Es

Environmental Science

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Lab Manual

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If you are allergic to latex, please contact us and we will send you vinyl gloves

Please note that the times listed are approximations and may differ. Please read through the procedure and plan accordingly.

Introduction

Lab 1 The Scientific Method

Time Required: 30 minutes

Additional Materials: None

Lab 2 How to Write a Lab Report

Time Required: 30 minutes; 7-10 days observation

Additional Materials: Paper towel, water, masking tape

Lab 3 Measurements

Time Required: 30 minutes

Additional Materials: None

Ecological Interactions

Lab 4 Ecosystems

Time Required: 60 minutes; 7 days observation

Additional Materials: Water

Lab 5 Ecology of Organisms

Time Required: 60 minutes; 2 hours observation

Additional Materials: Water

Lab 6 Biodiversity

Time Required: 60 minutes; 2 weeks observation

Additional Materials: Water

Lab 7 Population Biology

Time Required: 60 minutes; 2 weeks observation

Additional Materials: Water, germinated seeds from Biodiversity Lab ***OR*** additional 2 weeks to germinate seeds

Resources

Lab 8 Water Quality and Contamination

Time Required: 90 minutes

Additional Materials: Water

Lab 9 Air Quality and Contamination

Time Required: 60 minutes; 4 days observation

Additional Materials: Aquatic plant from pet store, water, paper towels, scissors

Lab 10 Soil Quality and Contamination

Time Required: 90 Minutes; 7 days observation

Additional Materials: Water, 1L container

Lab 11 Energy Sources and Alternative Energy

Time Required: 60 minutes; 48 hours observation

Additional Materials: Water, incandescent light source, sunlight

Geology

Lab 12 Weather and Climate Change

Time Required: 60 minutes; 12 hours observation

Additional Materials: Water, ice cubes, hot water

Lab 13 Rocks

Time Required: 60 minutes

Additional Materials: None

Lab 14 Minerals

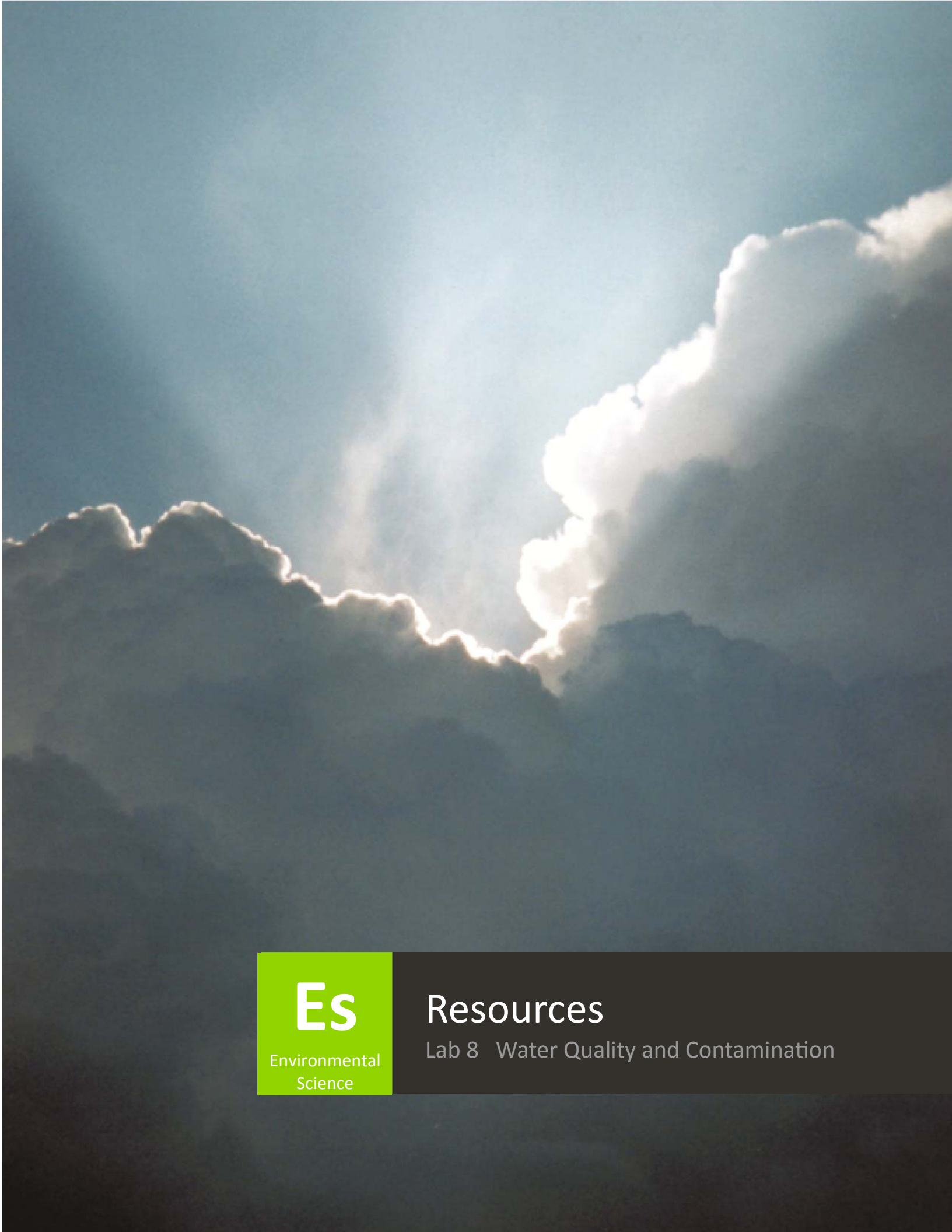
Time Required: 60 minutes

Additional Materials: Penny, fingernail (for scratch test)

Lab 15 Astronomy

Time Required: 60 minutes

Additional Materials: Pencil, scissors, masking tape, cardboard



Es
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Resources

Lab 8 Water Quality and Contamination

Concepts to Explore

- Usable water
- Ground water
- Surface water
- Ground water contaminates
- Water treatment
- Drinking water quality

Figure 1: *At any given moment, 97% of the planet's water is in the oceans. Only a small fraction of the remaining freshwater is usable by humans, underscoring the importance of treating our water supplies with care.*

It is no secret that water is one of the most valuable resources on planet Earth. Every plant and animal requires water to survive, not only for drinking, but also for food production, shelter creation and many other necessities. Water has also played a major role in transforming the earth's surface into the varied topography we see today.

While more than 70% of our planet is covered in water, only a small percent of this water is usable freshwater. The other 99% of the water is composed primarily of salt water, with a small percentage being composed of glaciers. Due to the high costs involved in transforming salt water into freshwater, the Earth's population survives off the less than 1% of freshwater available. Humans obtain freshwater from either surface water or groundwater.

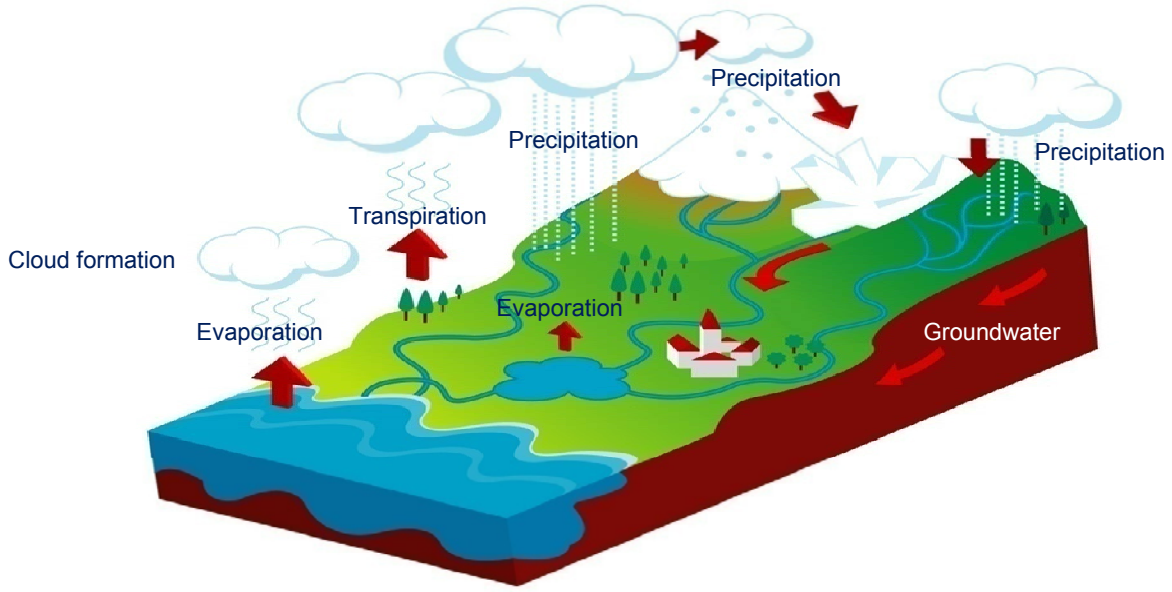


Figure 2: *Water is a renewable source, purified and delivered across the planet by the hydrological cycle.*

Surface water is the water that collects on the ground as a result of precipitation. The water that does not evaporate back into the atmosphere or infiltrate into the ground is typically collected in rivers, lakes, reservoirs, and other bodies of water and is easily accessible.

Groundwater, on the other hand, is precisely as the name suggests; water located underneath the ground. This water is stored in pores, fractures and other spaces within the soil and rock underneath the ground's surface. Precipitation, along with snowmelt, infiltrates through the ground and accumulates in available underground spaces.

Aquifers are areas in which water collects in sand, gravel, or permeable rock from which it can be extracted for useable freshwater. The depth of aquifers vary from less than 50 feet to well over 1,500 feet below the surface of the ground. The water within an aquifer typically does not flow through as it would through a river or stream, but instead soaks into the underground material, similar to a sponge. As aquifers are depleted by human use, they are also recharged from precipitation seeping into the ground and restoring the water level. However, many times the recharge of the aquifers does not equal the amount of water that has been extracted. If that cycle continues, the aquifer will eventually dry up and will no longer be a viable source of groundwater.

While the water that precipitates down in the form of rain is relatively pure, it does not take long for water to pick up contaminants. There are natural, animal, and man-made sources of water pollutants. They can travel freely from one location to another via streams, rivers, and even groundwater. Pollutants can also travel from land or air into the water. Groundwater contamination most often occurs when man-made products such as motor oil, gasoline, acidic chemicals and other substances leak into aquifers and other groundwater storage areas. The most

Water is the only substance that is found naturally in three forms: solid, liquid, and gas

If the entire world's supply of water could fit into a one-gallon jug, the fresh water available to use would equal less than one tablespoon

Approximately 66% of the human body consists of water - it exists within every organ and is essential for its function

common source of contaminants come from leaking storage tanks, poorly maintained landfills, and septic tanks, hazardous waste sites and the common use of chemicals such as pesticides and road salts.

The dangers of consuming contaminated water are high. Many deadly diseases, poisons and toxins can reside in the contaminated water supplies and severely affect the health of those who drink the water. It is also believed that an increased risk of cancer may result from ingesting contaminated groundwater.

With the many contaminants that can infiltrate our water supply, it is crucial that there be a thorough water treatment plan in place to purify the water and make it drinkable. While each municipality has its own water treatment facility, the process is much the same at each location.

The process begins with aeration in which air is added to the water to let trapped gases escape while increasing the amount of oxygen within the water. The next step is called coagulation or flocculation, in which chemicals, such as filter alum, are added to the incoming water and then stirred vigorously in a powerful mixer. The alum causes compounds such as carbonates and hydroxides to form tiny, sticky clumps called floc that attract dirt and other small particles. When the sticky clumps combine with the dirt they become heavy and sink to the bottom. In the next step, known as sedimentation, the heavy particles

Figure 3: *Sedimentation tanks, such as those shown above, are used to settle the sludge and remove oils and fats in sewage. This step can remove a good portion of the biological oxygen demand from the sewage, a key step before progressing with the treatments and eventually releasing into the ground or body of water.*

that sank to the bottom during coagulation are separated out and the remaining water is sent on to filtration. During filtration, the water passes through filters made of layers of sand, charcoal, gravel and pebbles that help filter out the smaller particles that have passed through until this point. The last step is called disinfection in which chlorine and/or other disinfectants are added to kill any bacteria that may still be in the water. At this point the water is stored until it is distributed through various pipes to city residents and businesses.

After the water goes through the treatment process, it must also pass the guidelines stated in the Safe Drinking Water Act in which various components are tested to ensure that the quality of the water is sufficient for drinking. There are currently over 65 contaminants that must be monitored and maintained on a regular basis to keep local drinking water safe for the public. Some of these chemical regulations include lead, chromium, selenium and arsenic. Other components such as smell, color, pH and metals are also monitored to ensure residents are provided clean and safe drinking water.

Figure 4: *Fresh water is essential to humans and other land-based life. Contaminated water must be treated before it can be released into the water supply.*

Experiment 1: Effects of Groundwater Contamination

In this lab you will observe the effects that many common pollutants have on groundwater.

Materials

(8) 250 mL Beakers
Permanent marker
Water*
(3) Wooden stir sticks
100 mL Graduated cylinder
10 mL Vegetable oil
10 mL Vinegar
10 mL Liquid laundry detergent
Funnel
100 mL Beaker
Cheesecloth
240 mL Soil
Scissors*
* You must provide

Procedure

1. Begin by labeling the beakers 1 to 8.
2. Set beakers 5-8 aside. Fill each of beakers 1-4 with 100 mL of water using your 100 mL graduated cylinder.
3. Record your observations of the water in Beaker 1 in Table 1. Remember to use a safe wafting technique to smell the solutions.
4. Add 10 mL of vegetable oil to Beaker 2. Mix thoroughly with a wooden stir stick. Record your observations of the water in Beaker 2 in Table 1. (Don't forget to wash the graduated cylinder between use!)
5. Add 10 mL vinegar to beaker 3. Mix thoroughly with a wooden stir stick. Record your observations of the water in Beaker 3 in Table 1 .
6. Add 10 mL of liquid laundry detergent to beaker 4. Mix thoroughly with a wooden stir stick. Record your observations of the water in Beaker 4 in Table 1.
7. Cut your piece of cheesecloth into four different pieces. Fold the cheesecloth so that you have a piece four layers thick and big enough to line the funnel. Place it inside the funnel.
8. Measure out 60 mL of soil using the 100 mL beaker and place it into the cheesecloth-lined funnel.
9. Place the funnel inside Beaker 5.
10. Pour the contents of Beaker 1 (water) through the funnel so that it filters into Beaker 5 for one minute. Record your observations of the filtered water in the beaker in Table 1.
11. Discard the cheesecloth and soil from the funnel.
12. Repeat steps 8-12 for Beakers 2, 3, and 4. (Filter the contents of Beaker 2 into Beaker 6, the contents of Beaker 3 into Beaker 7, and the contents of Beaker 4 into Beaker 8).

Table 1: *Water Observations (smell, color, etc.)*

Beaker	Observations
1	
2	
3	
4	
5	
6	
7	
8	

Questions

1. What affects did each of the contaminants have on the water in the experiment? Which contaminant seemed to have the most potent affect on the water?

2. On a larger scale, what type of affects would these contaminants have on a town's water source and the people who drank the water?

3. What type of human activity would cause contaminants like oil, acid and detergents to flow into the water supply?

4. What other items within your house do you believe could contaminant the water supply if you were to dump them into the ground?

Experiment 2: Water Treatment

With the many pollutants that are added to our water supply from daily human activity, it is important that we have a way to filter our water to make it safe for drinking. In this experiment, you will filter water using a similar process that water treatment facilities use in an effort to understand the measures that must be taken to purify your drinking water.

Materials

Water*
100 mL Potting soil
(2) 250 mL Beakers
(2) 100 mL Beakers
(1) Wooden stir stick
Alum
Funnel
Cheesecloth
40 mL Sand
20 mL Activated charcoal
60 mL Gravel
Bleach
100 mL Graduated cylinder
Stopwatch

* You must provide

Procedure

1. Add 100 mL of soil to the 250 mL beaker. Fill to the 200 mL mark with water.
2. Pour the soil solution back and forth between the two 250 mL beakers for a total of 15 times.
3. After the solution is created, pour 10 mL of the now "contaminated" water into a clean 100 mL beaker. This sample will be used to compare to the "treated" water at the end of the filtration process.
4. Add 10 grams of alum (all of the contents in the bag you have been given) to the 250 mL beaker containing the "contaminated" water. Slowly stir the mixture with a wooden stir stick for 1-2 minutes. Let the solution sit for 15 minutes.
5. In the meantime, rinse out the empty 250 mL beaker. Place the funnel into the clean 250 mL beaker. Fold a piece of cheesecloth so that you have a piece four layers thick that is big enough to line the funnel. Place it inside the funnel.
6. Begin layering the funnel, starting by pouring 40 mL of sand into the cheesecloth-lined funnel, then 20 mL activated charcoal, then 40 mL gravel. Use a 100 mL beaker to measure these amounts.
7. To solidify the filter, slowly pour clean tap water through the filter until the funnel is full. Discard the rinse water from the beaker and repeat four more times. Return the funnel to the top of the beaker and let sit for 5 minutes before emptying the beaker and continuing the experiment.
8. Now, without mixing up the current sediment in the "contaminated" water jar, pour about

3/4 of the “contaminated” water into the funnel. Let it filter through the funnel into the beaker for 5 minutes.

9. Note the smell of the filtered water, comparing it to the 10mL sample taken from the mixture in step 3.
10. Remove the filter and add a few drops of bleach solution to the filtered water within the beaker. Stir the water and bleach combination slowly for about 1 minute.
11. The “contaminated” water has now been filtered. Compare the newly created “treated” water with the 10mL sample of the initial “contaminated” water and answer the questions below.

Questions

1. What are the differences between the “contaminated” water and the “treated” water (look at color, smell, visibility, etc.)?

2. From the introduction to this lab, you know that there are typically five steps involved in the water treatment process. Identify the processes (i.e. coagulation) that were used in this lab and describe how they were performed.

Experiment 3: Drinking Water Quality

Bottled water is a billion dollar industry within the United States alone. Still, few people know the health benefits, if any, from drinking bottled water as opposed to tap water. This experiment will look at the levels of a variety of different chemical compounds in both tap water and a few types of bottled water to determine if there are health benefits in drinking bottled water.

Materials

Tap water*
Dasani bottled water
Fiji bottled water
Ammonia Test Strips
Chloride Test Strips
4 in 1 Test Strips
Phosphate Test Strips
Iron Test Strips
(3) 250mL Beakers
Permanent marker
Stopwatch
Parafilm
Pipettes
(3) Foil packets of reducing powder
* You must provide

Procedure

1. Label three 250mL beakers Tap Water, Dasani and Fiji. Pour 100 mL of the each type of water into the corresponding beakers.

Ammonia Test Strip

2. Locate the ammonia test strips. Begin by placing the test strip into the tap water sample and vigorously moving the strip up and down in the water for 30 seconds, making sure that the pads on the test strip are always submerged.
3. Remove the test strip from the water and shake off the excess water.
4. Hold the test strip level, with the pad side up, for 30 seconds.
5. Read the results by turning the test strip so the pads are facing away from you. Compare the color of the small pad to the color chart at the end of the lab. Record your results in Table 2 .
6. Repeat the procedure for both Dasani and Fiji Bottled Water. Record your results for both in Table 2.

Chloride Test Strip

7. Locate the chloride test strips. Begin by immersing all the reaction zones (“the pads”) of the test strip in to the tap water sample for 1 second.

Table 2: *Ammonia Test Results*

Water Sample	Test Results
Tap Water	
Dasani Bottled Water	
Fiji Bottled Water	

8. Shake off the excess liquid from the test strip and after 1 minute, determine which color row the test strip most noticeably coincides with on the color chart at the end of the lab. Record your results in Table 3.
9. Repeat the procedure for both Dasani and Fiji Bottled Water. Record your results for both in Table 3.

4 in 1 Test Strip

10. Locate the 4 in 1 test strips. Begin by dipping the test strip in the tap water for 5 seconds

Table 3: *Chloride Test Results*

Water Sample	Test Results
Tap Water	
Dasani Bottled Water	
Fiji Bottled Water	

with a gentle back and forth motion.

11. Remove the test strip from the water and shake once, briskly, to remove the excess water.
12. Wait 20 seconds and then using the color chart at the end of this lab, match the test strip to the pH, Total Alkalinity, Total Chlorine, and Total Hardness on the color chart. Be sure to do all of the readings within seconds of each other. Record your results in Table 4.
13. Repeat the procedure for both Dasani and Fiji Bottled Water. Record your results for both in Table 4.

Phosphate Test Strip

14. Locate the phosphate test strips. Being by dipping the test strip into the tap water for 5 se-

Table 4: *4 in 1 Test Results*

Water Sample	pH	Total Alkalinity	Total Chlorine	Total Hardness
Tap Water				
Dasani Bottled Water				
Fiji Bottled Water				

conds.

15. Remove the test strip from the water and hold horizontal, with the pad side up, for 45 seconds. Do not shake the excess water from the test strip.
16. Compare the results on the pad of the test strip with the color chart at the end of this lab. Record your results in Table 5.
17. Repeat the procedure for both Dasani and Fiji Bottled Water. Record your results for both in Table 5.

Table 5: *Phosphate Test Results*

Water Sample	Test Results
Tap Water	
Dasani Bottled Water	
Fiji Bottled Water	

Iron Test Strip

18. Locate the iron test strips. Begin by removing 70 mL of water from each beaker and discarding it, leaving a total of 30 mL within each of the three beakers.
19. Beginning with the tap water, open one foil packet and add the powder contents to the beaker. Cover the beaker with a piece of Parafilm and shake the beaker vigorously for 15 seconds.
19. Remove the Parafilm and dip the test pad of the iron test strip into the tap water sample, rapidly moving it back and forth under the water for 5 seconds.
20. Remove the strip and shake the excess water off. After 10 seconds, compare the test pad to the color chart at the end of this lab. If the color falls between two colors in the color chart, estimate your result. Record your results in Table 6 .
21. Repeat the procedure for both Dasani and Fiji Bottled Water. Record your results for both in Table 6.

Table 6: *Iron Test Results*

Water Sample	Test Results
Tap Water	
Dasani Bottled Water	
Fiji Bottled Water	

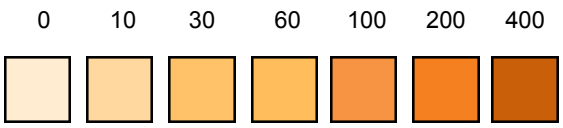
Questions

1. After comparing the results of tap water and bottled water, what major differences, if any, do you notice between the two?

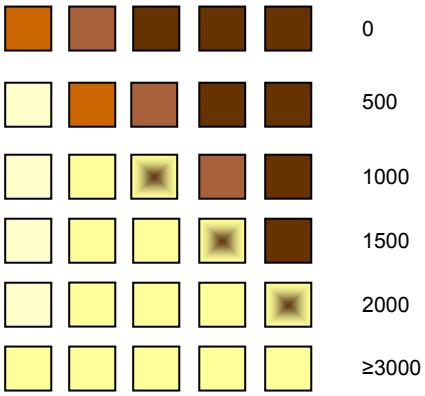
2. From your results, do you believe that bottled water is a healthier alternative when compared to tap water? Why or why not?

Test Strip Key:

Ammonia (mg/L):



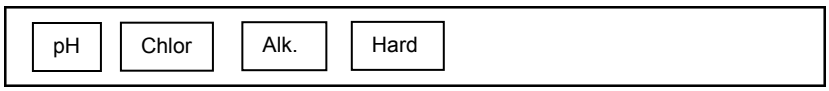
Chloride (mg/L):



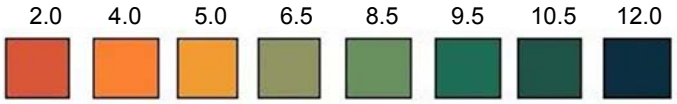
4-in-1 Test Strip:

*Note there are 4 pads on this test strip. From top to bottom (with the bottom of the strip being the handle), the pads are: pH, Chlorine, Alkalinity, and Hardness.

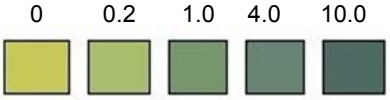
Example:



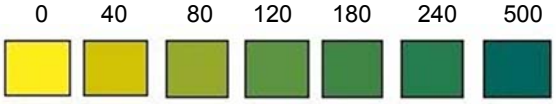
pH:



Total Chlorine (mg/L):



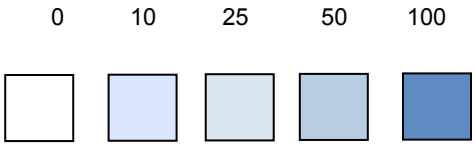
Total Alkalinity (mg/L):



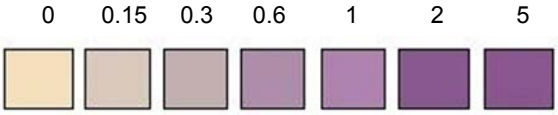
Total Hardness mg/L):

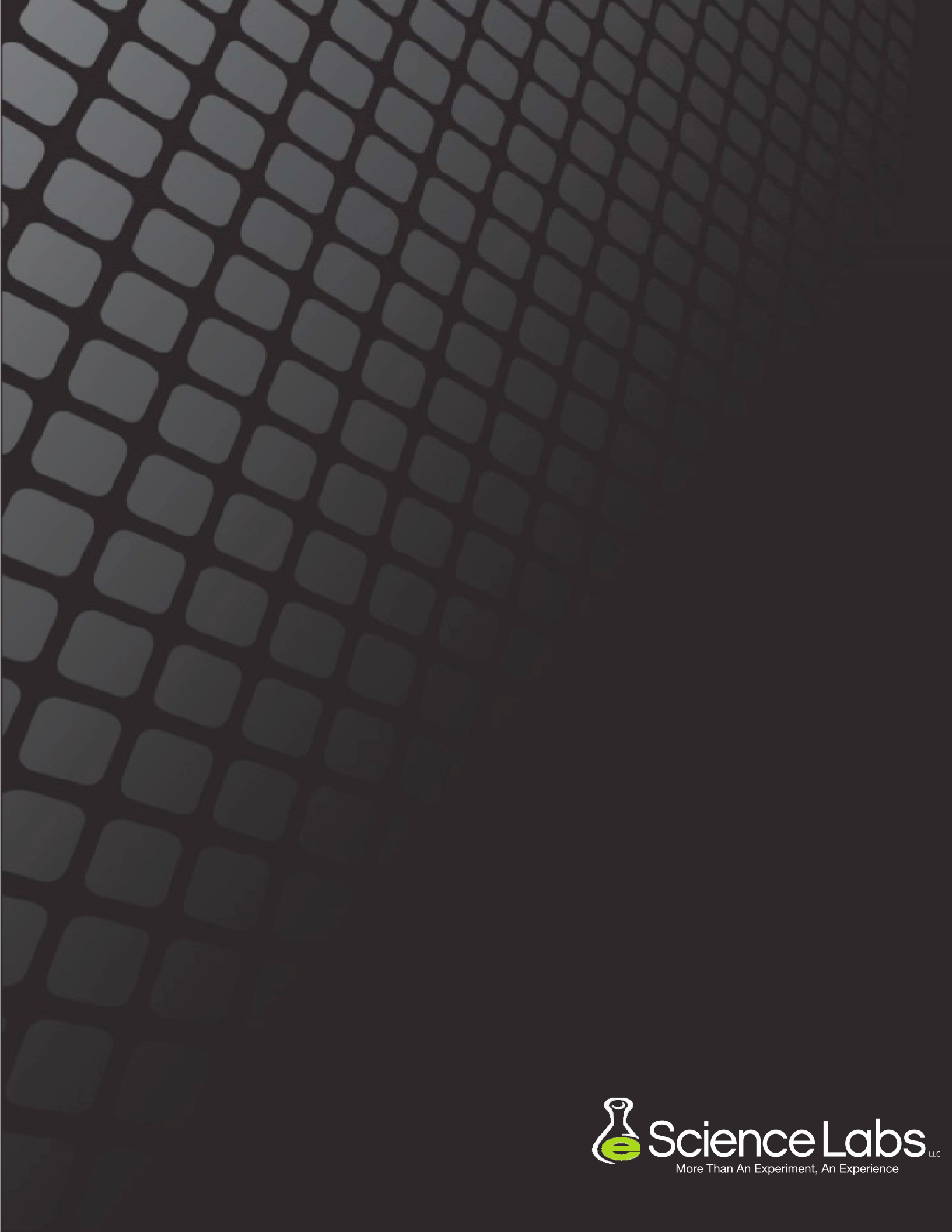
Test Strip Key (cont.):

Phosphate (ppm):



Total Iron (ppm):

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