

# EXAMINING ACTION POTENTIALS

$[H^+] = 0.054 M$   
 $[C_2H_3O_2^-] = 0.054 M$   
 $[C_2H_3O_2] = 0.10 - 0.054 M = 0.046 M$

Let us consider the equilibrium concentration of  $C_2O_4^{2-}$  in mol/L.  
Initial (M):  $C_2H_3O_2 = 0.054$   
Change (M):  $-y$   
Equilibrium (M):  $0.054 - y$

Let the ionization constant  $K_a = 6.1 \times 10^{-5}$

$$K_a = \frac{[H^+][C_2O_4^{2-}]}{[C_2H_3O_2]} = \frac{(0.054 + y)y}{(0.054 - y)}$$

The ionization constant is small, we can make the following approximation:

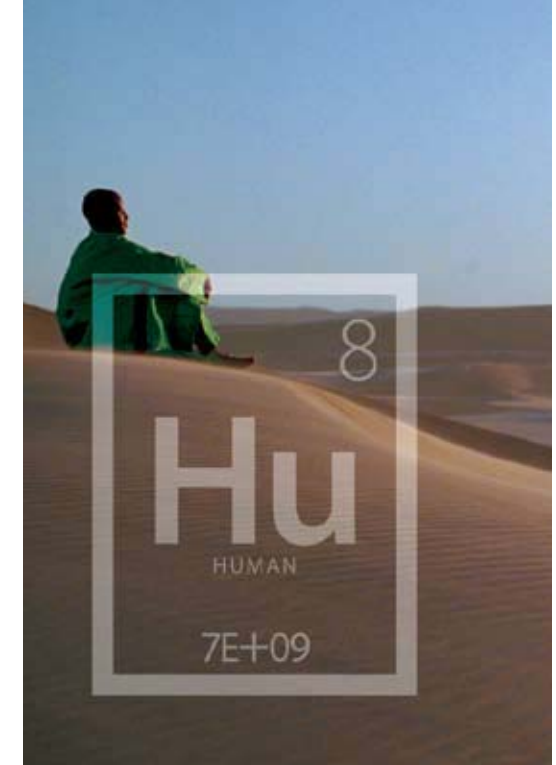
$$K_a \approx \frac{(0.054 + y)y}{0.054} = 6.1 \times 10^{-5}$$

Since there is no reaction, which

# Examining Action Taking Strategies

## Goal:

Students will examine, research and experiment with water filtering techniques and action taking strategies presented by the Sustainability Corps in order to collect data for the rating of their criteria.



## Objectives:

### Objectives:

*Students will...*

- Test the effectiveness of each action taking strategy
- Research and collect information on the Internet
- Organize data in relation to their predetermined criteria

Standards Met: S1, S2, S5, S6, S7, LA7, LA8

**Safety Note:** Although this activity may produce potable water, it is never allowable to let students drink (or eat) any substance in a science laboratory. There is always a chance of contamination or an allergic reaction which could be very dangerous to some students. This safety rule should be followed throughout the experiments presented in the module. Make sure that students wear safety glasses at all times as well as any other lab safety clothing necessary during all lab procedures. Also make sure that students wash their hands with anti-bacterial soap thoroughly before leaving the classroom.

# Materials (for a class of 30 students working at six different stations for at least two consecutive days):

*Note: The materials listed below include all of the supplies needed to test the action taking suggestions presented by the Sustainability Corps. These techniques were selected because of how human ingenuity (the Human Element) was incorporated into their design. They also require little or no energy to use, an important prerequisite in developing countries. If the instructor finds that some of these materials are too expensive for their budget or too time consuming to order or construct, other techniques from the Resource List can be substituted. These may include simple filtration and boiling, running water through a sock containing charcoal, using a Brita filter system, clear water bottles exposed to direct sunlight, etc.*



Time Required: Two – 45 to 60 minute class periods

Note: The labs below are designed so that each group can analyze the information on each of the action taking strategies presented by the experts of the Sustainability Corps. The rotation pattern is set up so that each group subdivides and one individual within the group is located at five of the six stations. In the two-day cycle, each person from a group will examine two of the proposed strategies and report back to their initial research group their findings. If the instructor wants all students to test each of the strategies, a six-day cycle would be required, and they could remain within their initial research groups.

- 30 pairs of safety glasses
- Six PUR® packets (The Procter & Gamble Company – [www.pg.com](http://www.pg.com))
- Green Water Monitoring Kit (Science Lab.com Cat #25-5848)
- Clay pot filter with 5 gallon water collection bucket (order from Potters for Peace - \$35 plus shipping)
- Biosand filter that you can purchase at ([www.watertiger.net/biosand/biosand\\_manual.html](http://www.watertiger.net/biosand/biosand_manual.html)) or see instructions for building your own below
- Solar cone or solar still (see instructions for building below)
- Roll of clear packing tape
- Large tray to collect overflow rain water
- Two – 500 mL beakers to act as rain barrels
- 250W heat lamp with reflector shield
- Seven – 250 mL graduated cylinders
- 12” square of cheese cloth or small sponge
- Six – 1 gallon plastic pails (ice cream tubs)
- Watering can that can hold 2 liters of “rain” water
- Six sets of building materials (cardboard boxes, ball of string, popsicle sticks, straws, etc.)
- Three X-acto knives
- Three scissors
- LifeStraw (order from [www.lifestraw.com](http://www.lifestraw.com))
- 500 mL Buchner funnel filtration kit with vacuum pump (order from [www.thesciencefair.com/Merchant2/merchant.mvc?Screen=PROD&Product\\_Code=KT3003-1&Category\\_Code=BUCFUNL](http://www.thesciencefair.com/Merchant2/merchant.mvc?Screen=PROD&Product_Code=KT3003-1&Category_Code=BUCFUNL))
- Two – 1’ section of vacuum quality plastic tubing
- #5 rubber stopper drilled to accept vacuum tubing
- 2” section of black tubing
- 6” diameter plastic funnel
- Two ring stands
- Two ring stand funnel holders
- Six pieces of filter paper
- Five stop watches
- Six plastic pipettes
- 5 two liter bottles (soda bottles) of contaminated water (see previous lab for preparation)
- Three metric rulers
- Large ring stand clamp
- One copy of Station Instructions for each of the six lab stations (see pages 124-129)

## Prep

- Order the PUR packets, Clay Pot, Buchner funnel filtration kit, LifeStraw, and biosand filter (unless you plan to construct your own) from the given websites several weeks before you plan to do these lab activities.
- For at least two nights before the lab, have the students go to this website – [www.jalmandir.com/](http://www.jalmandir.com/) and do additional research on the latest technologies for treating water. Have them outline important data on each of the examples given at this site. This will give them some ideas on what they should expect during their performance testing.
- Several days before the beginning of the labs, have the students (art and industrial art teachers could be very helpful) construct the materials below if they have not been purchased:

**Clay [ceramic] pots** – obtain the following materials from a local hardware/grocery store or online:

- 50 lb box of terra cotta clay ([www.dickblick.com/zz305/07/](http://www.dickblick.com/zz305/07/))
- 5 lbs of rice hulls (coffee grounds or sawdust can be substituted)
- 2-4 oz of colloidal silver ([www.amazon.com/dp/B00016QZRK/ref=nosim?tag=yahoo-hpc06-20&creative=380333&creativeASIN=B00016QZRK&linkCode=asn](http://www.amazon.com/dp/B00016QZRK/ref=nosim?tag=yahoo-hpc06-20&creative=380333&creativeASIN=B00016QZRK&linkCode=asn))

**Note: You will also need a kiln to fire the pots. Most school's art departments can supply this piece of equipment.**

### Instructions:

- Mix one handful of clay with one handful of dry organic material (rice hulls) ensuring it is well distributed through the clay.
- Add a little water if necessary to produce a stiff mixture that is firm to handle, is not wet and will not lose its shape when molded.
- Shape the clay mixture into a cylinder type pot and allow the mold to dry.
- The walls of the finished pot should be about as thick as an adult's index finger.
- Put the dried filter forms into a kiln and fire for 24 hours. The firing process will burn away the organic material, leaving passages (pores) that are wide enough for water to pass through, but too small for contaminants such as E. Coli.
- Remove the pots from the kiln.
- Allow the filter pots to cool.
- Coat the inside of the pot with a solution of colloidal silver and allow them to dry thoroughly.

# Process

- Discard the first water to pass through the filter, water can then be filtered through them. For heavy contamination, two or more filters can be used in a series.

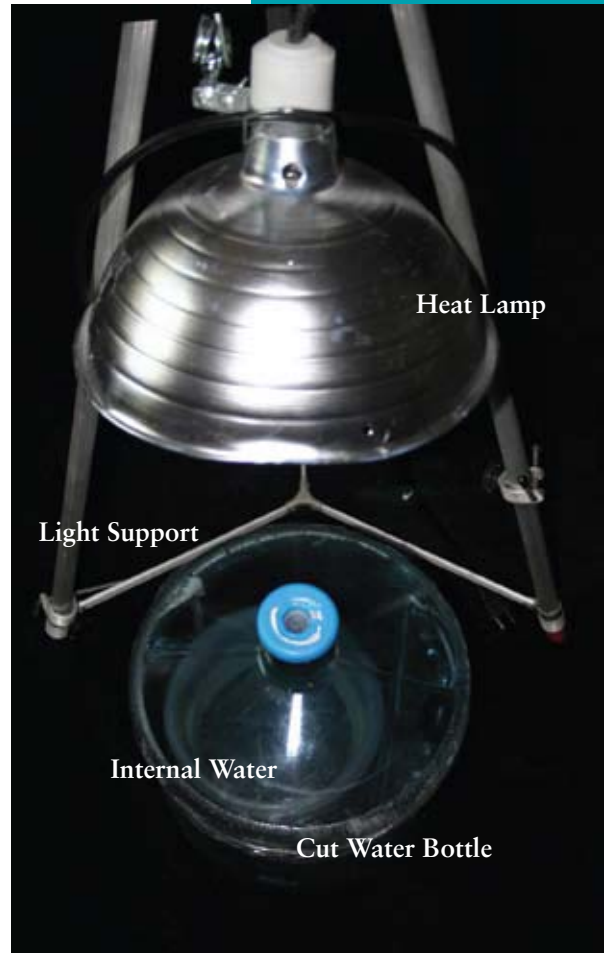
**Note:** The clay pot filtering system works best if it is kept wet between uses. Also, not all clay pots filter at the same rate, some are very slow. Make sure to have on hand about 1 gallon of clay filtered water for students to use for their water tests if they do not collect enough during their filtering experiment.

**Solar cone** – obtain the following materials:

- Saw to cut plastic, Dremel tool, or table saw
- Large (cooler type) water bottle (smaller 2½ gallon works best)

**Instructions:**

Cut the top of a large (cooler type) clear plastic water container where the funnel like top meets the top edge of the cylinder  $\frac{3}{4}$  around the rim so that the top is still attached. The remaining uncut section will act like a hinge. Save the cap for the experiments.



Solar Cone System

# procedure

**Biosand filter** – obtain the following materials from a local hardware store:

- 4 oz container of all purpose PVC cleaning solution
- 4 oz container of PVC cement
- Three – ½” 90 degree elbows
- 4” PVC cleanout plug
- 4” PVC female adapter
- ½” PVC ball valve
- 4” PVC vent guard
- 6” x 4” sewer reducer
- 4” PVC coupling
- 4” x 3’ PVC pipe
- ½” x 2’ PVC pipe
- ½” female screw adapter
- ½” male screw adapter
- Electric drill with ½” drill head
- PVC saw
- A roll of Teflon plumber’s tape
- Tape measure
- Small tube of silicon seal
- 5 lbs of large gravel
- 5 lbs of small gravel
- 5 lbs of coarse sand
- 5 lbs of fine sand

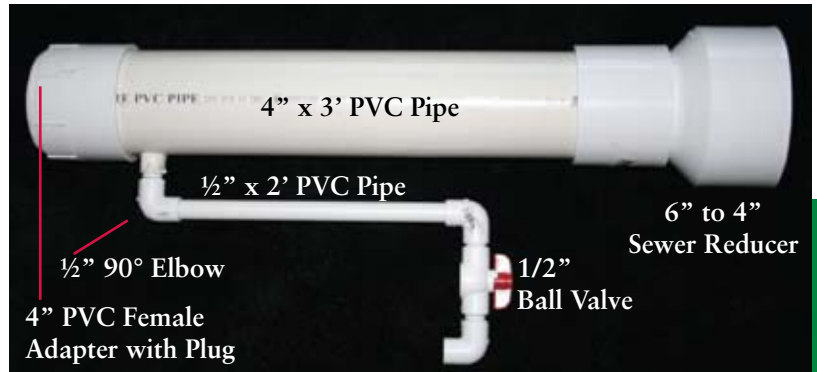
**Instructions:**

- Using the PVC cement, glue the 4” PVC female adapter to one end of the 4” PVC pipe.
- Drill a ½” hole in the 4” PVC pipe about 1” above the edge of the 4” PVC female adapter.
- Put a bead of silicon seal around the ½” male screw adapter and insert it into the hole.
- Attach the ½” female screw adapter to the male adapter on the inside of the pipe and tighten securely.
- Screw in the 4” PVC plug into the bottom screw end of the 4” PVC female adapter (it may be necessary to rap the threads with Teflon tape to prevent leaks).
- Cut three – 1¼” PVC “nipples” and a 1’ piece out of the ½” PVC pipe.
- Assemble and cement faucet arm in this order:
  1. Cement one nipple into the outside of the male screw adapter.
  2. Cement one ½” 90 degree elbow to end of nipple (make sure that elbow is pointed straight upwards).
  3. Cement the 1’ section of ½” pipe into end of ½” 90-degree elbow.
  4. Cement the second ½” 90 degree elbow to top of 1’ pipe with the elbow pointed directly away from 4” pipe.
  5. Cement the second nipple into the other end of ½” 90 degree elbow.
  6. Cement the ½” PVC ball valve on the other end of the second nipple.
  7. Cement the third nipple into the other end of the ball valve.
  8. Cement the third 90-degree elbow (pointing directly downward) onto the end of the third nipple.
  9. Pour about 6” of large gravel into bottom of filter.

10. On top of the large gravel, pour about 2" of small gravel.
11. Tightly pack the 12" square piece of cheesecloth or small sponge on top of the small gravel to create a filter to prevent sand from entering into the gravel below.
12. Add another 2" of small gravel on top of the cheesecloth or sponge filter.
13. On top of the small gravel add about 4" of coarse-grained sand.
14. On top of the coarse sand add about 4" of fine-grained sand.
15. Place (do not cement) the 4" PVC vent guard into the 4" PVC coupling with the filter coupling top being put in first.
16. Slip (do not cement) 4" PVC coupling onto top of 4" PVC pipe.
17. Slip (do not cement) 6" x 4" sewer reducer into top of coupling tightly.
18. Add water and test for leaks and proper flow. If leaks occur, use silicone sealer to stop them.

**Note:** Biosand filters need to sit with water in them for several days to become effective. The biosand filter that you constructed is smaller in size than conventional models. Standard biosand filters have longer columns of sand and gravel for better filtering action and larger diameters for increased flow.

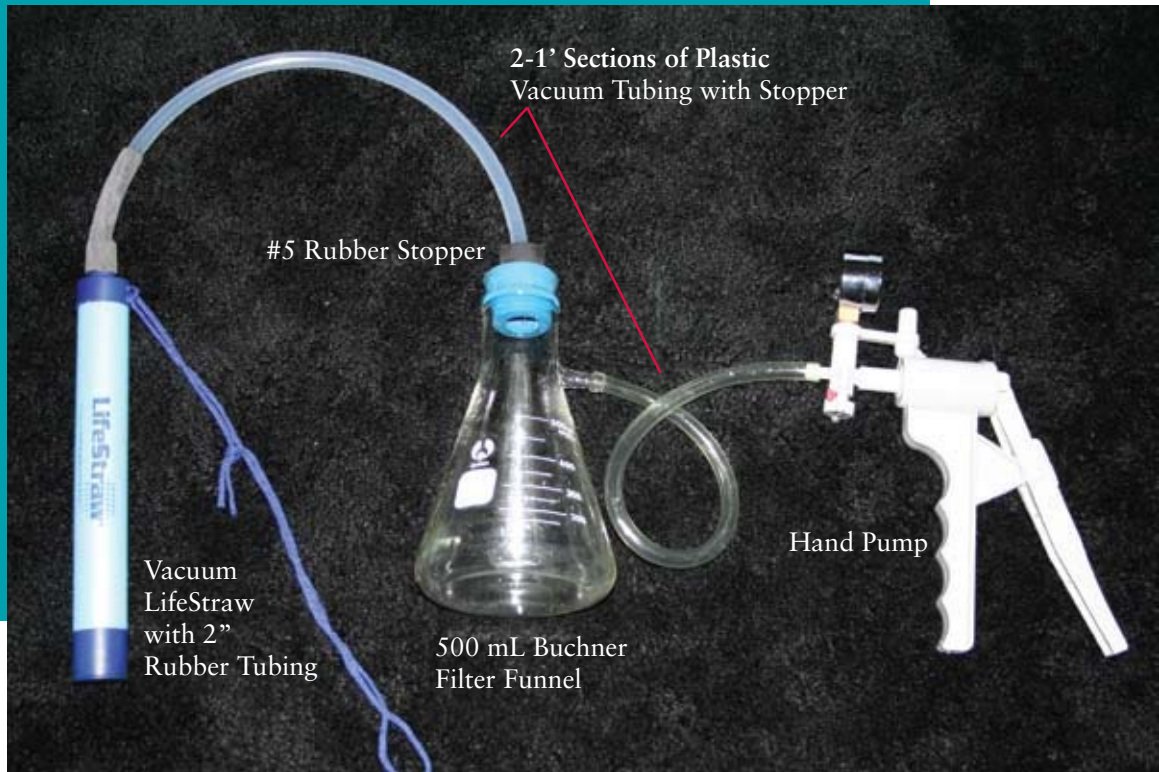
Homemade Biosand Filter (\$35-\$40)



Commercial Biosand Filter (\$400 includes shipping)



LifeStraw System – Set up the LifeStraw system similar to this picture.



Clay Pot System



Set up six stations around the classroom with the following equipment. These stations need to be set up for each of the two (or more) lab days:

**Station 1:**

- Large clay pot (or several of the smaller pots that the students have made)
- Plastic 5 gallon collection bucket with spigot
- 2 liter bottle of contaminated water
- 250 mL graduated cylinder
- Plastic pipette
- 1 gallon plastic pail
- Two Green water tests with instructions and necessary charts (temperature and turbidity)
- Stop watch
- Set of instructions

**Note:** The clay pot filtering system works best if it is kept wet between uses.

**Station 2:**

- LifeStraw
- 500 mL Buchner filtering flask kit
- Two – 1' sections of vacuum quality plastic tubing
- #5 rubber stopper drilled out to accept vacuum tubing
- 2" in length of rubber tubing (to connect Lifestraw to plastic funnel)
- 250 mL graduated cylinder
- Plastic pipette
- 1 gallon plastic pail
- 2 liter bottle of contaminated water (top may need to be cut off to fit LifeStraw into it)
- Two Green water tests with instructions and necessary charts (dissolved O<sub>2</sub> and pH)
- Stop watch
- Set of instructions



**Station 3:**

- Solar cone or solar still
- 250W heat lamps (near outlet)
- A roll of clear packing tape
- 250 mL graduated cylinder
- Plastic pipette
- 1 gallon plastic pail
- 2 liter bottle of contaminated water
- Two Green water tests with instructions and necessary charts (BOD and nitrates)
- Stop watch
- Set of Instructions

**Note:** This station needs to be set up at least 12 hours before the students start the labs. Place the 1-gallon plastic pail containing 2 liters of contaminated water inside the center of the solar cone. Seal the contact between the top of the solar cone and the side with clear packing tape. Turn on the heat lamp and place it close to the top of the solar cone but not so close as to melt the plastic. Because this method does not collect large amounts of clean water, it will be necessary to have additional water available that has been collected in this manner (condensation) for students to perform their water tests on.

**Station 4:**

- Biosand filter
- 250 mL graduated cylinder
- 1 gallon plastic pail
- 2 liter bottle of contaminated water
- Large ring stand
- Plastic pipette
- Large ring stand clamp
- Two Green water tests with instructions and necessary charts (phosphates and coliform bacteria)
- Stop watch
- Set of instructions

**Note:** The biosand filter system needs to be FILLED with contaminated water (not the 2 liters at the station) the night before the lab. Support the biosand filter in an upright position using a ring stand clap attached to the ring stand.

**Station 5:**

- PUR packet
- 250 mL graduated cylinder
- 1 gallon plastic pail
- 2 liter bottle of contaminated water
- Conductivity meter with instructions
- Stop watch
- Plastic pipette
- 6" diameter funnel
- Ring stand
- Scissors
- Piece of filter paper
- Ring stand filter holder
- Set of instructions

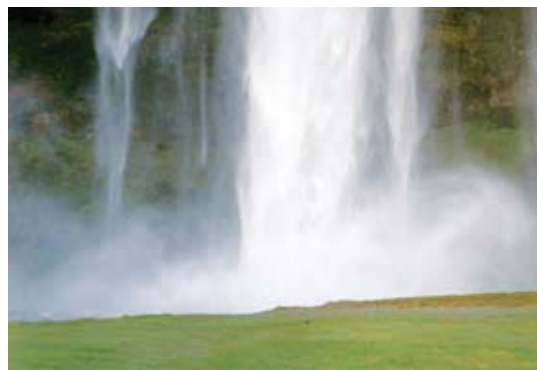
### Station 6:

- Watering can with 2 liters of “rain” water (fresh tap water)
- Large tray to collect rain water
- Two – 500 mL beakers to act as rain barrels
- Assorted building materials
- Three X-acto knives
- Two scissors
- Plastic pipette
- Three metric rulers
- Two – 250 mL graduated cylinders
- 1 gallon plastic pail
- Set of instructions

### *In Class*

#### Day 1

- Have all the students put on their safety glasses.
- Have one member of each research group report to one of the six stations set up around the room to form a new subgroup. It is advisable to start this activity with one station completely empty (during the filtering) and reopen it when the groups begin water testing.
- Working as a member of this new subgroup, have each station follow the instructions for using the filtering device at their station.



- Once their water has been filtered, have the subgroups rotate through the stations and conduct water tests at each of the stations. If time does not permit a rotation sequence, have one member of each group take a sample of their water to one of the five water testing stations (they will need some additional small beakers or paper cups for this) and perform the test(s) at that station. After the tests are completed, have the students return to their original station for this lab and share their results within their subgroup. **Note: Station Six does not conduct water tests, they will need the entire lab time to construct their structure and collect and measure the rainwater.**
- Tell the students that at the end of the labs (two to six days), they will be returning to their original research groups to report on all the data they have collected.
- At the end of the lab, it is important that each station is set up as it was in the beginning of the class period. **Note: The coliform and BOD tests needs to be stored before reading the results.**

#### Day 2 – Day 6

Have the students rotate to the next station in order (Station 6 goes to Station 1) and follow the same procedure as Day 1.

# Station 1

## – Clay Pot

# Instructions ●

1. Place the clay pot into the large plastic bucket with spigot. If the students are using their own pots (homemade) have them devise a way to collect the filtered water. **Note: The clay pot filtering system works best if it is kept wet between uses.**
2. Have one student start the stopwatch as another student pours the 2-liter bottle of contaminated water into the clay pot.
3. Let the system filter the water until all the water is gone from the clay pot or until 10 minutes have elapsed.
4. Remove the clay pot from the plastic bucket with spigot.
5. Record the amount of time it took to filter the water in Table 1 of your Examining Action Taking Strategies – Student Sheet.
6. Using the graduated cylinder, measure the amount of water that has been filtered and record its volume in Table 1 of your Examining Action Taking Strategies – Student Sheet.
7. Using this data, calculate the volume of water that could be filtered in 24 hours and enter your answer into Table 1 of your Examining Action Taking Strategies – Student Sheet.
8. Perform all of the water tests on your filtered sample (your instructor will explain how he/she wants you to do this) and record the results in Table 2. You will need to copy the pre-filtering data from the previous lab into Table 2. If you did not collect enough filtered water to complete your water tests, your instructor has extra water that has already been filtered using the same method.
9. Clean up your lab station making sure all equipment is ready for the next lab group.
10. Wash your hands thoroughly.
11. Answer the questions on your Examining Action Taking Strategies – Student Sheet for Station 1.

# Station 2

## – LifeStraw®

# Instructions

1. Assemble the equipment at the station in this order:
  - Attach stiff plastic tubing to vacuum filter flask.
  - Attach other end of plastic tubing to vacuum pump.
  - Place “mouth” end of LifeStraw® into 2” black flexible tubing.
  - Attach the other end of the black tubing to the second piece of plastic tubing and insert plastic tubing into the predrilled one-hole #5 rubber stopper.
  - Place #5 rubber stopper into large stopper of filter flask. Make sure stoppers are not leaking.
  - Place “water” end of LifeStraw into 2-liter bottle of contaminated water so that the end is at the bottom of the bottle (you will need to cut the top of the plastic bottle to fit the end of the LifeStraw into it).
2. Have one student start the stopwatch as another student pumps the vacuum pump to create suction on the LifeStraw to pull the contaminated water through the straw and into the flask. You may have to empty the flask into the plastic pail several times during this procedure.
3. Record the amount of time it took to filter all of the water in Table 1 of your Examining Action Taking Strategies – Student Sheet.
4. Using the graduated cylinder, measure the amount of water that has been filtered and record its volume in Table 1.
5. Using this data, calculate the volume of water that could be filtered in 24 hours and enter your answer into Table 1.
6. Perform all of the water tests on your filtered sample (your instructor will explain how he/she wants you to do this) and record the results in Table 2 of your Examining Action Taking Strategies – Student Sheet. You will need to copy the pre-filtering data from the previous lab into Table 2.
7. Clean up your lab station making sure all equipment is ready for the next lab group.
8. Wash your hands thoroughly.
9. Answer the questions on your Examining Action Taking Strategies – Student Sheet for Station 2.

# Station 3 – Solar Cone Instructions.

**Note:** The solar cone has been set-up and is collecting water. Your instructor will tell you how many hours it has been working. Record this time in Table 1 of your Examining Action Taking Strategies – Student Sheet.

1. Un-tape the solar cone container and using the graduated cylinder, measure the amount of water that has been collected in the bottom (not inside of the pail) of the solar cone and record its volume in Table 1 of your Examining Action Taking Strategies – Student Sheet.
2. Using this data, calculate the volume of water that could be collected in 24 hours and enter your answer into Table 1.
3. Perform all of the water tests on your collected sample (your instructor will explain how he/she wants you to do this) and record the results in Table 2 of your Student Answer Sheet. If there is not enough water collected to perform all of the tests, your instructor has extra water that was collected using the same method. You will need to copy the pre-filtering data from the previous lab into Table 2.
4. Clean up your lab station making sure all equipment is ready for the next lab group. It is important that you empty out the small pail and refill it with 2 liters of contaminated water. The bottom of the solar cone (inside bottom of water container) should be rinsed out and dried and the whole system should be set up the way that you found it at the beginning of the class period. Record on a small slip of paper the time you restarted the system and place the paper next to the solar cone so that the next lab group will have an accurate starting time.
5. Wash your hands thoroughly.
6. Answer the questions on your Examining Action Taking Strategies – Student Sheet for Station 3.

# Station 4 – Biosand Instructions

**Note:** The biosand filter at your station has been filled with contaminated water. Before you do your collection you will need to “zero” the system.

1. Place the one gallon plastic bucket at your station under the spigot of the biosand filter.
2. Open the valve and allow water to drain from the filter until it stops.
3. Close the valve on the filter.
4. Empty any water in the collection bucket and dry the bucket.
5. Place the bucket back under the spigot.
6. Have one student start the stopwatch as another student pours the 2-liter bottle of contaminated water into the top of the biosand filter (do not allow it to overflow) and a third student opens the spigot.
7. Allow water to drain from the filter until it stops. Record the time that the water stops flowing from the spigot in Table 1 of your student answer sheet.
8. Close the valve of the filter.
9. Using the graduated cylinder, measure the amount of water that has been filtered and record its volume in Table 1 of your Student Answer Sheet.
10. Using this data, calculate the volume of water that could be filtered in 24 hours and enter your answer into Table 1 of your Student Answer Sheet.
11. Perform all of the water tests on your filtered sample (your instructor will explain how he/she wants you to do this) and record the results in Table 2 of your Student Answer Sheet. You will need to copy the pre-filtering data from the previous lab into Table 2.
12. Ask the instructor to refill the biosand filter with contaminated water.
13. Clean up your lab station making sure all equipment is ready for the next lab group.
14. Wash your hands thoroughly.
15. Answer the questions on your Student Answer Sheet for Station 4.

# Station 5

## – PUR<sup>®</sup>

# Instructions

1. Cut open one PUR packet with the scissors provided.
2. Start the stopwatch.
3. Pour the entire contents of the packet into the 2-liter bottle of contaminated water.
4. Cap the bottle tightly and shake vigorously for 5 minutes. You should see a brown floc (precipitate) starting to form – the contaminants should start clumping together.
5. After 5 minutes of agitation, let the bottle stand for about 5 minutes to allow the floc to settle.
6. Set up the ring stand, filter holder, and filter.
7. Place a clean piece of filter paper into the funnel.
8. Place the one gallon plastic bucket at your station under the filter.
9. Pour the treated water into the funnel and filter paper until all has been filtered into the bucket.
10. Wait 10 minutes before testing the water to allow the chlorine disinfectant to kill the bacteria and viruses.
11. After the 10 minutes have elapsed, stop the stopwatch. This is the total time required to treat the volume of water you have collected in the plastic pail. Record this time in Table 1 of your Examining Action Taking Strategies – Student Sheet.
12. Using the graduated cylinder, measure the amount of water that has been filtered and record its volume in Table 1.
13. Using this data, calculate the volume of water that could be filtered in 24 hours and enter your answer into Table 1.
14. Perform all of the water tests on your filtered sample (your instructor will explain how he/she wants you to do this) and record the results in Table 2 of your Examining Action Taking Strategies – Student Sheet. You will need to copy the pre-filtering data from the previous lab into Table 2.
15. Clean up your lab station making sure all equipment is ready for the next lab group.
16. Wash your hands thoroughly.
17. Answer the questions on your Examining Action Taking Strategies – Student Sheet for Station 5.

# Station 6

## – Rain Water

# Instructions

1. Using the materials at your lab station, construct two small one-room houses with at least one door and one window. The houses must have roofs but they do not need floors. You should design the roofs so that, when it rains, a maximum amount of water hitting the roofs will be collected in a rain barrel.
2. After you are finished with the construction, place both houses close to each other in the large metal tray with the rain barrels (500 mL beakers) on the outside of each of the houses.
3. Start the stopwatch and at the same time using the watering can, slowly pour the “rain” water evenly over each of the houses.
4. After the rain stops (all 2 liters have been used), stop the stopwatch and record the time in Table 1 of your Examining Action Taking Strategies – Student Key.
5. Use the graduated cylinders to measure the volume of water collected in each rain barrel and record this data in Table 1.
6. Using this data, calculate the volume of water that could be filtered in 24 hours (assuming that it would rain at a constant rate during that time period) and enter your answer into Table 1.
7. Clean up your lab station making sure all equipment is ready for the next lab group.
8. Wash your hands thoroughly.
9. Answer the questions on your Examining Action Taking Strategies – Student Sheet for Station 6.

# Student Sheet



Name \_\_\_\_\_



Date \_\_\_\_\_

Table 1 - Time and Volume

Station #	Filtering Time (Seconds)	Volume Produced (Milliliters)	Volume Possible in 24 Hours
1 Clay Pots			
2 LifeStraw			
3 Solar Cone			
4 Biosand			
5 PUR			
6A Rain Water			
6B Rain Water			





Table 2 – Test Results

Test	Pre-filtering (from previous lab)	Post-filtering Station # _____ Day 1	Post-filtering Station# _____ Day 2
Temperature (°Celsius)			
Turbidity			
pH			
Dissolved O <sub>2</sub>			
BOD			
Nitrates			
Phosphates			
Coliform Bacteria			
Conductivity			


# Questions for Stations

## Station 1:

1. What allows the water to filter through the clay pot?
2. Why don't bacteria and viruses pass through the clay with the water?
3. What is the function of colloidal silver?
4. What are some of the drawbacks of this system?
5. What improvements could be made to this system?

## Station 2:

1. How does a LifeStraw filter out contaminants?



2. What are some of the advantages of LifeStaw over the other systems? Some disadvantages?

3. What improvements could be made in this system?

### Station 3:

1. What “cycle” does the solar cone mimic?

2. What factors influence the effectiveness of a solar cone?

3. What are some of the advantages of the solar cone over the other systems?  
Some disadvantages?

4. What improvements could be made to this system?


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Station 4:

1. Why does the biosand filter have to have water in it at the beginning of the experiment?
2. What does the term “schmutzdecke” refer to?
3. What are some of the advantages of the biosand filter over the other systems?  
Some disadvantages?
4. What improvements could be made to this system?

Station 5:

1. What does the term “floc” mean?
2. What chemical acts as a binder in this system?



3. What are some of the advantages of the PUR packets over the other systems?  
Some disadvantages?

4. What improvements could be made to this system?

#### Station 6:

1. What was the main difference in your two house designs?

2. How does roof area affect the amount of rainwater you can collect?

3. What are some of the advantages of rain harvesting over the other systems?  
Some disadvantages?

4. What improvements could be made to this system?

## Answer Key

Answers in Table 1 and Table 2 will vary between students.

### Station 1:

1. What allows the water to filter through the clay pot?  
*The pots are made by combining inorganic materials such as crushed, dried clay and organic materials such as rice husks. When the pots are fired, the rice husks incinerate leaving microscopic pores in the clay that the water can pass through.*
2. Why don't bacteria and viruses pass through the clay with the water?  
*The pores in the filter are wide enough for water molecules to pass through but too narrow for pathogens, eliminating 98 percent of bacteria and parasites.*
3. What is the function of colloidal silver?  
*Colloidal silver helps kill bacteria.*
4. What are some of the drawbacks of this system?  
*You have to have a kiln to fire the pots. Other answers are possible.*
5. What improvements could be made to this system?  
*Answers will vary.*

### Station 2:

1. How does a LifeStraw filter out contaminants?  
*LifeStraw contains a specially developed halogen-based resin, an extraordinarily effective material that kills bacteria on contact. Textile pre-filters are used to remove particles up to 15 microns. Active carbon withholds particles such as parasites.*

2. What are some of the advantages of LifeStaw over the other systems? Some disadvantages?  
*It is small, easy to carry and relatively inexpensive. However, it does not filter arsenic, heavy metals, or fluoride. Other answers are possible.*
3. What improvements could be made in this system?  
*Answers will vary.*

### Station 3:

1. What “cycle” does the solar cone mimic?  
*The solar cone mimics the water cycle.*
2. What factors influence the effectiveness of a solar cone?  
*Factors that influence the solar cone’s effectiveness include amount of sunlight, ambient temperature, and size of the cone. Other answers are possible.*
3. What are some of the advantages of the solar cone over the other systems? Some disadvantages?  
*One advantage of the solar cone is that it operates on solar power alone. One disadvantage is that it does not operate 24 hours a day. Other answers are possible.*
4. What improvements could be made to this system?  
*Answers will vary.*

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#### Station 4:

1. Why does the biosand filter have to have water in it at the beginning of the experiment?

*The biosand filter needs to have water in it at the beginning of the experiment because the material in the filter (sand) traps some of the water that is poured into it. By having it filled at the beginning of the experiment, and then letting it run until it stops, the inside material will not absorb as much of the water and most of the water poured into it will then pass through the filter.*

2. What does the term “schmutzdecke” refer to?

*The biological biofilm top layer of a biosand filter is called “schmutzdecke.” Its function is to remove the majority of the pathogens as the water passes through it.*

3. What are some of the advantages of the biosand filter over the other systems? Some disadvantages?

*One advantage of the biosand filter is that it uses materials that are easily attainable. One disadvantage is that it requires regular maintenance and cleaning approximately every one to three months. During times of monsoon or a very wet season, the sand could possibly need daily cleaning so it doesn't clog. Clogging is caused when the particle deposition increases and the pore size decreases, reducing flow rate.*

4. What improvements could be made to this system?

*Answers will vary.*


#### Station 5:

1. What does the term “floc” mean?

*Floc is a precipitate formed when ferric sulfate, a particle binder, combines with impurities such as dirt and also disease-causing pathogens.*

2. What chemical acts as a binder in this system?

*Ferric sulfate acts as the binder in this system.*

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3. What are some of the advantages of the PUR filter over the other systems? Some disadvantages?

*One of the advantages is the size of the packets. They are small and easy to carry and/or ship.*

*One of the disadvantages is that once the packets are gone, you can no longer filter water.*

*Other answers are possible.*

4. What improvements could be made to this system?

*Answers will vary.*

### Station 6:

1. What was the main difference in your two house designs?

*Answers will vary.*

2. How does roof area affect the amount of rainwater you can collect?

*The larger the area of the roof, the more water you should be able to collect.*

3. What are some of the advantages of rain harvesting over the other systems? Some disadvantages?

*One of the advantages is that all you really need is rain to make the system effective. One*

*disadvantage is that the system relies on the weather... no rain, no water.*

4. What improvements could be made to this system?

*Answers will vary.*