

# ARCTIC MARINE SCIENCE CURRICULUM

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## MODULE 1

### OCEANS, STRUCTURE & MOTION

# LAB MANUAL

2001

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# **MODULE 1**

# **LAB MANUAL**

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**LAB 1 - WHERE'S THE WATER?**

Using only the materials that you have been given, devise experiments to determine which of the liquids is water. Before you begin, each group must write out the procedures for each experimental test. Taste tests are not allowed under any circumstances. A data table has been provided on the next page.

**PROBLEM** Which liquid is water?

Name \_\_\_\_\_

Date \_\_\_\_\_

What we know about water's characteristics:

**PROCEDURE**

**DATA TABLE**

POSSIBLE QUESTIONS	LIQUID 1	LIQUID 2	LIQUID 3	LIQUID 4	LIQUID 5
Which materials dissolve in the liquid					
Which materials float on the liquid?					
What does a drop of the liquid look like on various surfaces?					
How much does the temperature change when placed in a hot water bath for 3 minutes?					
How long does it take for 2.5 mL of the liquid to evaporate?					
What is the pH of the liquid?					
Student designed tests:					

**CONCLUSION** (identify which liquid is water and support your conclusion with data):

## LAB 2 - SOLUBILITY OF A SOLID

NAME \_\_\_\_\_

DATE \_\_\_\_\_

### PURPOSE

To measure the maximum amount of solid that can be dissolved in a given amount of water at a particular temperature.

### SAFETY PRECAUTIONS

Check with your teacher for all safety precautions.

### MATERIALS

- 150 ml beaker
- 15 g of solid solute
- Bunsen burner
- Triple-beam balance or scale
- Graduated cylinder
- Stirring rod
- CBL or thermometer
- Water

### PROCEDURE

1. Carefully find the mass of a dry, clean 150 mL beaker. Record the value on the data table provided. Then mass approximately 15 g of solid solute to the nearest centigram 0.01g. Transfer the solid to the dry beaker. Next, using a graduated cylinder, measure 50 mL of water and pour into the beaker with the solid.
2. Gently heat the beaker containing the solid and water. Stir the mixture with a stirring rod to speed up the dissolving process. Heat the solution to approximately 60°C. At this temperature, all of the solid will dissolve.
3. Remove the beaker from the heat and allow the hot solution to slowly cool. Continue stirring with the rod. Observe the temperature of the solution as it cools until a precipitate begins to form. Record this value on the data table.
4. Heat up the beaker again to approximately 60°C until all the solid precipitate has dissolved. Repeat the cooling process as before and record the temperature at which the solid precipitates again.
5. Repeat the entire process one more time to ensure reliable results.

**DATA TABLE**

Mass of beaker \_\_\_\_\_

Volume of water \_\_\_\_\_

Temperature of solution @ precipitate

Trial #1	_____
Trial #2	_____
Trial #3	_____

Average temperature of solution @ precipitate \_\_\_\_\_

**CALCULATION AND QUESTIONS**

You have found the solubility as g/50 mL at a certain temperature.

1. What would be the solubility for 100 mL? 175 mL? Explain how you arrived at your answers.
2. Examine the solubility curves given in your student notes and determine the solubility at the temperature you used for the average. How would the solubility change if the temperature increased?
3. How does the solubility from the graph compare with the value that you found in your experiment?

4. Can you provide possible reasons for any difference between the two values?

**CONCLUSION**

Write a conclusion for this lab based on your results and observations.



## LAB 3 - CALCULATING DENSITY

### PURPOSE

To quantitatively measure the salt content in a sample of seawater and calculate the density of the sample.

### MATERIALS

250 mL beaker	100 ml Saltwater
Graduated cylinder	Freshwater
Cover for beaker	Triple-beam balance or scale

### PROCEDURE

1. In pencil, label a clean, dry 250 mL beaker with your last name. Carefully mass the beaker. Record the mass of the dry beaker on your data table.
2. Carefully measure 100 mL of the saltwater sample into the beaker you have just massed using an appropriately sized graduated cylinder.
3. Mass the saltwater and beaker and record this on the data table.
4. Cover the beaker to ensure that no extra material falls into the beaker while it is drying. Your teacher will now tell you where to put the beaker so the water will slowly evaporate for the next few days.
5. Once the water has evaporated, the beaker should be massed on the same instrument that was used originally to mass the empty beaker. Record the results on the data table provided.
6. This procedure should be repeated for as many trials as required to ensure reliability.

### DATA TABLE

OBJECT MASED	MASS		
	TRIAL #1	TRIAL #2	TRIAL #3
Volume of seawater			
Empty beaker			
Mass of seawater and beaker			
Mass of seawater			
Mass of beaker and residue			
Mass of residue			

**CALCULATIONS**

- a) Percent composition of salt in the seawater sample.

$$\begin{aligned} \text{Percent salt} &= \frac{\text{mass of salt (residue)}}{\text{mass of water}} \times 100 \\ &= \end{aligned}$$

b) Density of Seawater =  $\frac{\text{mass of seawater}}{\text{volume of seawater}}$

$$=$$

**DISCUSSION**

1. Compare your value for the density of seawater to the average density of seawater of 1.028 g / mL.
  
  
  
  
  
  
  
  
  
  
2. Suggest possible explanations for any variations between your results and the accepted value for the density of seawater.

## LAB 4 - DENSITY AND BUOYANCY

### PURPOSE

How does salinity affect density and buoyancy?

### HYPOTHESIS

### MATERIALS

- Safety goggles
- Saltwater (3.5% saline solution)
- Freshwater (tap water)
- Distilled water
- Microscope slides
- Eyedropper
- Desk lamp
- Microscope
- 100mL graduated Cylinder
- Triple-beam balance or scale
- 250 or 500 mL beakers
- Drinking straw
- Food colouring
- 30 cm wooden dowel

### PROCEDURE

1. Obtain samples of freshwater and seawater. Examine the appearance and odour of both samples.
2. Measure 3 drops of freshwater on a clean microscope slide. Rinse the eyedropper in distilled water. Measure 3 drops of saltwater on another slide.
3. Place the slides under a desk lamp to evaporate the water.
4. Using a microscope, examine any residue on the slides.
5. Measure the mass of an empty graduated cylinder.
6. Pour 100 mL of freshwater in the cylinder and measure the mass of both.
7. Calculate and record the mass of the water.
8. Rinse the cylinder with distilled water. Repeat steps 5-7 using saltwater.
9. Place a wooden dowel in a graduated cylinder containing 100 mL of freshwater. Use the markings on the graduated cylinder to measure the depth at which the bottom of the dowel floats.
10. Repeat step 9 for saltwater.
11. Add 1 drop of food colouring to 50 mL of freshwater.
12. Half fill a beaker with uncoloured saltwater.
13. Use a straw to transfer the coloured water to the surface of the saltwater. Repeat several times.

14. Repeat steps 11-13, this time transferring coloured saltwater onto the uncoloured freshwater.

**EXPLAIN WHAT VARIABLES ARE BEING CONTROLLED WITH THIS PROCEDURE:**

**DATA TABLE**

		FRESHWATER	SALTWATER
<b>A</b>	Appearance (include colour)		
<b>B</b>	Odour		
<b>C</b>	Residue after evaporation		
<b>D</b>	Density: <ul style="list-style-type: none"> <li>• Mass of empty graduated cylinder</li> <li>• Mass of graduated cylinder and 100 mL of water</li> <li>• Density of water sample (per 100 mL)</li> <li>• Density (per 1 mL)</li> </ul>		
<b>E</b>	Buoyancy: <ul style="list-style-type: none"> <li>• Depth to which dowel sank</li> <li>• Float test: freshwater over saltwater</li> <li>• Float test: saltwater over freshwater</li> </ul>		

**ANALYSIS AND INTERPRETATION**

Compare your data to data gathered by your classmates. Describe and attempt to explain any patterns or differences you observe. Identify potential sources of error.

**CONCLUSION****APPLICATIONS/IMPLICATIONS FOR DAILY LIFE/LINK TO AREA OF STUDY**

## **LAB 5 - WATER EVERYWHERE BUT, ...**

### **OVERVIEW**

Throughout the earth's geological history, the water we now have on the earth has been used and reused millions of times. The processes of melting, solidifying, condensing and vaporizing keep the water cycle moving due to heat from the sun. At any given time, about 97% of the earth's water can be found in the ocean. But how much of this can we use? This lab will give you some idea just how much usable water is available to us. The water that you drink every day is quite a chemical rarity!

### **PURPOSE**

To determine the proportion of freshwater that is available for human use.

### **MATERIALS**

- 10 mL graduated cylinder or measuring cup
- 1 large beaker or bucket able to hold 5 L
- 4 (250 mL) beakers
- Grease pencil to write on the beakers
- A medicine dropper
- Freshwater

### **PROCEDURE**

1. Mark the beakers or buckets with the following labels: Oceans, Icecaps & Glaciers, Groundwater, Lakes & Rivers, and Atmosphere. Mark the largest beaker/bucket "Oceans".
2. Working with a partner, carefully count the number of drops of water in 1 mL.
3. Pour 5 L of water into the container labeled 'Oceans'.
4. Using your value for the number of drops in 1 mL, calculate the volume for the number of drops in the following table.
5. From the 'Oceans' container measure out the amounts into the appropriate beakers.

CATEGORIES	NUMBER OF DROPS	VOLUME ( ML )	PERCENTAGE
Oceans	100,000	5000	97.2
Ice caps & glaciers	2150		
Groundwater	625		
Freshwater lakes & rivers	9.1	-	
Atmosphere	1	-	



## LAB 6 - PH PROTOCOL

### PURPOSE

To measure pH.

### OVERVIEW

The pH or acidity of the water sample is a key factor in determining what can live in the water.

### KEY CONCEPTS

- pH and its measurement
- Temperature affects pH
- Calibration
- pH buffers and standards

### SKILLS

- Using pH measuring equipment
- Recording data

### MATERIALS AND TOOLS

#### For Method 1

- pH indicator paper (Beginning)
- 50- or 100-mL beakers

#### For Method 2

- pH pen (Intermediate/Advanced)
- One jewelry screwdriver (for calibration)
- pH buffer solution for pH 7
- Three 50- or 100-mL beakers
- 50 mL polyethylene bottle with top or clean baby food jar with lid

OR

- pH meter (Intermediate/Advanced)
- Three 50-mL polyethylene bottles with tops or clean baby food jars with lid
- Five 50- or 100-mL beakers
- Three pH buffer solutions for pH 4, 7, and 10

*For both pen and meter techniques*

- 100 mL graduated cylinder
- Paper towels
- Soft tissues
- Stirring rod or spoon
- Distilled water in a squeeze bottle
- Masking tape
- Permanent marker
- Latex gloves and safety goggles



## HOW TO MEASURE PH

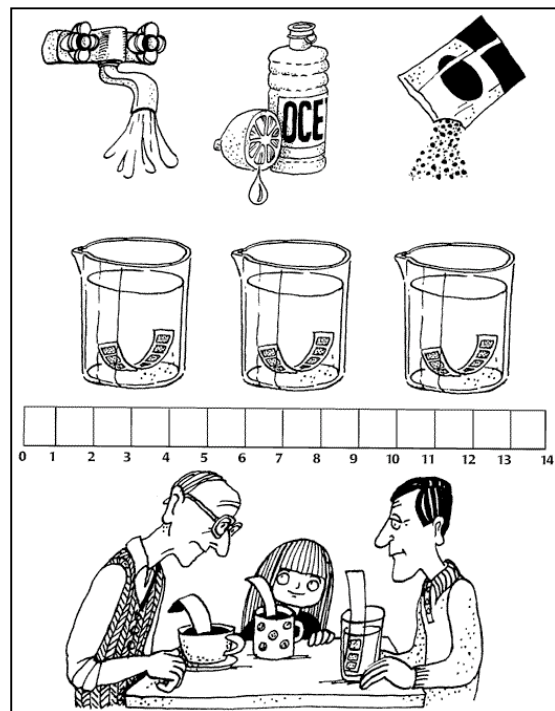
### METHOD 1: PH INDICATOR PAPER

#### Beginning Level

1. Rinse a 50 mL or 100 mL beaker at least twice with sample water.
2. Fill the beaker about halfway with the water to be tested.
3. Dip one strip of indicator paper into the sample water for at least one minute. Make sure all four segments of the paper are immersed in sample water.
4. Remove the paper from the water and compare the resultant four colour segments with the chart on the back of the pH indicator paper box. Try to find a sequence where all four segments on the sample paper match all four segments on the box.
5. If the reading is unclear, it may be because the paper needs more time to fully react. The indicator paper takes longer to react in water with conductivities below 400 microSiemens/cm (see the Electrical Conductivity Protocol). If this is the case, place the paper back into the water sample for an additional minute, and check again. Repeat until satisfied that the reading is accurate. If the reading is still unclear after 10 minutes, start over with a new strip of pH paper. If the test fails a second time, record this on your Hydrology Investigation Data Work Sheet.
6. Read the corresponding pH and record this value on your Hydrology Investigation Data Work Sheet.

**NOTE:** pH paper readings may not be accurate if your water sample has an electrical conductivity below 300 microSiemens/cm (pH paper does not function properly below this level).

Figure 1: Using pH paper strips



Source: Jan Smolik, 1996, TEREZA,  
Association for Environmental Education,  
Czech Republic

**METHOD 2: PH PEN OR PH METER****Intermediate and Advanced Levels**

In order to measure the pH of your water sample using the pH meter you need to:

- (1) Prepare buffer solutions,
- (2) Calibrate the instruments,
- (3) Recheck your instrument by measuring the buffers in the field, and
- (4) Measure the pH of your sample in the field.

**Calibration Procedure**

Calibration should be performed before each set of measurements. This procedure can be performed in the classroom before you go out in the field.

**Step 1: Prepare the Buffer Solutions**

Pre-mixed buffer solutions can be stored for 1 year, as long as they have not been contaminated. If you are using the powdered pillow buffer, then dissolve it in distilled water as described below. If you are using pre-mixed buffer solutions, measure 50 mL into a graduated cylinder and proceed to step 4.

**For each pH buffer (4, 7, and 10):**

1. Write the buffer pH and date on two pieces of masking tape. Place one on a clean, dry 100 mL beaker and the other on a 50 mL bottle or well-cleaned baby food jar.
2. Using a graduated cylinder, measure 50 mL of distilled water and pour it into the beaker.
3. Over the beaker, completely cut open one end of a pillow of buffer powder, then squeeze and shake the pillow to release the powder into the water. Make sure all the powder is released into the water. Stir with a stirring rod or spoon until all the powder dissolves.
4. Pour the buffer solution into the labeled bottle. Cap the bottle tightly. Discard after a month.
5. Continue preparing the other buffers, repeating steps 1-4 for each.

**Step 2: Calibrate the pH pen or meter****A. Calibration of the pH pen**

*NOTE:* If the pH pen does not have automatic temperature compensation, the buffer solution should be at 25° C.

1. Condition the electrode as described by the manufacturer.
2. Rinse the electrode (glass probe) and area around it twice with distilled water using a squeeze bottle and blot dry with a soft tissue after each rinse. Rinse into a discard beaker or sink. Do not discard into the pH buffer solution. Do not touch the electrode (glass probe) with your fingers.
3. Turn the pen on with the switch located on the top. Immerse the electrode entirely in the pH 7.0 buffer solution. See *Figure 2*.

4. Gently stir the buffer solution with the probe and wait for the reading to stabilize.
5. Use a jewelry screwdriver to turn the small screw in the hole in the back of the pen until the reading is exactly 7.0.
6. Remove the pH pen from the solution and rinse the electrode with distilled water; pour the buffer solution back into its labeled bottle and seal tightly.

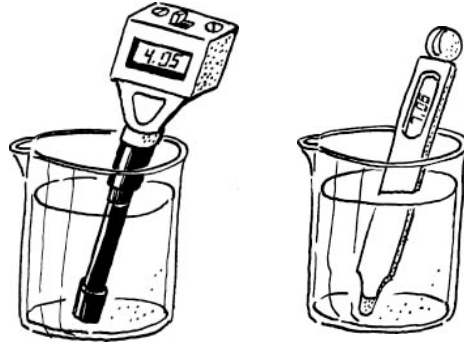
Figure 2: Immersing the pH pen



### B. Calibration of the pH meter

1. Condition the electrode (probe) as described in the manufacturer's instructions.
2. Rinse the electrode (glass probe) and area around it twice with distilled water using a squeeze bottle and blot dry with a soft tissue after each rinse. Rinse into a discard beaker or sink. Do not discard into the pH buffer solution. Do not touch the electrode (glass probe) with your fingers.
3. Turn the meter on (by pressing the ON/OFF button). Push the CAL button to indicate that you will be calibrating the instrument.
4. Immerse the electrode in the pH 7.0 buffer solution making sure that the electrode is entirely immersed. Do not immerse the instrument further than is necessary. See *Figure 2*.
5. Gently stir the buffer solution with the electrode and wait for the display value to stabilize. Once the reading has stabilized, press the HOLD/CON button to accept the value and complete the calibration. If the electrode is still immersed in the buffer, the display will read the same value as the pH of the buffer (i.e. 4, 7, or 10).
6. Remove the pH tester from the buffer solution, rinse the electrode with distilled water, and blot dry with soft tissue.
7. Repeat steps 3 through 6 using the pH 4 buffer and then using the pH 10 buffer.
8. Set the tester aside on a paper towel; turn the meter off by pushing the ON/OFF button.
9. Pour the buffer solution into their labeled bottles and cap them tightly.

Figure 3: Types of pH pens



Source: Jan Smolík, 1996, TEREZA, Association for Environmental Education, Czech Republic

### Step 3: Recheck your pH pen or meter in the Field

1. Take the pH buffer solutions into the field with you. Treat them as samples. Test the pH of the buffer solutions and record the field pH buffer values on the data sheets. If the values of the buffer solutions are more than + or - 0.2 pH units from the true value, go through the instrument calibration procedure again.
2. After you have tested the pen or meter with the buffer solutions, you are ready to measure the pH of the actual water sample.

### PH MEASUREMENT PROCEDURE

1. Rinse the electrode and the surrounding area with distilled water using the squeeze bottle. Blot the area dry with a soft tissue.
2. Fill a clean, dry 100 mL beaker to the 50 mL line with the water to be tested. Immerse the electrode in the water. Be sure that the entire electrode is immersed, but avoid immersing it any further than necessary.
3. Stir once and then let the display value stabilize.
4. Once the display value is stable, read the pH value and record it in your Hydrology Investigation Data Work Sheet.
5. Repeat steps 1 through 5 for another sample as a quality control check. The two pH values should agree to within 0.2 – the level of accuracy required for this technique.
6. Rinse the probe with distilled water, blot it dry with soft tissue, replace the cap on the probe, and turn the instrument off.
7. Take the average of pH values measured by the student groups. Discuss discrepancies and possible sources of error.

**NOTE:** pH pen or meter readings may not be accurate if your water sample's conductivity is below 100 microSiemens/cm (pH pens and meters do not function properly below this level).

## LAB 7- MEASUREMENT OF ALBEDO

### OVERVIEW

When light rays fall on the Earth, some of the energy is absorbed and some of it is reflected. The characteristics of the surface determine how much energy is absorbed and reflected. A portion of the radiation that comes to Earth is reflected back into the atmosphere. The ratio of the reflected radiation divided by the incident radiation is called the Albedo.

The Albedo is affected by the nature (colour, texture, composition) of the surface that the radiation strikes. This experiment compares the Albedo between some common Earth materials.

### PURPOSE

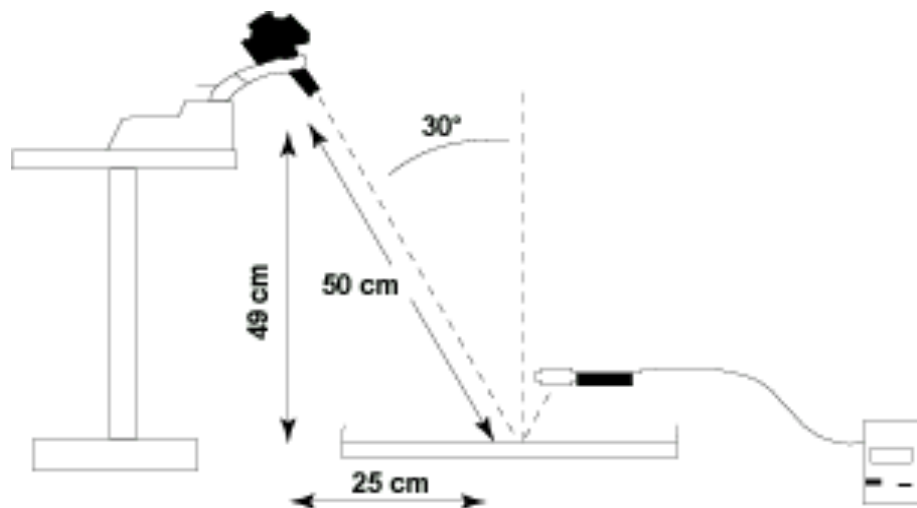
To compare the Albedo of some common surfaces.

### MATERIALS

- An aluminum pan
- A light meter
- A source of light
- Ice, water, white sand, dark sand

### PROCEDURE

1. A small aluminum pan is used to hold various earth materials over which the Albedo is measured. See *Figure 4* for set up.



*Figure 4: Setting up the Albedo measurement apparatus*

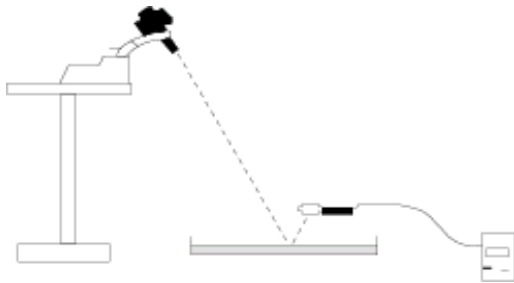
2. Make sure the light source is fixed at 30 degrees from the vertical. And 50 cm from the surface of the pan. The room lights should be off.

3. Add white sand to the pan so the bottom is completely covered. The sand mimics snow cover. Snow can be used instead of sand (make sure your tray is cold).
4. Measure the incident ray with the light meter keeping it parallel to the pan.
5. Turn the meter over and measure the reflected light. Make sure that all measurements are taken from the same place over the pan.
6. Calculate the Albedo. Record your results in the section below.
7. Repeat the measurement for the other substances.

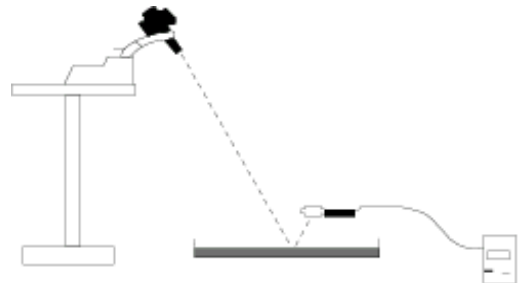
**DATA RESULTS**

Incident Radiation \_\_\_\_\_

a) White sand



b) Dark sand



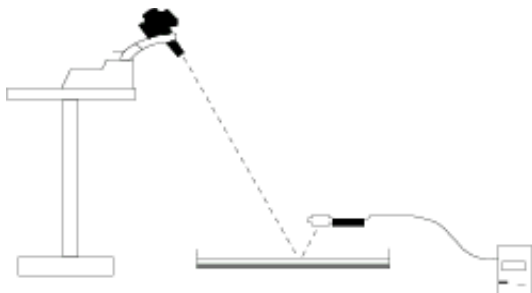
Reflected radiation \_\_\_\_\_

Reflected radiation \_\_\_\_\_

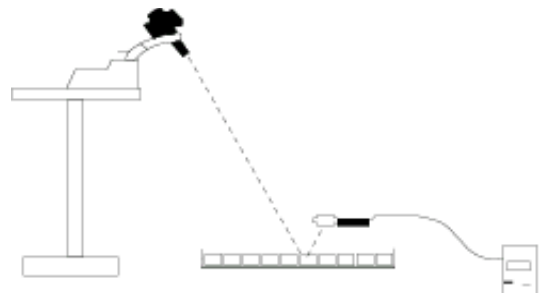
Albedo \_\_\_\_\_

Albedo \_\_\_\_\_

c) Water with dark sand



d) Ice with sand bottom



Reflected radiation \_\_\_\_\_

Reflected radiation \_\_\_\_\_

Albedo \_\_\_\_\_

Albedo \_\_\_\_\_

**QUESTION**

Which was the best reflector of incident light? Explain