International Year of
CHEMISTRY
2011

Global Experiment for the International Year of Chemistry

Water: a Chemical Solution

ACTIVITY BOOKLET

FOR STUDENTS

United Nations Educational, Scientific and Cultural Organization

International Union of Pure and Applied Chemistry

Partners for the International Year of Chemistry 2011

MICROSCALE GLOBAL WATER KIT INSTRUCTIONS

Global Experiment for the International Year of Chemistry

pH of the Planet

(Testing the pH of Different Water Sources)

Students' Instructions

Experiment Outline

Students should work in small groups (4 – 6 students, or pairs if numbers permit) to measure the pH of a water sample collected from a local source (fresh, salt, estuarine, marine, etc.). One Microscale Global Water Kit should be used per group. The results should be analyzed and reported on the International Year of Chemistry Global Experiment Database.

Just prior to performing the pH activity, use the thermometer in the School Resource Kit to measure the temperature of the water sample. Record the value on the Results Sheet.

The pH of the Planet activity involves the following steps:

- Collection of a natural water sample from an identifiable source.

Thereafter, to find the pH of the sample:

- Measuring out 2 mℓ volumes of the water sample into the large wells of the comboplate.
- Adding drops of a coloured indicator to the sample and matching these colours to pH values using a colour indicator chart specific for each indicator.

Lastly, to complete the activity:

- Analyzing the data and reporting results to the Global Experiment Database.

Materials needed for the pH Activity

Collect the following:

- 1 x sample of water from local source such as sea, fresh, estuarine or marine (100 – 250 mℓ)
- Tap water (for rinsing)
- Permanent marker or ink pen (used for labelling of propettes)
- A piece of white paper

Components from the Microscale Global Water Kit:

- 1 x comboplate
- 1 x 2 mℓ plastic syringe
- 2 x propettes (for indicators)
- 1 x plastic microspatula per water sample (for stirring)

MICROSCALE GLOBAL WATER KIT INSTRUCTIONS

Components and Chemicals from the School Resource Kit

- a thermometer - ASK YOUR TEACHER FOR THE THERMOMETER
- bromothymol blue indicator solution – ASK YOUR TEACHER FOR THIS INDICATOR
- *m*-cresol purple indicator solution - ASK YOUR TEACHER FOR THIS INDICATOR
- colour charts for the bromothymol blue and *m*-cresol purple indicators - ASK YOUR TEACHER FOR THE COLOUR CHARTS

Safety Precautions

The water in this activity is not safe to drink. Direct contact with water samples and indicator solutions should be avoided. Wash your hands with soap and water after doing the activity.

Testing the pH of your Water Sample with Bromothymol Blue Indicator

1. Before you start, make sure that all of your equipment is clean and dry. If there is any residue in the wells of the comboplate or in the syringe, the water sample may be contaminated and the pH results may be affected.
2. Using the thermometer from the School Resource Kit, measure and record the temperature of the water sample.
3. Place the comboplate on the piece of white paper to help you see the indicator colours better.
4. Use the clean, dry 2 mℓ syringe to remove 2 mℓ of the test water sample from the container.
5. Add the 2 mℓ of water sample from the syringe to a large well of the comboplate, such as well F1.
6. Repeat steps 4 and 5 another two times, this time adding your water sample to wells F2 and F3.
7. Use a permanent marker or ink pen to label the bulb of a clean propette with the abbreviation "**BTB**" for **bromothymol blue**.
8. Fill the propette with the bromothymol blue indicator solution. Carefully add three drops of the indicator solution to each of wells F1, F2 and F3 containing your water sample. The drops must all be equal in size.

HINT: You can share the bromothymol blue indicator in your propette with another group or groups because you only need three drops at a time.

9. Stir the sample in each well with a clean microspatula to thoroughly mix the contents.
10. Use the colour indicator chart for bromothymol blue to estimate the pH of the water sample in each of wells F1 to F3. Record each result to one decimal place on the Students' Result Sheet. Determine the average pH of your sample.

Testing the pH of your Water Sample with *m*-Cresol Purple Indicator (only for samples with pH ≥ 7.6)

1. If the pH of your sample is 7.6 or greater using bromothymol blue indicator, you must repeat the procedure again but this time using the *m*-cresol purple indicator.

2. Use the syringe to add 2 mℓ of the same water sample to wells F4, F5 and F6.

3. Use the marker or ink pen to label another clean propette. This time use the abbreviation "**mCP**" for ***m*-cresol purple**.

4. Fill the propette with the *m*-cresol purple indicator solution. Add three equal-sized drops of the indicator solution to the sample in each well. (Remember to share the indicator with other groups.)

5. Stir the contents of the wells with a clean microspatula. (Do not use the microspatula you used before when adding bromothymol blue, unless you have properly cleaned and dried it.)

6. Use the colour indicator chart for *m*-cresol purple to estimate the pH of the sample in each of wells F4 to F6. Record each result on the Students' Result Sheet as before. Find the average pH of your sample to one decimal place.

Analysing and Submitting your results

1. Decide which indicator solution gave the best measure of the pH of your sample.

2. Add the average result you have selected to the Class Table of Results.

3. If the entire class has used the same water sample, calculate the class average result for the local water sample. This is the pH value that will be submitted to the Global Experiment Database.

4. If different groups have tested other water samples, then the average pH values of the different water samples can also be submitted to the Global Experiment Database as long as each sample is appropriately identified.

Rinse and dry all of the equipment you used and place it safely back in the kit. Wash your hands with soap and water.

Students' Observations and Results Sheet for the **pH Activity**

Complete a separate Results Sheet for each water sample tested.

1. Complete the following table:

Date of water sample collection	
Date the pH measurement was performed	
Temperature of water at time of measuring pH	......................°C
Type of water (sea, river, pond, swamp, etc.)	
Describe where you found the water	

2. Record the pH values of your water sample in the table below.

Well Number	**pH value with Bromothymol Blue Indicator**	**pH value with m-cresol Purple Indicator**	**Average pH value using best indicator**

MICROSCALE GLOBAL WATER KIT INSTRUCTIONS

Global Experiment for the International Year of Chemistry

Salty Waters

Students' Instructions

Experiment Outline

Freezing and melting of sea ice, as well as evaporation and precipitation over the sea affect the saltiness of ocean water. The melting of sea ice, increased rainfall and rivers flowing into the ocean all make sea water less salty. The more salty water is, the less fit it is for human consumption (i.e. poor potability).

When evaporation of a salt solution occurs, the water vapour enters the atmosphere and leaves behind a solution which is more concentrated with respect to non-volatile (non-evaporating) substances. If evaporation proceeds to dryness, a solid deposit is formed. In the case of seawater, this deposit consists of sea salt crystals composed mostly of sodium chloride, $NaC\ell(s)$ (95%).

Students should work in small groups (4 – 6 students, or pairs if numbers permit) and use a known volume and mass of salt water sample (or prepared salt solution). The sample will be allowed to evaporate to dryness and the solid that remains will be weighed. The mass of salt in the sample after evaporation can then be calculated. Older students can calculate the density and salinity of the sample.

Prior to performing the Salty Waters activity, use the thermometer in the Global Water Kit to measure the temperature of the water sample or the water used to prepare the salt solution.

The Salty Waters activity involves the following steps:

1. Preparation of a salt water sample (saline solution) OR collection of a natural salt water sample e.g. sea water.
2. Finding the mass of a known volume (2 mℓ) of the sample.
3. Evaporation of the salt water sample.

Thereafter, to find the mass of salt in the sample/solution:

4. Weighing of the remaining salt after evaporation i.e. the mass of salt that was dissolved in the salt solution (younger and older students).
5. Calculating the density and thereafter salinity of the sample (older students).

Lastly, to complete the activity:

6. Analyzing the data and reporting results to the Global Experiment Database.

Materials needed for the Salty Waters Activity

Collect the following:

- 1 x 250 mℓ sample of seawater or saline surface water OR a salty solution prepared as described in Part 1 of the Procedure below.
- A plastic cup or similar container (200 – 250 mℓ capacity)
- Tap water (if you are preparing a salty solution)

Components from the Global Water Kit:

- 1 x small Petri dish with lid
- a plastic teaspoon
- 1 x 2 ml plastic syringe

Chemical from the Global Water Kit:

- Table Salt in plastic bag (sodium chloride)

Components from the School Resource Kit:

- a thermometer - ASK YOUR TEACHER FOR THE THERMOMETER
- Digital Pocket Scale (DPS – 150 g) – ASK YOUR TEACHER FOR THE DPS

Safety Precautions

The water in this activity is not safe to drink and direct contact with water samples should be avoided. Wash your hands with soap and water after doing the activity.

Part 1 - Procedure for Preparing the Salty Water Sample

1. If you have a seawater or surface water sample, then you do not have to prepare a saline solution. Simply use your collected water sample.

HINT: Try to use the water sample very soon after it is collected. Measure and record the temperature of the water at the time it is collected.

2. If you do not have a natural water sample, you will need to prepare a salt solution. First fill a plastic cup or similar container with about 200 to 250 mℓ of clean tap water. Measure and record the temperature of the water.

3. Add 1 level teaspoon of salt from the Global Water Kit (GWK) and stir until all of the salt has dissolved.

Part 2 - Procedure for Finding the Volume and Mass of the Salty Water Sample

1. Switch on the DPS. When the "0.00" appears on the screen, place the base of a clean, empty Petri dish onto the pan of the DPS and weigh it.

2. Write down the exact mass of the empty Petri dish. Record this on the Student Observations and Results Sheet provided for Sample A.

3. Use the syringe to remove 2 mℓ of the salt solution from the cup. Add this carefully to the Petri dish without spilling.

4. Now carefully weigh the Petri dish as before using the DPS. Record the exact mass of the Petri dish + water on the Student Observations and Results Sheet.

5. Repeat steps 1 to 4 using the lid of the same Petri dish. Record the results on the Observations and Results Sheet for Sample B.

6. Calculate the mass of water used in Sample A and Sample B, and the average mass of water sample used. Record the results on the Observations and Results Sheet.

Part 3 - Procedure for Evaporating the Salty Water Sample and Finding its Salt Content

1. Place both the base and lid of the Petri dish in a warm sunny place (such as on a window sill in the sun) and leave them there until all of the water has evaporated.

2. Observe the contents of the Petri dish base and lid and write down what you see on the Student Observations and Results Sheet.

3. Now use the DPS as before to find the mass of the Petri dish base and its contents after evaporation. Do the same for the Petri dish lid. Record these values on the Results Sheet.

4. Calculate the mass of salt remaining in the Petri dish base and lid. Use these two values to calculate the average mass of salt in the water sample. (All learners)

5. Calculate the density ($g.cm^{-3}$) of the original solution using the average mass value. (Older learners)

6. Find the salinity of the sample in g/kg. (Older learners).

7. Add your results to the Class Table of Results.

8. Make sure that the DPS is switched off so that the batteries do not run out.

Rinse and dry all of the equipment you used and place it safely back in the kit. Wash your hands with soap and water.

If possible, keep your salty solution for the Solar Still activity.

Students' Observations and Results Sheet for the **Salty Waters** Activity

Nature of water: (tick the option that applies)	**Salt Solution Prepared with Global Water Kit**	**Natural Body of Salt Water**			
		Estuarine	**Marine**	**Inland Sea**	**Other**
Location of Water Source (if natural):					
Date sampled:					
Temperature of Water:					
Weather conditions	Ambient air temperature ………..ºC Wet ……………………..Dry ………………Wind………………..				

Observations

What do you notice about the contents of the base and lid of the Petri dish after all of the water has evaporated?

Calculating Mass of Dissolved Salt	Sample A	Sample B
Mass of empty Petri Dish (g)		
Mass of Petri Dish + Water Sample (g)		
Mass of Water Sample Used (g)		
Average Mass of Water Sample Used (g)		
Mass of Petri Dish after Evaporation (g)		
Mass of Dissolved Salt in Sample (g)		
Average Mass of Dissolved Salt in Sample (g)		

Calculating Density and Salinity of the Saline Solution (older learners)

Density of Saline Solution, $g.cm^{-3}$	
Salinity of Sample (g/kg)	

*See next page for formulae needed to calculate density and salinity.

Calculating Density (g/cm^{-3}) of Salt Solution

An initial volume of 2 mℓ of the sample was used in both the base and lid of the Petri dish. The average mass of dissolved salt recorded in the table above is therefore for a 2 mℓ sample.

To obtain the density one must find the mass of salt in a 1 mℓ sample i.e. divide by 2

$$\text{Density} = \frac{\text{Average Mass of Dissolved Salt (g)}}{2\ m\ell\ \text{water sample}}$$

$$= \frac{\text{Mass of Dissolved Salt (g)}}{1\ m\ell\ \text{water sample}}$$

1 mℓ = 1 cm^3

∴ **Density of your saline solution = _______________g.cm^{-3}**

Calculating Salinity (g/kg) of the Saline Solution

$$\text{Salinity} = \frac{\text{Mass of Dissolved Salt (g)}}{\text{Mass of water sample (kg)}}$$

You have recorded the average mass in grams of water sample used. Convert this to a mass in kg and calculate salinity of the sample

∴ **Salinity of your solution = _______________g/kg**

International Year of CHEMISTRY 2011

MICROSCALE GLOBAL WATER KIT INSTRUCTIONS

Global Experiment for the International Year of Chemistry

No Dirt, No Germs!

(How Water Treatment helps us)

Students' Instructions

Experiment Outline

Drinking water chlorination represents a smart use of chemistry in our everyday lives. Small amounts of chlorine added to large volumes of drinking water help destroy germs, including bacteria and viruses that once killed thousands of people every year. Adding chlorine to drinking water has improved public health in many places in the world today.

Students should work in small groups (4 – 6 students, or pairs if numbers permit) to treat dirty water from a natural local source. The experiment carries out one or both of the main steps of water treatment: clarification and disinfection.

Clarification is the process used to remove solid debris from natural or waste water and involves four steps:

1. **Aeration,** the first step in the treatment process, adds air to water. It allows gases dissolved in the water to escape and adds oxygen to the water, which will help to kill germs.
2. **Coagulation** is the process by which dirt and other floating solid particles chemically "stick together" into flocs (clumps of dissolved alum and sediment) so they can easily be removed from water.
3. **Sedimentation** is the process that occurs when gravity pulls the particles of floc to the bottom of the container. At a treatment plant, there are settling beds that collect flocs that float to the bottom, allowing the clear water to be drained from the top of the bed and continue through the process.
4. **Filtration** through a sand and pebble filter removes most of the impurities remaining in water after coagulation and sedimentation have taken place.

Disinfection is the process used to destroy germs in the filtered water. In this activity, chlorine disinfectant will be used to destroy germs chemically (recommended for older students or as demonstration for younger students).

Thereafter, to get clean drinking water,

- **Disinfect** the water sample using a chlorine-based disinfectant.

Lastly, to complete the activity,

- **Analyze** the data and report results online to the Global Experiment Database.

Materials needed for Water Clarification

Collect the following:

- 200 – 500 mℓ of "dirty" natural water. The water can be collected from a stream, pond, river or swamp (or you can add 2 – 3 teaspoons of dirt or mud to a cup of water and stir it well). Don't try to collect "clean" water – the water should be murky.
- 1-2 teaspoons washed and dried fine sand (± 1mm grain size).
- 1-2 teaspoons washed and dried coarse sand (maximum 5mm grain size).
- A clock with a second hand or a stopwatch, if possible.

Components from the Global Water Kit:

- 2 large sample vials with lids
- 2 x 2,5 mℓ disposable plastic syringes
- Comboplate
- Microstand with cross-arm
- A small piece of cotton wool
- 1 microspatula
- 2 propettes
- 1 plastic teaspoon

Chemical from the Global Water Kit:

- Crystals of alum in plastic bag (potassium aluminium sulfate).

Safety Precautions

The water in this activity is not safe to drink and direct contact with water, alum and disinfectant should be avoided. Wash your hands with soap and water after doing the activity.

Procedure for Water Clarification

1. Shake/stir your dirty water sample. Pour enough of your dirty water into one of the large sample vials to fill it ¾ full. Describe the appearance and smell of the water, using the Students' Observation Sheet for Water Clarification.
2. Place the lid on the sample vial and vigorously shake the vial for 30 seconds. Continue the aeration process by pouring the water into the second sample vial, then pouring the water back and forth between them about 10 times. Once aerated, any bubbles should be gone.
3. Use the thin end of the microspatula and add one large crystal (or two small crystals) of alum to the aerated water. Slowly stir the mixture for 5 minutes, using the back end of the plastic teaspoon. Describe the appearance and smell of the water, using the Students' Observation Sheet for Water Clarification.

4. Allow the water to stand undisturbed in the vial. Observe the water at 5 minute intervals for a total of 10 minutes. This (water + alum) sample is needed for the filtration stage.

5. Write down what you see - what is the appearance of the water now? Use the Students' Observation Sheet for Water Clarification to note your observations.

6. Construct a sand filter in one of the disposable syringes:

- **a.** Remove the plunger from one of the syringes and put it to one side.
- **b.** Use the comboplate and the microstand to support the syringe.
- **c.** Put a small piece of cotton wool in the bottom of the syringe. The cotton wool should be pulled apart so that you have a thin layer of cotton wool. If the layer is too thick, the filter won't work properly. Use a pen or pencil and lightly tap the cotton wool into position
- **d.** Use the back end of the teaspoon to pour the coarse sand on top of the cotton wool, up to the 1,5 mℓ mark. It doesn't matter if there are spaces between the grains of sand.
- **e.** Pour the fine sand on top of the coarse sand, to fill the syringe, leaving a space of approximately 1mm at the top. You don't need to press in the sand tightly.
- **f.** Clean the filter by slowly and carefully adding clean drinking water using a propette. Throw away the water that has passed through the filter.

7. Clean the second sample vial with clean drinking water. You are going to use it to collect the water which has been filtered.

8. After a large amount of sediment has settled on the bottom of the sample vial containing your (water + alum), use a clean propette to suck up some of the water/alum mixture from just below the liquid surface. Add the water/alum mixture to the filter in the syringe. Be careful not to disturb the sediment. Filter approximately ¾ of the water and alum mixture.

9. Collect the filtered water in the clean sample vial.

10. Compare the treated and untreated water. How has treatment changed the appearance and smell of the water?

11. Keep the filtered water for disinfection (for younger students, your teacher will do this step for you).

Water Disinfection

Why is Disinfection necessary?

Filtered water is clear of many visible particles but contains many invisible live germs that can make people sick. Chlorine is used in many water treatment facilities to destroy harmful germs and small particles of organic matter. In this part of the activity, we'll be measuring "free available chlorine". "Free available chlorine" is the level of chlorine available in water to destroy germs and organic matter. Water treatment plants add enough chlorine to destroy germs plus a little bit more to fight any new germs that are encountered before the water reaches your home, for example. This small extra amount is known as the "free available chlorine" and it can be detected using chlorine test strips.

Materials needed for Water Disinfection

Your filtrate from the Water Clarification step

Components from the Global Water Kit:

- Chlorine test strips and colour chart
- One propette containing calcium hypochlorite solution
- 1x 2,5 mℓ disposable plastic syringe
- A clock with a second hand or a stopwatch

Warning:
Do not drink the water from this experiment.

Chemical:

- A solution of calcium hypochlorite (collect this from your teacher in the propette)

Procedure for Water Disinfection

(Based on U.S. Environmental Protection Agency activity at: http://www.epa.gov/ogwdw000/kids/grades_4-8_water_filtration.html)

1. Use the syringe and add 2mℓ of filtrate from the filtration activity to a large well in the comboplate.
2. Dip a chlorine test strip into the clear liquid and use the product colour-code chart to estimate the "free available chlorine" level of the liquid. Record the results on the Students' Result Sheet for Water Disinfection.
3. Add 2 drops of calcium hypochlorite solution to the filtered liquid, stir gently for 5 seconds with a microspatula, and repeat the test strip reading immediately. Use a new chlorine test strip for each chlorine measurement. Record your results. (If no free chlorine was detected now, proceed directly to Step 5).
4. Wait 10 minutes WITHOUT ADDING MORE CALCIUM HYPOCHLORITE and again record the "free available chlorine" level.
5. If less than 1ppm free chlorine level is measured after 10 minutes (Step 4), add 2 more drops of calcium hypochlorite and measure the free chlorine after stirring. Wait 10 minutes and measure "free available chlorine" again.
6. Repeat Step 5, adding 2 additional drops of calcium hypochlorite at a time until a "free available chlorine" level reading of at least 1 – 3 parts per million can be measured 10 minutes after chlorine addition.

Students' Observation Sheet for Water Clarification

1. Complete the following table for the "dirty" water you have collected:

Date of water sample collection	
Temperature of water when collected	…………..°C
Type of water (pond, river, stream or swamp)	
Describe where you found the water	
Fresh or from a river running into the sea (estuarine)	
Appearance and smell of the "dirty" water before treatment	

Describe the appearance of the water:

Immediately after the alum was added.	
5 minutes after the alum was added	
10 minutes after the alum was added	

2. Compare the treated and untreated water. Has treatment changed the appearance and smell of the water?

3. Do you think your treated water is now safe to drink? Give a reason for your answer.

Students' Results Sheet for Water Disinfection

Date of water sample collection	
Temperature of water when collected	………….°C
Type of water (pond, river, stream or swamp)	
Describe where you found the water	
Fresh or estuarine water	

Free Available Chlorine Observation Table
(Complete a separate table for each water sample)

Filtered water/ Total number of drops of disinfectant added	**Free Available Chlorine**		
	YES/NO	**Colour of chlorine test strip**	**Free available chlorine/ parts per million**
No disinfection			
+2 drops disinfectant			
+2 drops disinfectant left for 10 minutes			
+4 drops in total			
+4 drops in total left for 10 minutes			
+6 drops in total			
+ 6 drops in total left for 10 minutes			

Do you think your treated water is now safe to drink? Give a reason for your answer.

International Year of CHEMISTRY 2011

MICROSCALE GLOBAL WATER KIT INSTRUCTIONS

Global Experiment for the International Year of Chemistry

SuperPower Sun ⟶ Clean Water

(Designing and building a Solar Still)

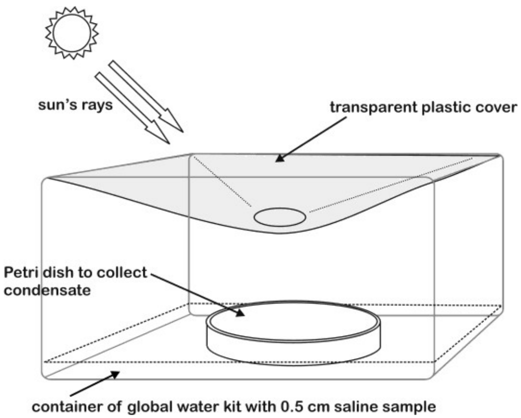
Students' Instructions

Experiment Outline

Water is the only substance found naturally in all three states: liquid, solid, and gas. The Earth is exposed to the Sun from which it gets the energy it uses for its needs. Solar heating promotes melting of ice to liquid water and evaporation of water into vapour, which may enter the atmosphere and form clouds. Evaporation followed by vapour collection and condensation is one of the recommended procedures to recover purified water. It efficiently separates water from non-volatile dissolved matter and plays a role in disinfection because microorganisms are also removed. This procedure can be done by distillation assisted by conventional heating, but environmentally friendly solutions, e.g. solar stills can be used with success. Solar stills can range from simple setups made from common materials, to more professional apparatus.

Students will use a saline solution for this activity, which may either be seawater obtained from the nearby sea or estuary, or a salt solution made up by dissolving table salt in fresh water, or some contaminated surface water. A simple solar still will be constructed using items in the Global Water Kit, which students will use to evaporate the water, condense its vapour and collect the resulting desalinated water.

The solar still should be made up according to the following schematic representation.



Other models and materials can be used to construct the solar still and the development of improved designs with more efficient performance is a challenge to students and teachers.

Older students may carry out an optional quantitative version of the activity where they can measure the volumes of the water samples before and after the desalination process. With this information they can calculate the yield of the process.

Students should work in small groups (4 − 6 students, or pairs if numbers permit) to construct a simple solar still and use it to desalinate a sample of water (i.e. a sample of seawater from a nearby seawater body, a salty solution or dirty water samples). One Global Water Kit should be used per group.

Prior to performing the Solar Still activity, use the thermometer in the Global Water Kit to measure the temperature of the water sample.

The Solar Still activity involves the following steps:

1. Collecting a seawater or surface water sample prior to the activity OR,

   Preparing a coloured, salty solution using the table salt and food colouring/copper sulfate provided in the Global Water Kit.

   HINT: The saline sample (without food colour or copper sulfate) can also be used for the Salty Waters activity, so keep a small amount on the side.

2. Construction of a solar still using the components in the Global Water Kit.

Thereafter, to get clean drinking water,

3. Using the solar still to evaporate the water and collect the condensed vapour, by simple exposure to direct sunlight.

Lastly, to complete the activity,

4. Analyzing the data, discussing the success of the solar still and suggesting ways to improve the solar still.
5. Reporting results to the Global Experiment Database.

Materials needed for the Solar Still Activity

Collect the following:

- 1 x 250 mℓ sample of seawater or saline/dirty surface water OR a salty solution prepared as described in the Procedure below.
- a plastic cup or similar container (200 – 250 mℓ capacity)
- tap water
- a ruler
- a coin or stone
- adhesive tape (optional)

Components from the Global Water Kit:

- 1 x Petri dish
- 1 x microspatula
- a teaspoon
- a small piece of Prestik (adhesive putty)
- the lunch box of the Global Water Kit
- a piece of clean cling wrap
- 2 x elastic bands

Chemical from the Global Water Kit:

- table salt (i.e. sodium chloride)

From the School Resource Kit:

- copper sulfate crystals (or any colour powdered food colouring of your own)
- a thermometer

Safety Precautions

The water in this activity is not safe to drink and direct contact with water samples should be avoided. Wash your hands with soap and water after doing the activity.

Procedure for Preparing the Salty Water Sample

1. If you have a seawater or surface water sample, then you do not have to prepare a salt solution. Simply use your collected water sample in the solar still. If the water sample is noticeably dirty, then use it without adding any food colouring. If the water sample is clear and looks like clean water, then add one level microspatula of the powdered food colouring or copper sulfate crystals to about 200 – 250 mℓ of the water sample and stir with the plastic teaspoon.

2. Try to use the water sample very soon after it is collected. Measure and record the temperature of the water at the time it is collected.

3. If you do not have a natural water sample, you will need to prepare a salt solution. First fill a plastic cup or similar container with about 200 to 250 mℓ of clean tap water. Measure and record the temperature of the water.
4. Add 1 level teaspoon of salt from the Global Water Kit (GWK) and stir until all of the salt has dissolved.
5. Using the spoon end of a clean microspatula, add one level spatula of food colouring/copper sulfate to the solution and stir until the colour is the same throughout the solution.

Procedure for Constructing the Solar Still

1. Take all the equipment out of the lunch box and put it in a safe place. Carefully pour about ½ cm of the coloured salt solution into the empty plastic lunch box (use a ruler to measure the depth of the solution in the lunch box).
2. Attach a piece of Prestik to the underside of a clean Petri dish. Place the Petri dish into the centre of the solution in the lunch box, making sure that no solution splashes into the Petri dish. Use the Prestik to stick the Petri dish to the bottom of the lunch box.
3. Loosely cover the top of the lunch box with the piece of cling wrap. Secure the plastic around the sides of the lunch box in such a way that no air will be able to enter the lunch box. (You can use one or two elastic bands to help make the cling wrap airtight around the container.) The plastic must be loose on top– do not pull it tightly over the lunch box.
4. Rest a small coin or stone on the cling wrap over the centre of the Petri dish in the lunch box. If the coin/stone moves, you may tape it to the plastic in the correct position. The plastic should be slanting downwards/inwards over the centre of the Petri dish.

Procedure for Desalination

1. Carefully place the lunch box in a warm, sunny place for a few hours. Make sure that none of the coloured solution flows into the Petri dish whilst you are carrying the solar still. If you have time you can check on the lunch box every hour and write down what you observe.

NOTE: It is best to set up your solar still on a warm, sunny day. Record the weather conditions at the time that you carry out the desalination.

2. After a few hours, carefully remove the cling wrap cover from the lunch box.
3. Complete the Students' Observation Sheet provided with this activity.

Rinse and dry all of the equipment you used and place it safely back in the kit.
Wash your hands with soap and water.

Students' Observation Sheet for the **Solar Still Activity**

1. Complete the following table:

Date of water sample collection	
Temperature of water when collected	.....................ºC
Type of water (sea, prepared salt water solution, swamp, etc.)	
Describe where you found the water	
Date the experiment was performed	
Conditions in which the water sample was preserved between collection and performing the activity	
Time when the desalination began	
Time when the desalination finished, or was stopped	
Weather conditions	Ambient air temperature..............ºC Wet ....Dry .... Wind....................

1. What do you notice inside the Petri dish after desalination? (Take the Petri dish out of the lunch box if you need to see clearly what is in the dish.)
2. What do you notice inside the lunch box after desalination?
3. Has the desalination process changed the appearance of the water sample?
4. Does the Petri dish contain all of the clean water that evaporated and condensed in the still? (Are there other places in the still where the water may have collected and not fallen into the Petri dish?)
5. How can you improve your Solar Still so that more clean water is collected?

Optional Quantitative Activity for Older Students

Procedure for Quantitative Solar Still Activity

1. Follow instructions 1 to 4 above for the *Procedure for Preparing the Salt Water Sample*.

2. Follow instruction 1 above for the *Procedure for Constructing the Solar Still.*

3. Using your knowledge of 3D shapes (rectangular prisms), calculate the volume of coloured solution you have poured into the lunch box,

   i.e. Volume = Length x Breadth x Height/Depth

   This will be your initial volume**, V_i** . Record this value on the Students' Result Sheet provided.

4. Follow instructions 2 to 4 above for the *Procedure for Constructing the Solar Still*, as well as all the instructions for the *Procedure for Desalination of the Salty Water Sample*. If possible, leave the solar still in the sun until all of the water has evaporated.

5. Use a clean, dry syringe to suck up the water from the Petri dish. Fill the syringe to the 2 mℓ mark each time and calculate the total volume removed from the Petri dish once all the water has been sucked up.

   This will be your final volume**, V_f** . Record this volume on the Students' Results Sheet provided.

6. Calculate the yield of the desalination process: **($\frac{Vf}{Vi}$) x 100 %.**

   Record the yield on the Students' Results Sheet provided.

   Is there any of the original water sample remaining in the solar still?
   If so, what is a more accurate way of calculating the % yield, taking into account that evaporation has not gone to completion?

Students' Results Sheet for the
Optional Quantitative Solar Still Activity
For Older Students

Complete a separate Results Sheet for each solar still and each water sample tested.

1. **Table of Initial and Final Volumes**

Initial Volume (of water sample used in the solar still)	**V_i = ________ mℓ**
Final Volume (of condensate remaining in the Petri dish after desalination)	**V_f = ________ mℓ**
Total time allowed for desalination	_____________**hours**
Yield	________________ **%**
Solar Still: description; photo or drawing	

2. Compare the treated and untreated water. Has treatment by desalination changed the characteristics of the water?

3. Do you think your treated/de-salted water is now safe to drink? Give a reason for your answer.

4. If the evaporation in your solar still did not go to completion, write down a better way of calculating the yield which will take into consideration any of the original water sample that remains in the solar still.

5. Suggest ways in which you could improve your solar still to improve the yield of clean water.

6. Suggest any disadvantages in using a solar still to desalinate salt water?

MICROSCALE GLOBAL WATER KIT INSTRUCTIONS

PREPARED BY

THE RADMASTE CENTRE
UNIVERSITY OF THE WITWATERSRAND
JOHANNESBURG, SOUTH AFRICA
www.radmaste.org.za; www.microsci.org.za

IYC GLOBAL PARTNERS

IYC GLOBAL SPONSORS