.9 1.6
10 M	0240 [illegible] 1516 2124	3.5 1.9 2.[illegible] 1.6	25 Tu	0505 1143 1756 2350	3.5 1.5 3.1 1.5
11 Tu	0416 1056 1650 2248	3.4 1.6 3.0 1.4	26 W	0611 1237 1846	3.7 1.2 3.3
12 W	0535 1203 [illegible] [illegible]	3.7 1.3 3.3 1.2	27 Th	0043 0700 [illegible] 1925	1.3 3.8 1.1 3.5
13 Th	0637 1300 [illegible]	4.0 1.0 3.6	28 F	0124 [illegible] [illegible] 2000	1.1 [illegible] 0.8 3.7
14 F	[illegible] [illegible] [illegible] 1952	0.9 4.3 0.7 3.9	29 Sa	0200 [illegible] 1424 2031	1.0 4.0 0.8 3.8
15 Sa	[illegible] 0818 1437 2039	0.6 4.6 0.4 4.1	30 Su	0231 0843 1450 2100	0.9 4.0 0.8 3.9
			31 M	0301 0911 1516 2130	0.8 4.0 0.7 3.9

APRIL

Day	Time	M	Day	Time	M
1 Tu	0331 0939 1543 2158	0.8 4.0 0.7 3.9	16 W	0403 1011 1612 2237	0.3 4.3 0.3 4.5
2 W	[illegible] [illegible] [illegible] [illegible]	0.8 3.9 0.8 3.9	17 Th	0445 1054 1658 [illegible]	0.5 4.0 0.5 [illegible]
3 Th	[illegible]	[illegible] [illegible] 0.9 [illegible]	18 F	0523 [illegible] 1720	0.7 [illegible] 0.6
4 F	[illegible] [illegible] [illegible] [illegible]	1.1 [illegible] 1.0 3.7	19 Sa	[illegible] [illegible] [illegible] [illegible]	4.2 [illegible] [illegible] [illegible]
5 Sa	0537 1139 [illegible]	1.2 3.[illegible] 1.2	20 Su	[illegible]	[illegible] [illegible] [illegible] 1.4
6 Su	0005 [illegible] 1222 1807	3.6 1.[illegible] 3.[illegible] 1.4	21 M	[illegible] [illegible] [illegible] 2020	[illegible] [illegible] 2.8 [illegible]
7 M	[illegible] [illegible] 1324 [illegible]	3.5 1.[illegible] 2.9 [illegible]	22 Tu	0300 [illegible] [illegible] [illegible]	3.4 1.6 [illegible] [illegible]
8 Tu	0209 0854 [illegible] 2045	3.4 1.5 2.[illegible] 1.6	23 W	[illegible] [illegible] 1722 2316	[illegible] [illegible] 3.0 [illegible]
9 W	0335 1024 [illegible] [illegible]	3.4 1.4 [illegible] [illegible]	24 Th	[illegible] [illegible] [illegible]	3.4 [illegible] 3.2
10 Th	0500 1123 1741 2337	3.6 1.1 3.3 [illegible]	25 F	[illegible] 0618 [illegible] 1854	[illegible] 3.[illegible] 1.0 3.4
11 F	0609 1231 [illegible]	3.8 0.8 3.6	26 Sa	[illegible] 0700 1311 1928	1.2 3.7 0.5 3.8
12 Sa	[illegible] [illegible] [illegible] [illegible]	0.8 4.[illegible] [illegible] 4.0	27 Su	[illegible]	[illegible]
13 Su	[illegible]	0.5 4.4 [illegible] [illegible]	28 M	[illegible] [illegible] [illegible] [illegible]	0.9 3.8 0.7 3.9
14 M	[illegible] [illegible] 1456 2107	0.4 4.5 0.2 4.4	29 Tu	[illegible] [illegible] 1441 2105	0.6 [illegible] [illegible] [illegible]
15 Tu	[illegible] [illegible] [illegible] [illegible]	[illegible] 4.4 0.2 4.5	30 W	[illegible] [illegible] [illegible] [illegible]	[illegible] [illegible] 0.7 4.0

HEIGHT IN METRES

GRADE 11 OCEANOGRAPHY

CORRECT USE OF LABORATORY GLASSWARE

Observing the following guidelines will ensure that you treat all laboratory glassware correctly. You will obtain the best possible results from your equipment when it is kept in good condition.

1. Scratched or etched glassware should never be heated, since scratches and etches are zones of weakness and may cause the glass to break.
2. Water and concentrated acids should not be mixed inside a measuring cylinder, since the resulting heat may crack the base.
3. Never place hot glassware on either cold or wet surfaces as the sudden change in temperature may cause the glass to break.
4. Always use tongs or a similar lifting device to remove hot glassware from the heat, otherwise unpleasant skin burns may result.
5. Allow all heated items of glassware to cool slowly, since forced cooling may lead to shattering.
6. Heat liquids in glass vessels slowly and with rotation to avoid overheating any particular area.
7. Use a "policeman" on all stirring rods, thereby preventing the scratching of inner glass surfaces.
8. Do not use hot, concentrated alkalis or hydrofluoric acid with glassware, since these substances tend to attach glass.
9. Any item of glassware that has been used to hold chemical solutions should be washed as soon afterwards as possible. The longer such items are left, the more difficult they are to clean.
10. Take great care when washing measuring cylinders, burettes and pipettes, since it is easy to accidentally break these items on sinks or water taps.
11. Always watch evaporation procedures very carefully so that the vessel may be removed from the heat the moment that evaporation is finished. Otherwise the vessel may crack.
12. Individual items of glassware should always be stored in their correct racks, cupboards or drawers, with no two pieces in contact with each other and none in danger of being broken.
13. Separate burette stopcocks, ground joints, flask stoppers, etc. when storing, to prevent sticking.
14. To prevent sticking, use petroleum jelly to lubricate stopcocks in burettes and separating funnels.