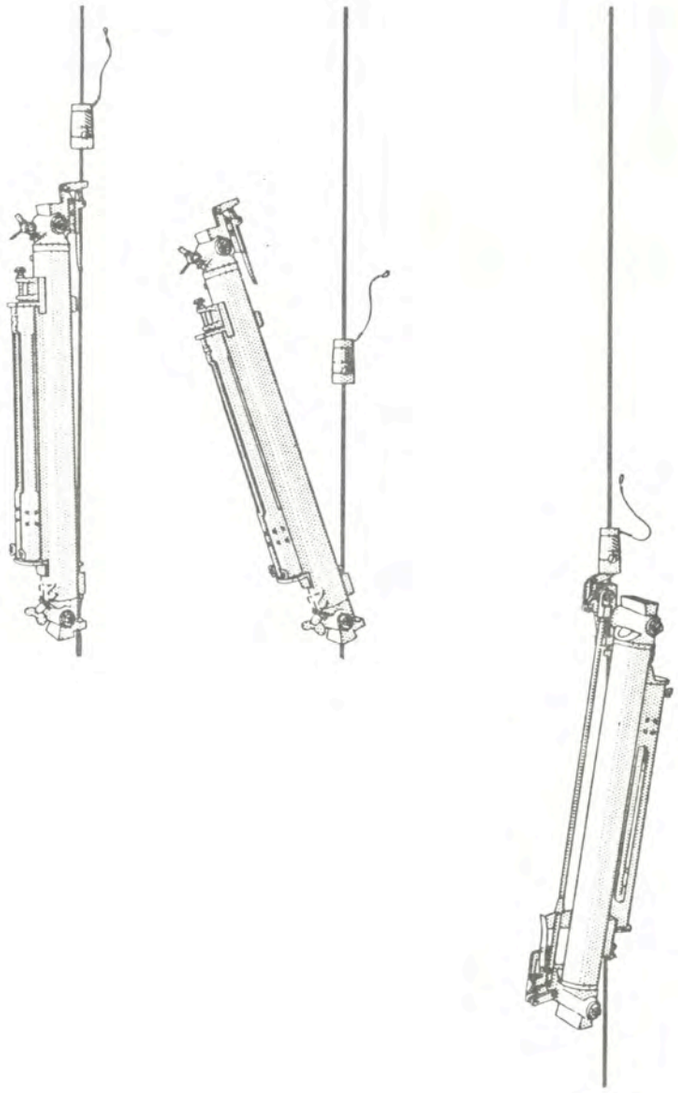
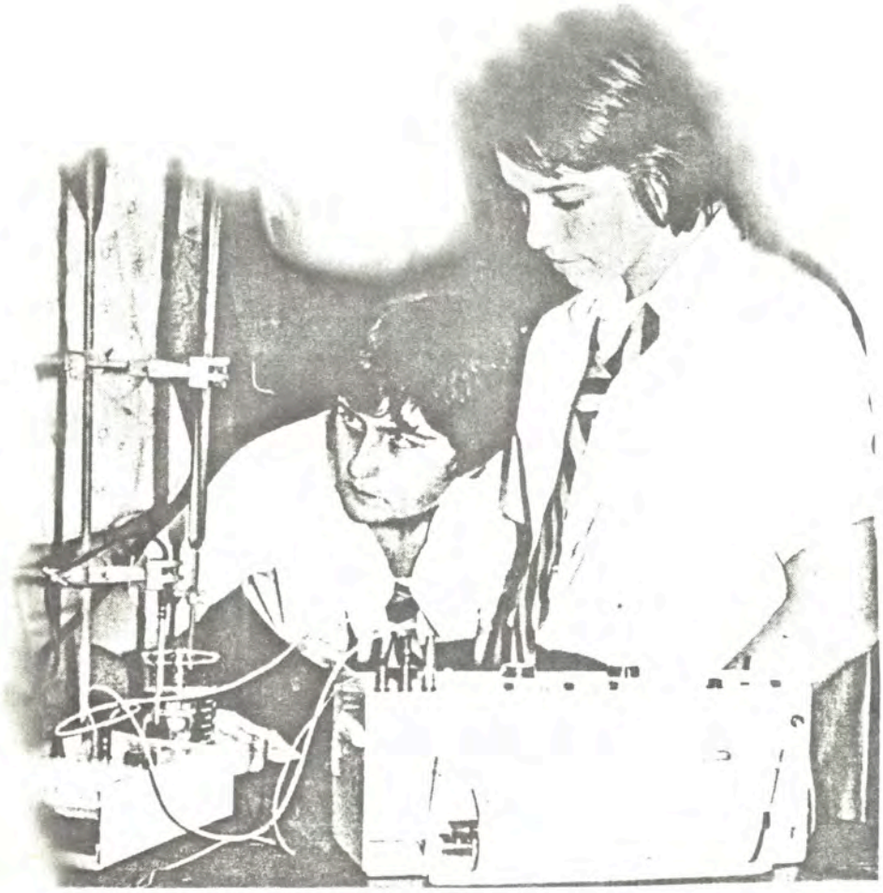
SCIENCE TEACHERS ASSOCIATION OF QUEENSLAND



COASTAL AND ESTUARINE OCEANOGRAPHY



UNIT IV

ESTUARINE CHEMISTRY

written by

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B.Sc. Dip Ed.

TRIAL UNIT

"TO GREAT DAYS AT THE ALEX"

Australia's coastline forms a special place in our environment because over 90% of us live there. Due to different Ecological, Economic, Social and Recreational interests many conflicts arise over the use of our Estuaries, Beaches and Barrier Reefs. Sand Mining, High Rise development, Longline Fishing, Low water Land sales, Resort development and oil Pollution are but a few of the real issues that face us now. There is an urgent need for all Australians to develop an attitude towards sensible resolution of these conflicts. This set of notes is one in a series that hopefully will give students the skills necessary to become involved in these issues and make sensible contributions to coastal environmental decision making. In doing so I hope that the coastline may be managed in such a way that future Australians will derive as much pleasure out of it as I have.

My thanks must go to S.T.A.Q. for providing the financial backing and support for this project. Thanks also to my Mother and Father who deciphered and typed my bad writing; and to Len Zell of the Great Barrier Reef Marine Park Authority who read and critised the draft and for making many useful contributions. As this is a first draft any comments would be gratefully acknowledged.

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UNIT IV

CHEMICAL OCEANOGRAPHY

CHAPTER 8.

LABORATORY METHODS

CHAPTER 9.

SALT WATER CHEMISTRY

INVESTIGATIONS:

CHAPTER 8.

LABORATORY METHODS

8.1 Glassware

You may have used some of the glassware that will be described here before. If you have, then this Chapter will be a simple revision, but for those of you who have not, an oceanographer's laboratory contains many valuable pieces of glassware which must be correctly used and stored safely.

Here is some of the equipment drawn in side view that you will use.

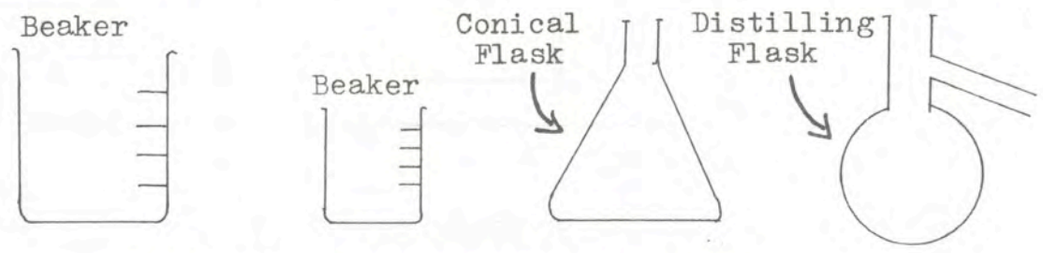


Fig. 8-1: Glassware for weighing.

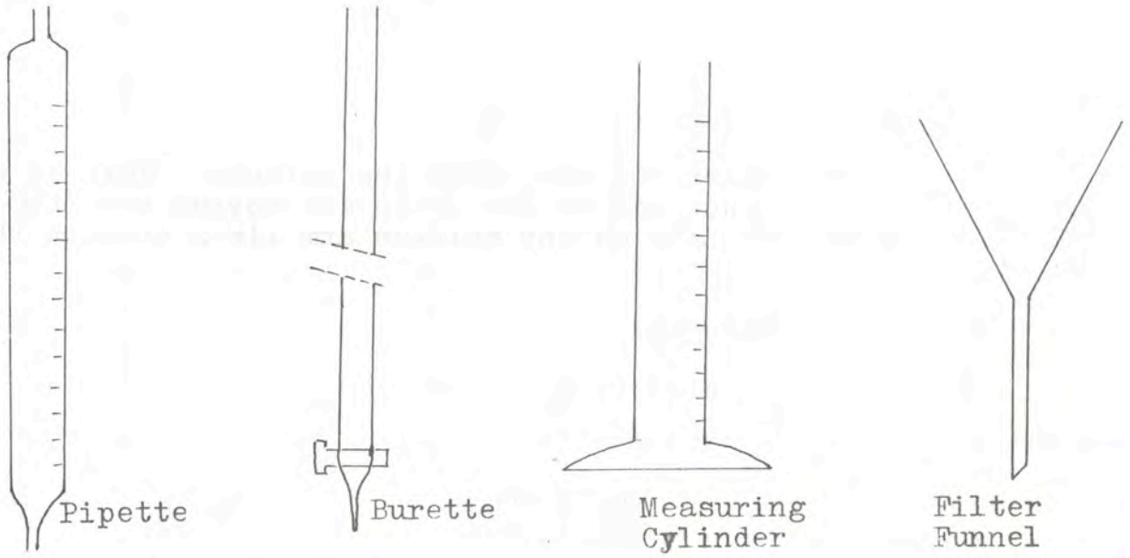


Fig. 8-2: Glassware for measuring.

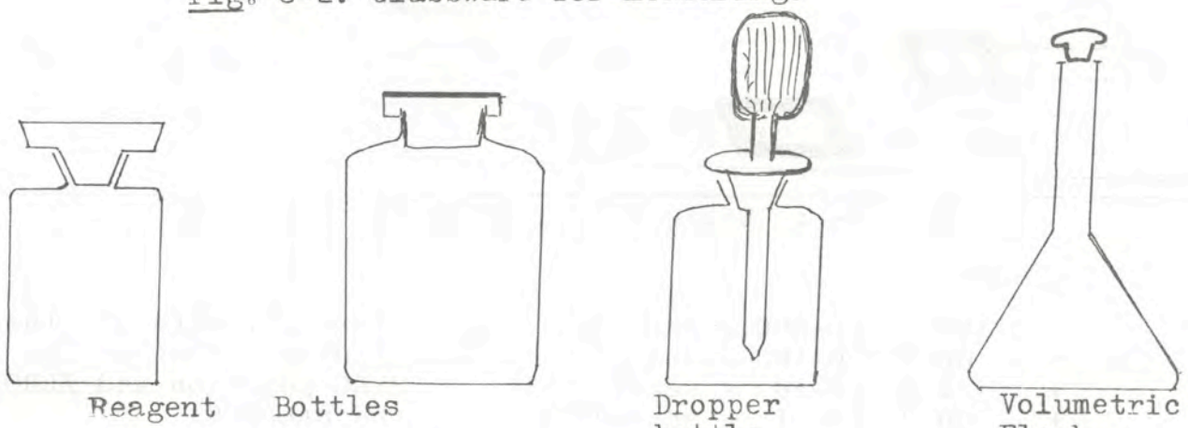
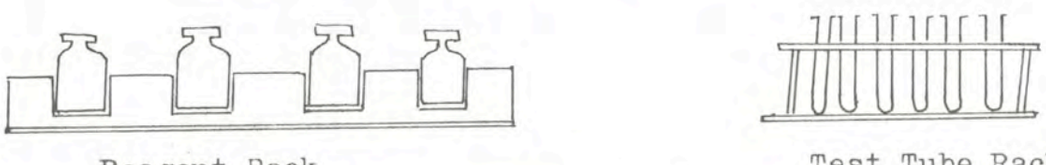
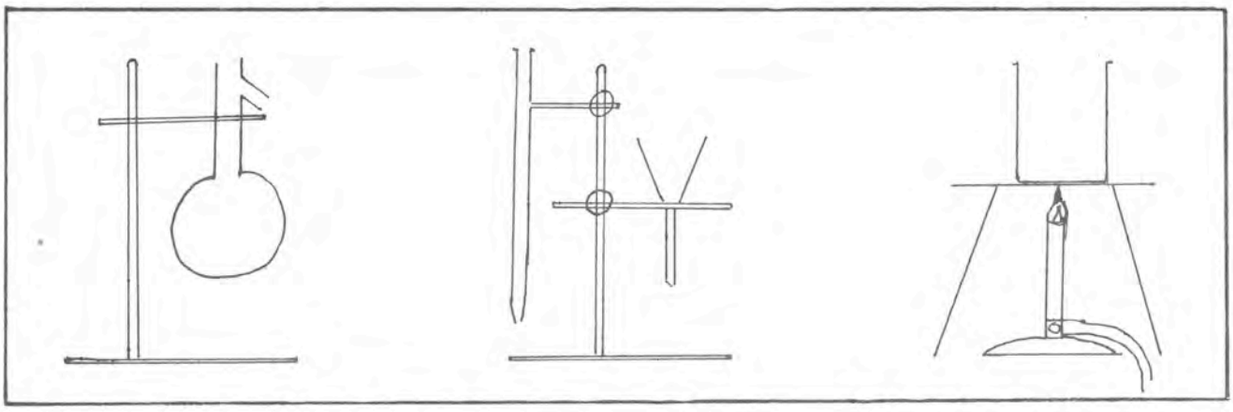


Fig. 8-3 Glassware for storage



8.2 *Apparatus for holding Safety Glassware*



Pick out the following:

RETORT STAND, CLAMP, BOSS HEAD, DISTILLING FLASK, BUNSEN BURNER, FILTER FUNNEL, BURETTE, TRIPOD STAND, BEAKER, RING STAND, AIR PORT.

Fig. 8-4: Apparatus for holding equipment safely

8.3 *Apparatus for Weighing the Balance:*

Before you start you must ZERO the balance. This is done by placing the balance pan on the scale and moving the ZERO ADJUSTMENT KNOB until the Line on the balance arm lines up with the Zero Point.

Measuring of Masses:

Suppose you wanted to weigh out 162.5 g of starch.

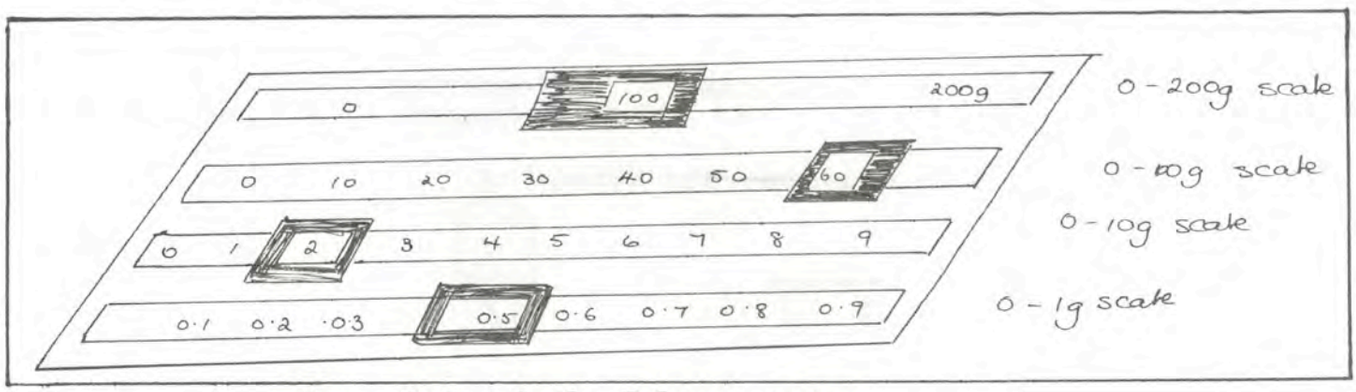


Fig. 8-5: Scale Balance arms.

Readings:

	100.0	(0-200 g scale):
+	60.0	(0-100 g scale):
+	2.0	(0-10 g scale):
+	0.5	(0- 1 g scale):
	162.5 ⟵	Weight :

1. Start off with all the sliding masses on the ZERO position and ZERO the BALANCE.
2. Place a piece of filter paper on the scale and weigh it by moving the 0-1 g scale.
3. Add this to your desired weight.
4. Set the scale.
5. Add starch until the scale balances.

8.4 Burettes

A Burette is an invaluable instrument in titrations of one chemical into another. Such titrations will tell you how much OXYGEN, SALT, ACID, and CARBON-DIOXIDE is in a water sample.

What to do:

* Fill the Burette at (A) with a labelled filter funnel.

  Always use the same burette with the same solution.

  If not enough burettes exist, rinse out the burette with CHROMIC ACID and then rinse out the burette with the solution that is to be used NEXT.

  Don't mix filter funnels when filling.

* The Stop Cock (E) is a delicate piece of glassware. It is TURNED by lightly pushing the handle (F) IN.

  The Stop Cock is lightly greased on both sides of the ground glass, but not to the point where grease plugs up the small hole.

  A CIRCLIP (G) holds the Stop Cock on.

* DO NOT REMOVE THE STOP COCK - leave this for the Laboratory Assistant or your teacher.

* Read the INITIAL VOLUME from the bottom of the MENISCUS at (B) with your eye in line with the MINISCUS.

  Similarly at (D) - FINAL READING.

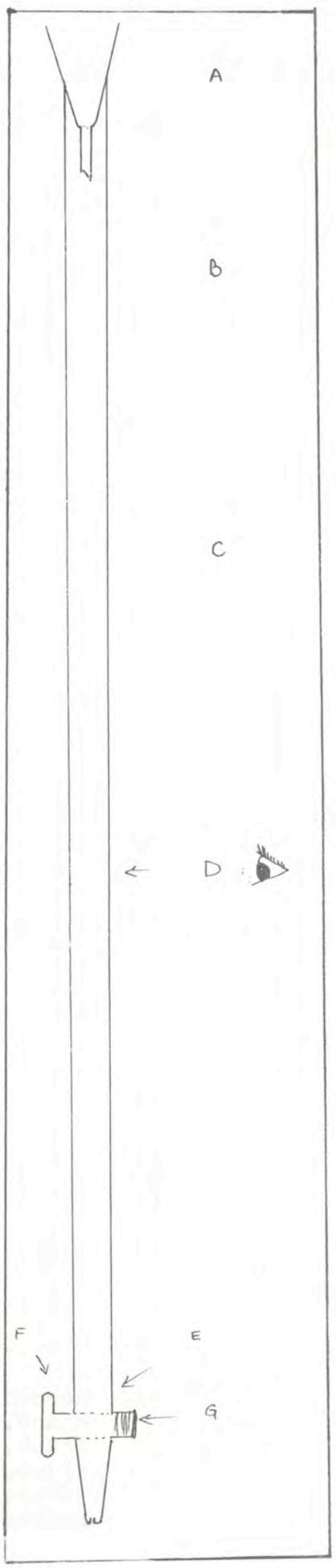


Fig. 8-6: Burette

8.5 *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. 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.
8. Take great care when washing measuring cylinders, burettes and pipettes, since it is easy to accidentally break these items on sinks or water taps.
9. 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.
10. 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.
11. Separate burette stopcocks, ground joints, flask stoppers, etc. when storing, to prevent sticking.
12. Place thermometers in the middle of the DESK and be careful how you take them out of their containers.

Before you begin the next part of the notes, go through the following checklist:

I CAN

(a) Decant a liquid ☐

(b) Wash a precipitate ☐

(c) Dilute a acid ☐

(d) Evaporate with a water bath ☐

(e) Use a burette ☐

(f) Heat a liquid ☐

(g) Recognise, a test tube, a burette, a tripod stand, a bunsen, conical flask, beaker, volumetric flask, balance, gause mat, retort stand, boss head, clamp, filter paper, pipette, pipette bulb, dropper bottle, reagent bottle, thermometer, test tube rack, graduated measuring cylinder, wash bottle

☐

8.6 *Some Practice*

THE CLEANING OF LABORATORY GLASSWARE

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
* 100ml beaker
* glass rod
* 60ml bottle with glass stopper
* 1 or 5ml pipette

* *Be careful of the reaction*
* *Pour the acid very carefully*

Procedure:

1. Pipette 1ml of distilled water to a 100ml beaker.
2. Weigh out about 0.7g of potassium dichromate and dissolve this in the distilled water.
3. Carefully add 50ml 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 (to be cleaned)

Procedure:

1. Transfer about 15ml 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.

Radiolarian ×100

8.7 *Oceanographic Units and Measurements*

VOLUME:

Millilitres - expressed as Mls : 1000mls = 1 litre
Litres - expressed as L.

Use a BEAKER, MEASURING CYLINDER, PIPETTE OR BURETTE.

e.g. A 100ml measuring cylinder will hold 100mls to the MARK. It may hold a bit more, but is so called because of its MAXIMUM VOLUME MARK.

MASS:

Kilogrammes - expressed as Kg.
Grammes - expressed as g. : 1000mls = 1 Kg.

Use a Triple Beam Balance: Express weight as 94.2 g. or 49.62 g. LIMIT OF ACCURACY is 0.01 g.

TEMPERATURE:

Water boils at 100 C. and freezes at 0 C. at standard atmospheric pressure.

Queensland sea air temperature ranges from 12 C. to 25 C. and water temperature from 16 C. to 22 C.

There are exceptions.

Use a hand Lens to measure to 0.1 C. accuracy, and use a 0-50 C. range thermometer.

EXTINCTION COEFFICIENT

Secchi Disc = $\frac{1}{2}$ L where L = length of rope under water in metres.

SPEED:

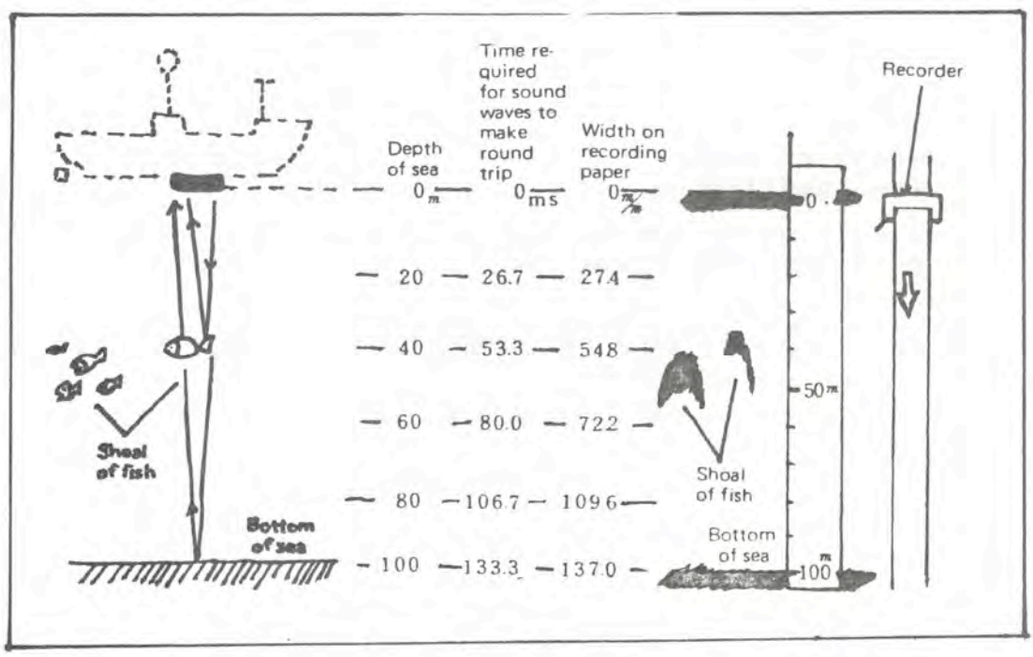
Knots: 1 Knot = 1 Nautical Mile per hour.

Used for speed of vessel and wind and current speed.

Km/hr = Kilometres per hour - Air speeds, Current speeds.

TIME:

Hours, minutes, seconds - used in Navigation.



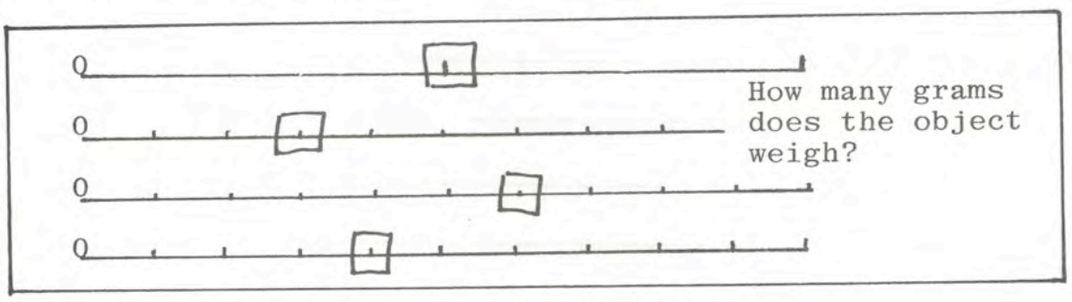
Principles of sounding machine

MAIN IDEAS

1. In a chemical laboratory there is a place for everything and everything in its place.
2. Burettes need special care.
3. Chronic acid is used to clean glassware.
4. As in all sciences, each measurement has a set of units.
5. A Laboratory Balance is a delicate scientific piece of apparatus and not a toy.

REVIEW QUESTIONS

1. How many significant figures are there in each of the following quantities?
   (a) 37.2 m
   (b) 0.000 076 secs
   (c) 301.5 kg
   (d) 56.02 m
   (e) 5.00 m
   (f) 0.000 000 000 97 m
   (g) 0.05 m
2. A triple beam balance as follows



3. List the dangers with acids and alkalis.
4. What precautions must be taken when using and making chronic acids?
5. How do you care for a burette?
6. How do you care for a balance?
7. Name 9 pieces of glassware.
8. How should liquids be poured? How should the pipette bulbs be used?

CHAPTER 9.

SALT WATER CHEMISTRY

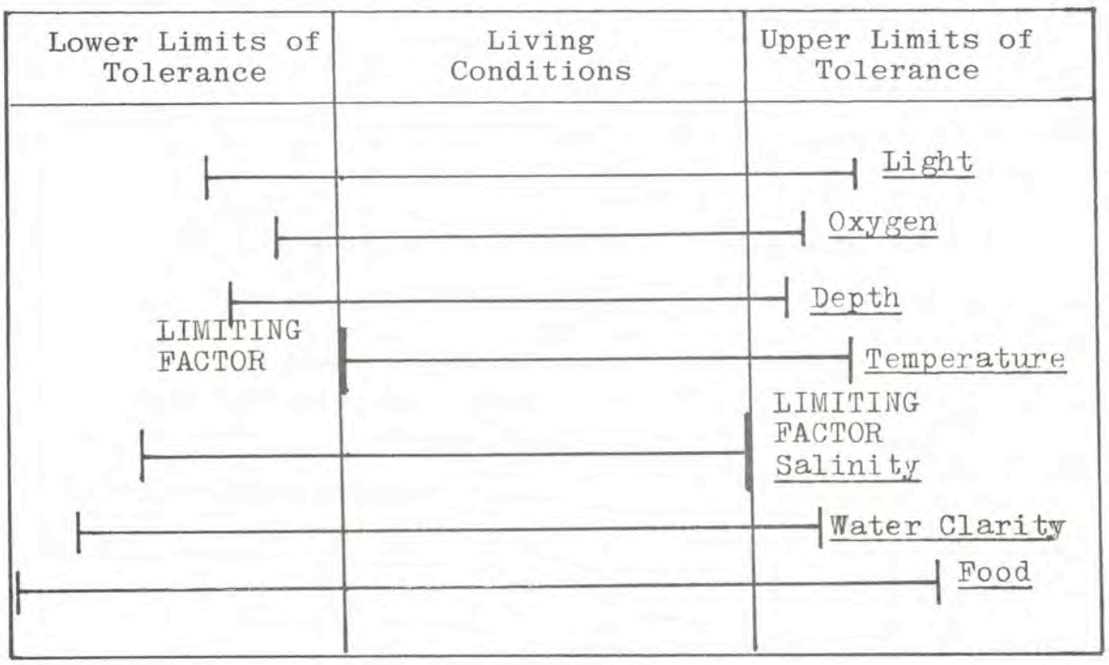
9.1 *Limits of Tolerance*

When studying the chemistry of sea water, we should not study it as a study of its own. The results and observations you learn about in this chapter will drastically affect the organisms that inhabit the estuaries.

An animal's survival is often limited by the factor with the narrowest tolerance. The limits of tolerance describe a range of living conditions specific to each organism and each living or non-living factor affecting it. Every species of animal and plant has a range of tolerance for each factor which determines its survival. There are tolerances for food, predation, shelter, breeding conditions, temperature, salinity, water clarity, light, pressure, oxygen, depth, and other factors that affect ist surroundings at any stage of a life cycle. An animal's survival is often limited by the factor with the lowest tolerance.

TABLE 9-1

The Limit of Tolerance



Let us study now how each is recorded:

9.2 *Temperature in Estuaries*

Water with high salinities tends to sink and therefore will be colder than water with lower salinities. It seems reasonable therefore to suggest that the bottom layers of an estuary will be colder and denser compared with the top layers.

Water temperatures in estuaries can often change quite dramatically due to floods, droughts, location of heavy industry or meat works. An increase in the heat content of water can have a serious effect on the life in an estuary.

Power stations, for example, use VAST quantities of water in cooling processes. This water is returned to an estuarine waterway a lot hotter than the surrounding water. Also, evaporation at the surface can cause the water temperature to be colder than at the middle layers.

Investigation 9-1: Enyironmental Effects of Temperature

You will need:

PART A : Effect of Pollutants

* Sea water sample. (From investigation)
* 3 test tubes
* Test tube rack
* Dilute sulphuric acid
* 0.50°C. Thermometer
* 250ml beaker

PART B.

* 3 x 250ml measuring cylinders
* Hydrometer or Salanometer
* Hot water
* Cold water
* Urn (if hot water supply not available)

PART C.

* Graph paper

What to do:

PART A.

1. Set up 3 test tubes half full of water and read the temperature in each to the nearest 0.1°C.

   ☐ Record in data table.

2. Add drops of bleach, acid and iron filings to each of the test tubes.

   ☐ Record the temperature change in each to the nearest 0.1°C.

CARE : Do not add too much acid or you will break the thermometer. ALWAYS add acid to water.

PART B.

Fill 3 X 250ml measuring cylinders with cold, warm, and hot water.

☐ Record the hydrometer reading and temperature in each.

PART C.

Examine the data table below on temperature and dissolved oxygen content in parts per million.

Temperature °C	Dissolved oxygen
0°C	13 PPM
5°C	10 PPM
10°C	8 PPM
15°C	6 PPM
20°C	5 PPM
25°C	4 PPM

Plot a Graph of the Data

Analysing the results:

1. In which test tubes in PART A did the temperature increase the greatest?
2. Which water pushes up the hydrometer the most?
   HOT or COLD?
   Is cold water more or less dense than Hot Water? WHY?
3. How could acids, bleach, or iron filings enter an estuary?
4. Predict the dissolved oxygen in sea water at 22.5 C and 28 C.

Drawings:

Try this : Try dissolving an alka-seltzer tablet in hot water.

5. Make pencil line drawings of the experimental equipment used in PARTS A and B.

The environmental effects of temperature are many. Fish can die or move elsewhere if temperatures change. Rainbow trout cannot live if the temperature rises above 15 C, or perch above 24 C. Each of these species can only tolerate a temperature rise of only 5 C.

Poisoning by chemicals such as acids or heavy metals can be increased dramatically if temperatures in estuaries increase by 10 C.

The amount of oxygen decreases rapidly as temperature rises. This can effect the type of fish that breed in estuaries or the survival rate of their young.

9.3 Salinity

Estuaries are places where fresh water from the land mixes with ocean water. Salinity is a measure of the amount of dissolved salt in the water. Water which has a less amount of salt in it, not equivalent to oceanic water, is called brackish water.

Investigation 9-2: Making Sea Water

You will need:

* A salinometer (or Beer Hydrometer)
* An empty 2 litre wine flagon + cap
* OR 1 X 1 litre measuring cylinder
* 70g of salt (35g if using a 1 litre cylinder)
* Triple Beam Balance
* Spoon or large Spatula

What to do:

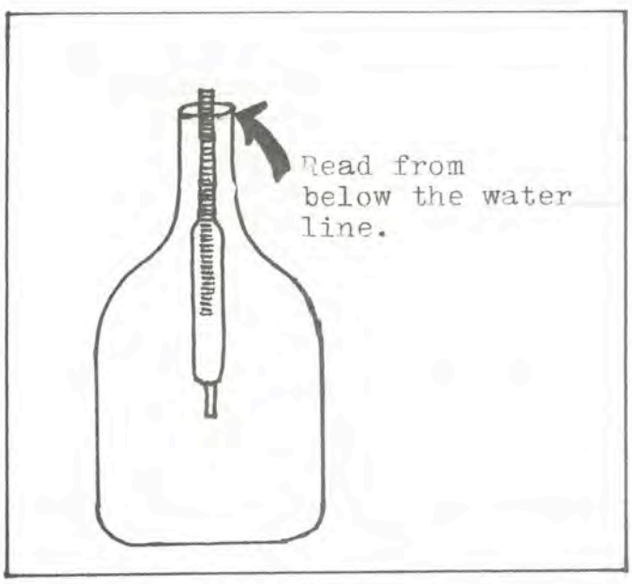


Fig. 9 - 1: Hydrometer in Wine Flagon.

1. Fill the wine flagon almost to the top with water (This represents water from the land) and place the salinometer in and top up.

   Read and record the salinity from under the water line.

2. Now weigh out 10g. salt (5g. if you use a 1 lt. cylinder). Take out the salinometer, pour in the salt, screw the cap of the wine flagon on, and shake. Replace the salinometer and top up again if necessary.

   Read and record the salinity. What has happened?

3. Repeat this 7 times until 70g. of salt has been added, recording the salinity each time.

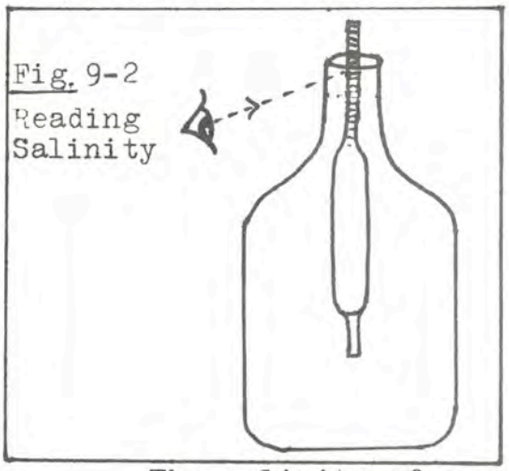
4. Plot a graph of SALINITY versus GRAMS OF SALT. This will serve as a very useful calibration curve in field work and should be plotted carefully and accurately, and covered with clear contact if necessary, AND

KEEP YOUR SALT WATER NOW FOR FURTHER EXPERIMENTS.

Questions:

1. What happened as you added the salt?
2. What did you do to the water to make this happen?
3. When you had added 70 grams of salt to 2,000mls of water, what % salt was in the water?
4. Extrapolate the curve and predict the salinity reading when 9.5 grams of salt was added.

The saltiness of sea water is called SALINITY and is measured in parts per thousand (PPT). In the ocean, the salinity is usually 35 PPT, or if you took a litre of sea water and boiled it all away you would be left with 35g. of salt.



In 2 litres of water you added 70 grams of SALT.

This is equivalent to adding 35 grams in 1 litre.

This is approximately the salinity of sea water and is written as

35%

35 parts per thousand.

The salinity of ocean waters anywhere in the world is usually between 34-36 PPT. In estuaries the salinity can be much less than the ocean because water in the rivers, mixing with the ocean water, dilutes it. The salinity can be as high as 35 PPT or as low as 10 PPT.

In Northern Queensland estuaries the salinity varies from time to time due to seasonal rains. In Summer, when there is a lot of rain, there is a tremendous flow of water into the rivers. When this occurs the salinity drops to 10-12 PPT. In the Winter, when there is little or no rain, the level of the rivers drops and the amount of fresh water reaching the sea is not as great. This is when the salinity of the estuary increases.

The salinity varies also with tides. Depending on the size of the local tides, a gradual influx of water into the estuary can change the salinity.

Let us look at this more closely. *Investigation* proved that salty water pushed the hydrometer up. This was because of the increase in density of the salt water.

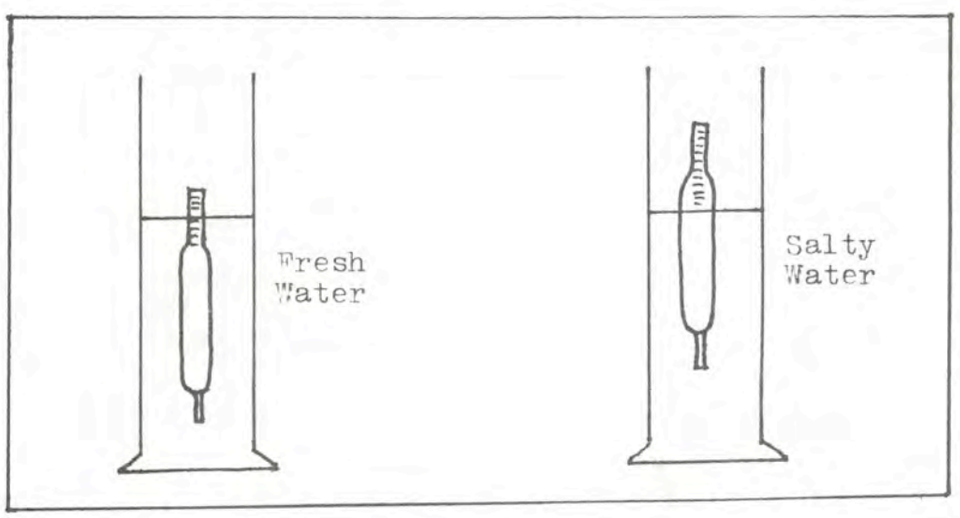


Fig 9 - 3:
Comparing Salt and Fresh water

Salt water is said to be denser and therefore will tend to sink, whereas fresh water will tend to float.

Consider now an estuary from the side.

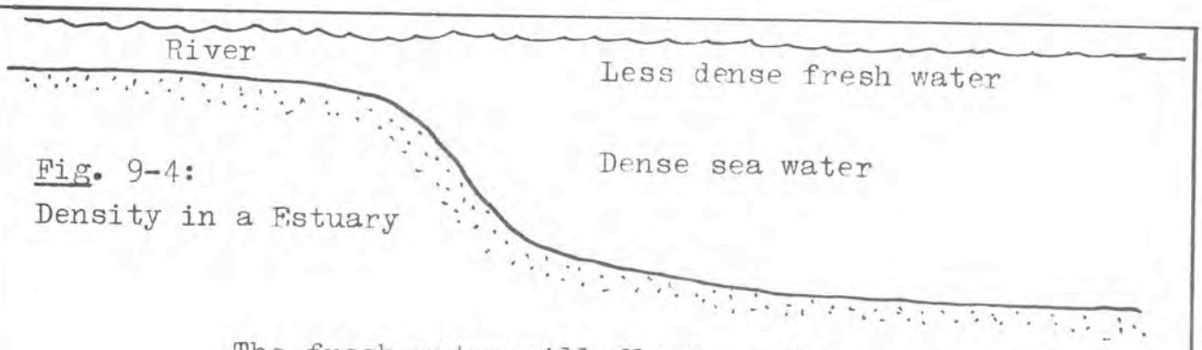


Fig. 9-4:
Density in a Estuary

The fresh water will float on the surface. When the tide comes in there will be a mixing of water and the Fresh water will float to the surface layer.

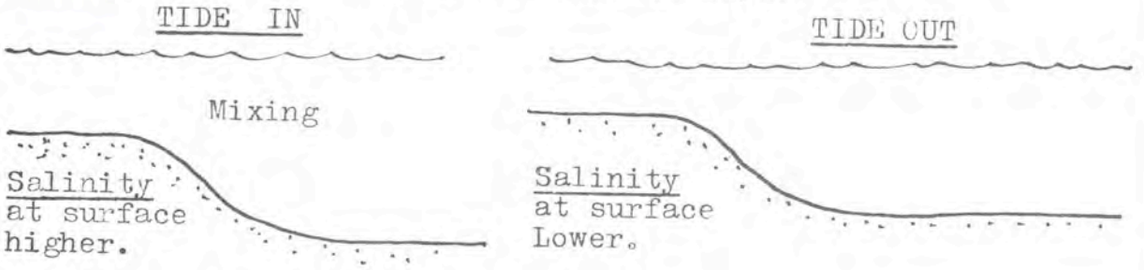


Fig. 9-5: Tide effects on Estuaries.

Investigation 9-3: *Measuring Salinity of a Sea Water Sample*

You will need:

* Burette
* Silver Nitrate solution (fresh) 100mls
* 10mls filtered sea water sample
* 1ml pipette and dropper
* 50ml conical flask
* Potassium chromate indicator
* Small funnel (for filling Burette)

Notes on Solutions:

Silver Nitrate solution : Weigh out 0.497g 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.

Potassium chromate indicator : Weigh out 5g of potassium chromate and dissolve this in 90ml of distilled water in a 250ml 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.

This solution of $AgNo_3$ is cheap, as large amounts are required for Field Work.

*What to do: Note - If you have not mastered the stop-cock yet, fill the Burette with water and practice.

1. Fill the burette with silvernitrate solution.
2. Pipette 1ml of filtered sea water into a 50ml conical flask.
3. Add 1 drop of potassium chromate indicator.
4. Run the silver nitrate into the conical flask, taking care as you approach the end point which is indicated by a red colour.
5. Repeat or use class set results to obtain average.

*Sample Calculation

Each milligram 0.001g of chloride in the sea water uses .1ml of silver nitrate solution.

Initial Burette reading = 0.00ml
Final Burette reading = 60.00ml
Volume of Silver Nitrate used = 60.00 - 0.00mls
= 60mls

IF 0.1mls *uses* 0.001g.

THEN 60. mls x grams

$$0.1x = 0.001 \times 60$$

$$\frac{x}{10} = \frac{60}{1000}$$

$$x = \frac{600}{1000} = 0.6g$$

To get PPM x 1000

$$\therefore \text{ PPM of chloride} = \frac{6 \times 1000}{10} = 600 \text{ PPM}$$

Questions:

1. Often in estuaries the salinity is higher near the bottom than the top. Why?
2. You wish to measure salinity at 4 depths at 3 times during the day. How much silver nitrate would you need?
3. Study the table below. Plot a graph of Salinity v's Latitude.

SALINITY %	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

4. What relationships exist between the PLIMPSOL line on Ships and SALINITY?

9.4 *Sediments and Turbidity*

During rainy seasons river heights rise washing off topsoil from their banks. This soil becomes dissolved or suspended in the river water and is washed into estuaries. Mud can cause problems for the animals and plants that live nearby, or it can provide an excellent hiding place.

Because water is such an excellent solvent, many compounds dissolve in it easily. It is expected that all water bodies will contain a certain amount of dissolved material since chemical compounds are constantly being weathered out of rock and soil, and the T.D.S. content of a river increases rapidly as it approaches the sea. T.D.S. can also be increased by industrial effluent, sewage disposal and irrigation, which washes salts from the land.

It has been realised that for many years, that a number of dissolved solids in the sea water can have a harmful effect. Every now and then you hear of oyster poisoning or mercury poisoning. The increasing use of metallic elements (mercury, lead, zinc and cadnium, is of concern when these elements end up in waterways.

Factors that can contribute to increasing include :

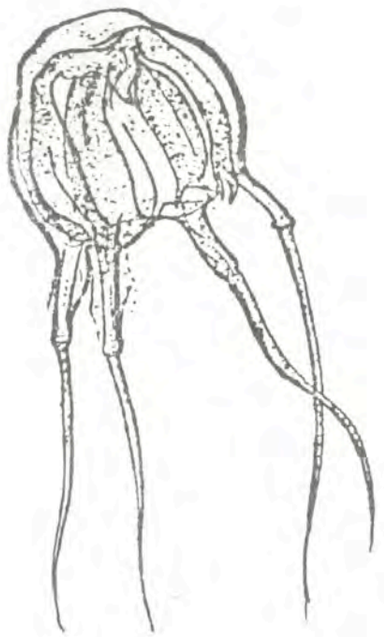
1. Industrial effluent.
2. Irrigation - a process that dissolves huge quantities of fertilisers that end up in estuaries.
3. Ocean inundations by other areas containing dissolved particles.

About 97% of all the world's water is found in the sea. Less than 1% is actually fresh water. In estuaries there is a mixing of water.

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 realise 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.



Turbidity of water clarity is measured with a secchi disc. This disc is lowered over the side of the boat. A record of depth is kept when the white disappears. This is multiplied by 2 (because we are observing reflected light).

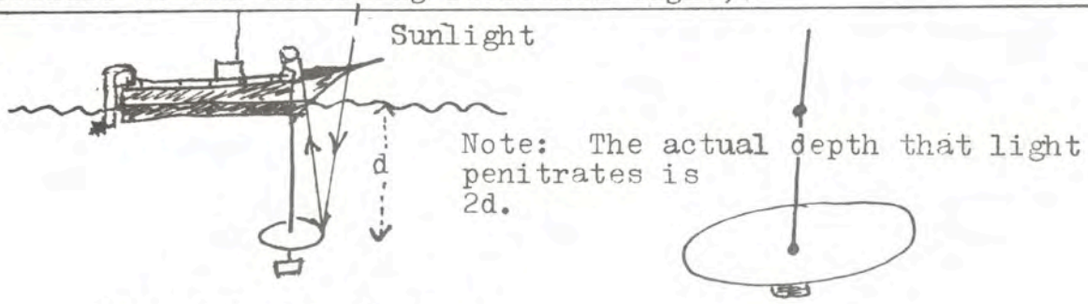


Fig. 9-6: Secchi Disc.

The value obtained is called the *EXTINCTION COEFFICIENT* and is used world wide as an accepted measure of Turbidity. The zone that light penetrates in the ocean is called the Photio Zone.

Extinction Coefficient	Water Content
½ metre	Very muddy
1 metre	Much suspended particles
5 metres	Few suspended particles
10 metres	Very clear

ADDITIONAL METHOD: Turgimeter

Note : A Turgimeter consists of :

WHAT TO DO:

Fill the tube with water sample and record the reading on the light meter.

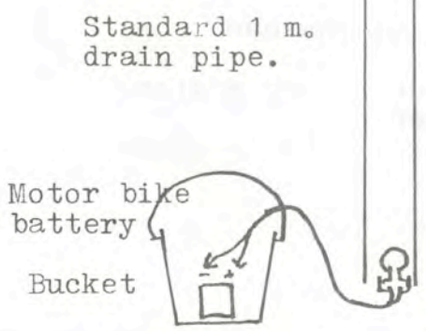
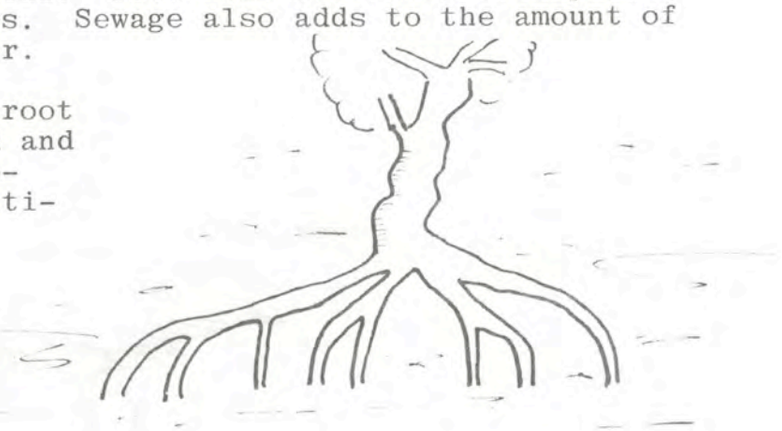


Fig: 9-7: Turgimeter.

Man causes high *TURBIDITY* in estuaries by clearing land of trees and vegetation, so that grass and root systems no longer bind, (together) the top soil. Both wind and water transport this material to water ways. Sewage also adds to the amount of suspended material in water.

Mangroves have large root systems which trap the mud and provide an excellent micro-environment in which a multitude of organisms live.



Investigation 9-4: *Measuring the total suspended solids T.S.S. and total dissolved solids T.D.S. in a sea water sample.*

You will need:

* Triple Beam Balance or (Analytic Balance)

PART A. T.S.S.

* 3 x 250ml sea water samples containing different solids. You will have to make them up (Clear, Some, Lots)
* 3 filter papers
* 3 filter stands or tripod stands
* 3 filter funnels
* 6 x 250ml conical flasks
* Balance (second day)
* Drying lights or oven
* 100 or 250ml measuring cylinder
* Wash bottle

PART B. Total Suspended Solids

1. Make up 3 different 250ml sea water solutions by adding some soil to the sea water sample in 3 x 250ml conical flasks. Add 0.5g., 1g. and 5g. approximately.
2. Set up 3 filter funnels with 3 more 250ml conical flasks. Weigh the filter papers to the nearest 0.02g and then fold, and place in the funnels.
3. Measure out 100mls of sample and filter this so that sea water (the filtrate) passes through, leaving the residue trapped in the filter paper.
4. After all the 100mls has filtered through, dry the filter paper in an oven or under lights overnight.

NEXT DAY - Carefully weigh the dried filter papers with the same balance you used.

Calculate the number of grams of residue :

Mass of filter paper = x grams
Mass of filter paper + residue ..... = y grams

∴ Mass of residue. = y-x grams

Express your answer in PPM.

SALT GRASS MARSHES

NOTE : Calculate part per million : Note 1ml = 1 gram

If 100mls contains 0.01g.

Then 1,000,000mls contains x gr.

Cross multiplying:

100 — 0.01g

1,000,000 — x g

$100x = 0.01 \times 1000$

$x = \frac{0.01 \times 1,000,000}{100}$

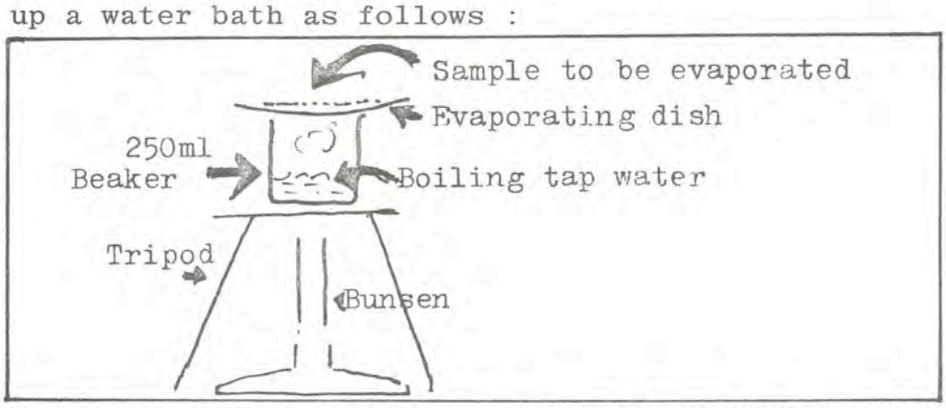
$= 0.01 \times 10,000$

= 10 grams per million

OR = 10 PPM

PART B. Total Dissolved Solids

Set up a water bath as follows :



1. Weigh out 3 numbered clean evaporating dishes and record their weights to the nearest 0.01g.
2. Add 5mls of filtered water sample to each, and evaporate off all the water.
3. Place in a Dessicator overnight.

NEXT DAY

4. Weigh the numbered evaporating basins on the *same balance*.

Record the change in weight
Calculate the PPM of each sample

Mass of Basin = a.grams
Mass of Basin + TDS = b.grams
Mass of TDS = (a-b)grams

If 5mls contains (a-b)g. of dissolved solid
Then 1,000,000mls " a.grams

$5x = (a-b) \times 1,000,000$

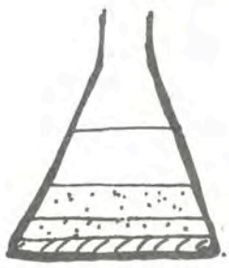
$x = \frac{(a-b)g \times 1,000,000}{5}$ PPM

RESULTS : Produce a data table to summarize your findings in PART A and PART B.

QUESTIONS:

1. How did your results compare with the expected results?
2. Why is it necessary to use the same balance all the time?
3. Why did you place the evaporating basins in the dessicator overnight?
4. Why are parts per million used?
5. Write a paragraph explaining the effects of dissolved soil particles on fish in an estuary.

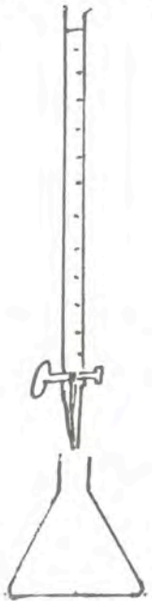
9.5 *Turbidity and Oxygen*



If you let your dirtiest sea water sample settle overnight you will see that the sediment will settle out. Shake it again and we see it becomes dirty, or it has what we call *High Turbidity*. The turbidity is due to the mud which you know consists of dissolved and suspended materials.

Turbidity prevents light from reaching plants below the surface. It is only when plants get sunlight that they can build up a store of food by the process called *photosynthesis*. If light is prevented from reaching them by high turbidity, photosynthetic rates decrease and the amount of oxygen will decrease. Mangrove swamps are characterised by characteristic odours. Lack of oxygen is a contributing factor.

Investigation 9-5. *Measuring the Dissolved Oxygen Content of Sea Water*



You will need: Freshly made solutions of

* Starch solution
* Concentrated sulphuric acid
* Manganese II sulphate solution
* Alkaline Iodide solution
* Sodium Thiosulphate solution
* 250ml conical flask and stopper
* 500ml conical flask
* 3 x 2ml droppers, OR 3 x 2 ml pipettes with filter bulbs
* 250ml measuring cylinder
* Burette

NNB. 1. 2ml samples must *NEVER* be pipetted using a *MOUTH* pipette. These chemicals are extremely *POISONOUS*.

2. For each 2ml added, use a separate pipette or dropper, i.e. name one for maganese sulphate, one for alkaline iodide, and one for sulphuric acid.

Teachers Note - keep these from year to year.

What to do:

1. Fill a burette with water and drain the burette in short spurts - adjust the stop-cock so that it will give you drops. Practice this a few times.
2. Take a 250ml sample of water to be tested and place in a conical flask. (Note : If this is to be done in the field later, use a tube to add the water to the bottom of the sample bottle to avoid air bubbles which may increase the D.O. of the sample Steps 3-5 must then be done immediately).
   Add 2mls of Maganese sulphate.

What to do: (cont)

3. Steps (i) to (v) should be done immediately. The subsequent titration may be delayed several hours to be done in a Laboratory. Steps (ii) to (v) should be done on a surface which cannot be harmed by the overflow.

   (i) Take a 250ml sample of water to be tested. Place this in a conical flask. Use a tube to add water to the bottom of the sample bottle to avoid air bubbles, which may increase the D.). of the sample.

   (ii) Add 2ml of Maganese sulphate below the level of the sample, again to avoid air bubbles.

   (iii) Add 2ml of alkaline iodide solution below the surface.

   (iv) Replace stopper carefully in bottle, shake vigorously, and allow precipitate to settle.

   (v) Add 2ml of conc. sulphuric acid above the water level, replace the stopper and shake.

   (vi) Transfer 200ml of the solution to a 500ml conical flask using a 250ml measuring cylinder.

   (vii) Titrate with standardized sodium thiosulphate solution, using starch indicator for the end point (blue colour just disappears). The D.O. in mg/1, i.e. PPM, is the number of mls of sodium thiosulphate used to reach the end point.

NNB. 2ml samples of chemicals *MUST NOT* be pipetted using a mouth pipette. These chemicals are extremely dangerous.

ALSO NOTE : For each 2ml added, use a separate pipette or dropper, i.e. nominate one dropper for the maganese sulphate, one for the alkaline iodide, and one for the sulphuric acid.

4. *Calculations:*

Initial Burette reading	=	0.02mls
Final Burette reading	=	5.02mls
Volume of Thiosulphate used ...	=	Final reading-Initial reading
	=	5.02-0.02mls
	=	5.00mls

The dissolved oxygen, or D.O., in mg/litre is the number of mls of sodium thiosulphate used to reach the end point.

So, in our sample there are 5 PPM of dissolved O_2

RESULTS:

For really accurate calculations, class averages must be taken, or repeat your titration three times. You may want to heat one of your samples and calculate the dissolved oxygen.

5. *Questions:*

   1. What exactly is the end point?
   2. List safety precautions with sulphuric acids. What first aid procedures should be adopted if acid spills in the eye? On the body?
   3. What effect does heat have on dissolved oxygen?
   4. Write a paragraph on the relationship that you might expect between oxygen, light, temperature and fish.

Solutions required:

Use as freshly made as possible.

* *Manganese II sulphate* :

Make 100g of $MnSO_4.2H_2O$ to 250ml solution

Or 120g of $MnSo_4.4H_2O$ to 250ml solution

* *Alkaline Iodide solution* :

Either (a) 100g NaOH + 27g Na_2I + 10g sodium azide
Make up to 200ml solution
OR (b) 140g KOH + 30g K_2I + 10g sodium azide
Make up to 200ml solution

(Note : Sodium azide prolongs the life of the solution)

.025M $NA_2S_2O_3$: 3.95g per litre of solution
Or 6.2g of $NA_2S_2O3.5\ H_2O$ per litre of solution

* *Starch Indicator* :

Mix 1g of soluble starch in water to a fluid paste. Transfer to 100ml boiling water. After cooling, add 0.5ml of 40% formalin. (Formalin may be omitted if used fresh).

* *Concentrated H_2SO_4* : Standard 18m

9.6 *The Importance of Oxygen*

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 PPM of oxygen

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

Between 1 PPM and 5 PPM 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 PPM 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 be 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 at sea level pressure, a value as high as 9 PPM 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.

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: $C + O_2 \quad CO_2$. 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.

9.7 *Biological Oxygen Demand*

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. (PPM)
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.S: U.S. Government 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.

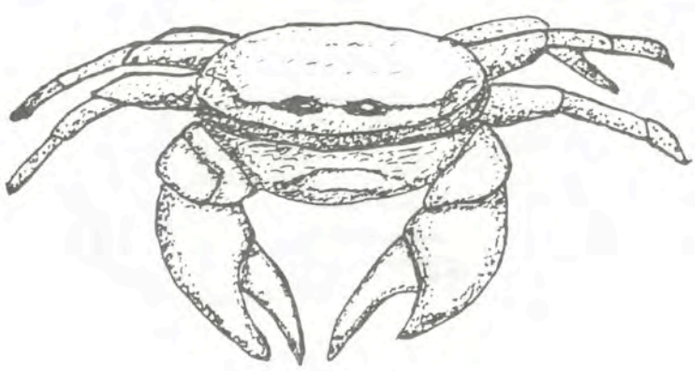
Aquatic life may disappear when oxygen is removed from water, because it has died of oxygen starvation or because it has moved to more favourable areas. A further result of oxygen depletion is an increase in the number of anaerobic organisms, which, in contrast to aerobic organisms, thrive in the absence 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 fish smell. Hydrogen sulphide (H_2S) is evil smelling and toxic. Some phosphorous compounds also have unpleasant odours. Obviously, a change from aerobic to anerobic conditions is most undesirable where water is to be used for human consumption, and also where water is used for recreation.

Investigation 9-6. Measurement of Biological Oxygen Demand - BOD

BOD is the measure of dissolved oxygen used during the aerobic decomposition of organic matter present in the water. This is often used as an organic pollution indicator. The greater the amount of organic matter present, the higher the BOD.

Chlorinated water should not be tested for BOD as chlorination destroys the organisms which decompose the organic matter.



You will need:

* Water sampler -
* 250ml measuring cylinder
* 3 x 2ml pipettes with filter bulbs or 3 x 2ml droppers
* 2 x 500ml conical flasks with stoppers
* Burette and stand
* 2 beakers
* Length of polythene or rubber tubing
* At least 5 x 500ml flasks with stoppers
* An incubator or dark water bath which can be set at 20 C.

Solutions:

As for
In sufficient quantity for at least 1 titration per day for 5 days.

What to do:

1. Collect 5 samples of water and place each in a flask and stopper tightly. Do not shake.
2. Incubate 4 of these flasks at 20 C in the dark to preclude any photosynthesis which might occur.
3. Test 1 flask (as shown in for dissolved oxygen.
4. Each day for the next four days, test one flask for dissolved oxygen.
5. Set up table, e.g.

DAY	1	2	3	4	5
DISSOLVED OXYGEN					

6. Express the BOD as: mg 1^{-1} (PPM) oxygen original, minus minus PPM oxygen final, over 24 hour, 48 hour, 72 hour, 96 hour, and 120 hour periods.

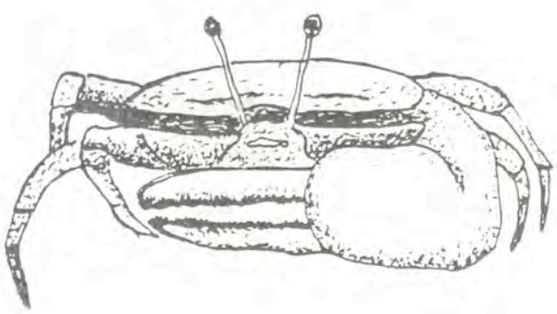
   This gives a reading in mg 1^{-1} of the amount of oxygen oxygen used during each time period, and so indicates the amount of organic material in your sample.

9.8 *Other Chemical Aspects of Sea Water*

There are many other chemical tests for carbon dioxide, acidity, etc. If you have time you may like to try them. They are listed below :

Carbon Dioxide: 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:

$$CO_2 + H_2O \text{ — } H_2CO_3$$



Acidity: 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 7.00; alkaline solutions have a pH greater than 7.0. If a body of fresh water has a pH value outside the range of 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 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.

Investigation 9-7. Measuring the acidity or alkalinity of Sea Water

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 250ml conical flasks
* 25ml pipette

What to do:

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:

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

Measure 25ml of your water sample into a 250ml 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 25ml sample. Multiplying by 40 gives the result in parts per million alkali.

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

alkalinity = x X 40 (PPM 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 25ml sample:

acidity = number of ml NaOH added X 40 (PPM 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.

NNB: You must learn how to clean the Burette and grease the Tap. Failure to do this will *SPOIL ALL YOUR RESULTS* and will lead you to frustration. A Burette is a delicate piece of glassware, which must be treated with *RESPECT*.

Investigation 9-8. Measuring the carbon dioxide concentration

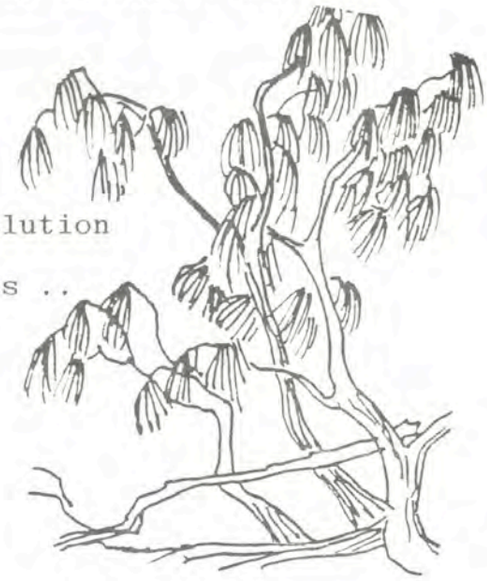
Aim:

To calculate the CO_2 concentration in PPM for a sea water sample.

Introduction:

Water bodies tend to contain dissolved carbon dioxide because this gas dissolves in rain droplets and 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 in water is carbonic acid.

$$CO_2 + H_2O \text{ — } H_2CO_3$$



You will need:

* Water samples
* 100mls 0.0227 M sodium carbonate solution in a stoppered volumetric flask
* Phenolphthalein indicator in bottles ..
* 100ml Measuring Cylinder
* Boss head clamp and stand
* Distilled water
* Burette (clean)
* 3 x 250ml conical flasks
* Pipette

What to do:

A standard 0.0227 M solution of sodium carbonate is made up by dissolving 2.406g of sodium carbonate in 1 litre of distilled water that has been boiled and cooled immediately before preparing the solution. Then take 100mls of this and add to 900mls of distilled water. Pour into stoppered volumetric flask.

Using a pipette, transfer 100ml 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. Use some filter paper under the flask.

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:

1ml of 0.0227 M sodium carbonate used = 10 PPM carbon dioxide.

Results: (Alter results and calculations X 10).

Present yours similar to those below:

Sample No.1
Initial burette reading 0.00ml
Final burette reading 2.50ml
Volume of 0.0227 M sodium carbonate used
= final reading - initial reading
= (2.50 - 0.00)ml
= 2.50ml
1ml sodium carbonate = 10 PPM CO_2
∴ 2.5ml = 25 PPM CO_2

∴ carbon dioxide concentration in sample No.1 - 25 PPM.

Your results will be more meaningful if you compare the 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.

MAIN IDEAS

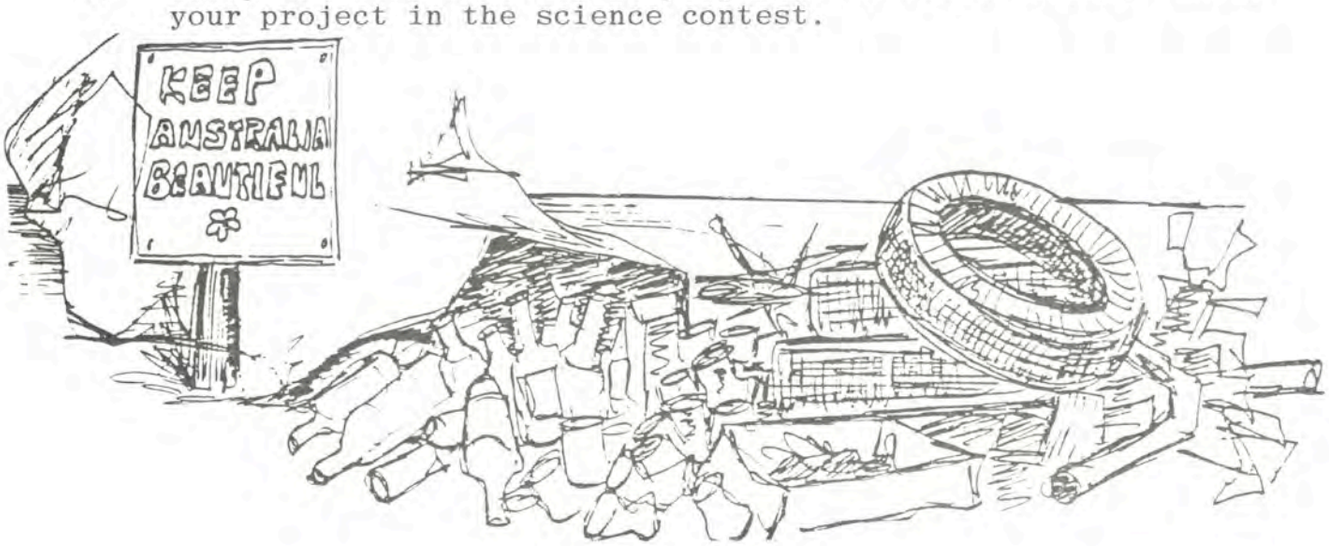
1. We study the characteristics of ocean water to understand marine ecology.
2. Ocean minerals are brought to the ocean by land.
3. Salinity refers to the amount of dissolved salts in the sea. Seawater is $3\frac{1}{2}\%$ salt or 35% .
4. Seawater is heavier than freshwater because of its dissolved salts.
5. The chief gases of the sea are CO_2 and O_2.
6. Cold water is heavier than warm water.
7. Ocean water is transparent and lets light penetrate in the photic zone.

REVIEW QUESTIONS

1. Why is sea water heavier than salt water?
2. Why do you find cold water near the ocean bottom?
3. How does the nature of ocean water help us to understand ecology?
4. How far does light penetrate in the sea? What is this zone called? What instrument measures it?
5. In warmer parts of the world salinities would be high or low. A ship setting out from India to Antartica would have to take what ballast precautions?
6. What is BOD? What does it measure? How important is it?
7. Why is the photic zone important?

STUDY ASSIGNMENTS

1. Write to A.I.M.S. in Townsville and ask them about their experiments with a floating temperature, pH, oxygen probe.
2. Ask your local garage to show you how a hydrometer is used. Write a report on it.
3. Find out the world health standards (W.H.O.) for BOD, O_2 content.
4. Try flame tests for salt, calcium or potassium.
5. Carry out a small research project on a local stream. Enter your project in the science contest.



SCIENCE TEACHERS ASSOCIATION OF QUEENSLAND

(Incorporated in Queensland)

c/- Brisbane Education Centre PO Box 84 Spring Hill 4000

Mr Bob Moffatt
c/- Benowa Marine
Benowa S H S

14 June 1984

Dear Bob,

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Accordingly, I advise that STAQ Publications will sell out its remaining stock of units and will then not offer the materials for further sale. The Council believes that the best interests of members will be served by advising them that you are now the sole distributor.

May I take this opportunity to wish you well in your innovative venture with Benowa Marine.

Yours sincerely,

Bob McAllister

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