WATER TREATMENT SOLUTIONS FOR HOMES

Description

Students learn about different water treatment methods to treat groundwater from private wells or to supplement treatment in public water systems. Students construct miniature filter devices and experiment to determine what type of treatment is most appropriate for different water contaminants.

Student Outcomes

Students will:

- Understand water treatment options for residences.
- Understand how an activated carbon filter works.
- Understand how ion exchange water softeners work.
- Decide what treatment option(s) is most appropriate for different water contaminants.

Student Products

- *Reading for Understanding Questions*
- *Water Treatment Lab Report*

Prerequisites

- Background Activity 3: *Source to Sink*
- Background Activity 4: *What's in Your Drinking Water?*
- Background Activity 5: *Reading Water Quality Reports*
- Background Activity 8: *Solution Concentrations*
- Background Activity 9: *Sampling and Monitoring*

National Standards

Subject Area Standards Covered: *Language Arts, Math, and Science.*
See Appendix D for the complete list of national content standards.

Teamwork Skills

Check to make sure that everyone understands.

Activity Timing

Time Estimate	Two 50-minute Class Periods
60 min	Prep Time: photocopying and activity set-up
Day 1	Introduction and Preparing Water Filters
Day 2	Treating and Testing a Water Sample

Materials

- Hydroville Journal

Day 1: Class Materials

Activated carbon (AC)

- One pound container of Activated Carbon Charcoal, 6-14 mesh
- 3-4 measuring teaspoons
- Large beaker or container

Water Softener (WS)

- 500 mL (2 ½ cups) water softener resin beads
- 3-4 measuring teaspoons
- Large beaker or container

Saturated NaCl solution (4 L/class)

- 4 L distilled water
- 150 g table salt (NaCl)
- Large container for mixing
- 15 wash bottles

Day 2: Class Materials

Contaminated water sample (1 L/class)

- 1 L distilled water
- 1 L Erlenmeyer flask or glass container with screw cap
- 1.0 g $MgSO_4$ (Epsom salt)
- 0.5 g potassium nitrate (KNO_3) or sodium nitrate ($NaNO_3$)
- 10 drops methylene blue
- Balance (measures to 0.1 g)

Soap solution

- Dr. Bronner's liquid soap
- 5 small beakers (25 or 50 mL)
- 15 disposable pipettes or eye droppers

Nitrate Test

- Nitrate Test Kit for Freshwater/Saltwater Aquariums (Brand: Aquarium Pharmaceutical) – contains 90 tests

For Day 1. Preparing Water Filters (per pair of students)

- Safety equipment: goggles, gloves, lab coat
- Two 20 mL syringes without needles (Brand: *Air-Tite Norm-Ject*)
- Pencil
- Two regular sized cotton balls
- Two large test tubes (25 mm diameter) and 1000 mL beaker **OR** Two 50 mL graduated cylinders
- Wash bottle with distilled water
- Small funnel
- Wash bottle with saturated salt solution
- Liquid waste container

For Day 2. Treating and Testing a Water Sample (per pair of students)

- Safety equipment: goggles, gloves, lab coat
- Activated carbon (AC) filter and water softener (WS) filter prepared on Day 1
- Eight small test tubes (16 mm diameter) in a test tube rack
- Four rubber stoppers to fit test tubes
- 10 mL graduated cylinder
- 25 mL graduated cylinder
- Wash bottle with distilled water
- Masking tape
- White sheet of paper
- Liquid waste container

Teacher Information

Read the Background Reading: *Water Treatment Solutions for Homes*.

This activity demonstrates various water treatment solutions available for use in homes. It uses many different materials, but is worth the effort. You will make a water sample that contains three common contaminants that may be found in any public water system or private well. The water sample will include the following contaminants represented by the chemical in parentheses.

- Organic chemical (Methylene blue – See Figure 1)
- Magnesium, Mg^{2+} (a component of hard water, Epsom salt)
- Nitrate, NO_3^-

Students will be able to see and test changes to water quality depending on what filter media they use and can determine what type of water treatment is most appropriate for different water quality problems.

- Activated carbon removes organic compounds, but not nitrate or hard water.
- An ion exchange resin (used in water softeners) removes positively charged ions of calcium (Ca^{2+}) and magnesium (Mg^{2+}) and replaces them with sodium ions (Na^+), but does not remove nitrate or organics.
- Reverse osmosis is typically used in homes with wells to remove nitrate (and also removes hard water minerals and organic compounds). However, we do not demonstrate reverse osmosis in this activity.

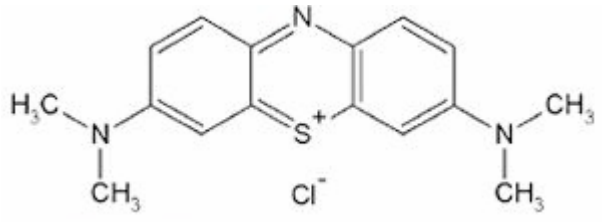

Figure 1. Methylene blue

Terminology

- Activated carbon (AC)
- Adsorption
- Distillation
- Ion exchange
- Negative control
- Reverse osmosis
- Positive control
- Point of use treatment device
- Point of entry treatment device
- Water softener (WS)

Suggested Lesson Plan

Getting Started

1. Purchase activated carbon from Fisher Scientific. One pound container of Activated Carbon Charcoal, 6 to 14 mesh (Fisher Scientific, www.fishersci.com, Product number 05-685A, about $41.00.

2. Purchase nitrate test kits for freshwater/saltwater aquariums which can also be found at a pet store in the fish department. You will need a test kit that can run at least 60 tests/class. The Aquarium Pharmaceutical brand works for nitrates.

3. Obtain about 500 mL of water softener resin beads per class. You can get them from local water softening professional services companies (e.g., Culligan).

4. You can purchase a pack of 100, 20mL syringes from Fisher Scientific for about $40.00. Brand: *Air-Tite Norm-Ject*, No. A20, order number: 14-817-32.

5. Prepare the materials and solutions for the Water Treatment Lab listed below. This can be done several days ahead of time.

6. **Create a saturated NaCl solution**
   a. Put 4 L distilled water into a large container.
   b. Add 150 g NaCl.
   c. Stir well for 2-3 minutes. Not all the salt will dissolve because the solution is saturated.
   d. For each pair of students, fill a wash bottle with saturated salt solution. **Do not pour undissolved salt into the wash bottle.** Label wash bottles "Salt Solution" for use on Day 1.

7. For each pair of students, fill a wash bottle with distilled water. Label the wash bottle "Distilled Water" for use on Day 1.

8. **Mix up a water sample of "contaminated water"**
   a. Add 1 L of distilled water to a 1 L Erlenmeyer flask or glass container with screw cap.
   b. Add the following and mix well:
      - 1.0 g MgSO4 (Epsom salt)
      - 0.5 g potassium nitrate or sodium nitrate
      - 10 drops of methylene blue

c. Seal container with lid until you are ready to use on Day 2. Label "Contaminated Water Sample".

9. **Soap solution**
   a. Pour about 50 mL of liquid soap solution into 5 beakers
   b. Place 3 disposable pipettes or eye droppers into beakers

10. Set up materials for Day 1. Preparing Water Filters.

11. **Homework:** Assign Background Reading: *Water Treatment Solutions for Homes* and Worksheet 1: *Reading for Understanding Questions*.

Day 1. Preparing Water Filters

Doing the Activity

1. **Journal Prompt-12** (TM-1):
   a. Name an example of a water treatment device that is used in homes.
   Answers will vary. Examples can include a water softener, Brita filter, Pur filter, Culligan filter, or reverse osmosis treatment.
   b. Why is this water treatment device used?
   A *water softener removes calcium and magnesium to make water "soft". A Brita filter, Pur filter, Culligan filter, or reverse osmosis treatment: all these remove contaminants such as organics, chlorine, lead, copper, etc.*

2. Divide students into pairs. They will work together for both Day 1 and Day 2.

3. Hand out Worksheet 2 to each pair of students. Review lab instructions and outcomes for Day 1. Students will prepare one activated charcoal (AC) filter and one water softener (WS) using 20 mL syringes, activated charcoal, water softener resin beads, and cotton balls. Then they will saturate the filters with distilled water and store for testing on Day 2.

4. Students should wear gloves, lab coat, and goggles while handling materials.

5. Have the class materials available in a central location:
   - Activated carbon (AC) with 3-4 teaspoons
   - Water softening (WS) resin beads with 3-4 teaspoons

Wrap-up

1. Students should seal their filters with the syringe plungers to prevent them from drying out.

2. Store filters upright in large test tubes for Day 2. Use as soon as possible so they don't dry out.

Day 2. Treating and Testing a Water Sample

Doing the Activity

1. Set up materials for Day 2. Students should work in the same pairs as in Day 1.

2. Show TM-2 to review ion exchange in water softeners.

3. Review lab instructions and outcomes on Worksheet 3 for Day 2. Students prepare neutral and positive controls and then test AC and water softener WS filters using the contaminated water sample.

4. Remind students to wear gloves, lab coat, and goggles.

5. Have the following class materials available in a central location:
   - Contaminated water sample
   - Nitrate test kit
   - Soap solution
   - A large container for liquid waste

Wrap-up

1. Cleanup:
   a. Students can dispose of liquid solutions down the drain.
   b. Spent activated charcoal can be put in the trash.
   c. A straightened paperclip or piece of stiff wire is useful to push the cotton ball out of the syringe. Cotton balls can go in the trash.
   d. Water softening resin is re-useable. Students can dump the resin into a designated waste container during class. Afterwards, store in a plastic reclosable bag. It is best to store the resin moistened.

2. Students complete Worksheet 3. *Water Treatment Report.*

Assessment

The following student products can be used for assessment:

Individual
- *Reading for Understanding Questions* (WS-1)

Group
- *Water Treatment Lab Report* (WS-4)

Resources

See the Hydroville Water Quality Curriculum Web Resources webpage for current links:
http://www.hydroville.org/links/wq_resources.aspx

Teacher Keys

Reading for Understanding Questions **(WS-1)**

1. After reading Water Quality Solutions for Homes, place an "X" in where the six different treatments are most effective. Leave other boxes blank.

Contaminants	Boiling	Distillation	Reverse Osmosis	Activated Carbon Filter	Water softener (Ion exchange)
Primary Standards					
Microorganisms	***X***	***X***			
Organic chemicals			***X***	***X***	
Inorganic chemicals					
Nitrate		***X***	***X***		
Copper		***X***	***X***		
Lead		***X***	***X***		
Secondary Standards					
Bad odors & Tastes			***X***	***X***	
Total Dissolved Solids (cloudiness)		***X***	***X***	***X***	
Hard Water (Mg & Ca)		***X***			***X***

2. What water treatment device should you use if an organic chemical is present in your drinking water well?
   Reverse osmosis or activated charcoal filters.

3. Your plumbing fixtures and pipes have mineral buildup, a sign of hard water. What water treatment method should you use to correct this problem?
   A water softener.

4. You live in the city and get your water from the public water system. You want to get rid of the bad taste and odor. What should you use?
   Distillation, reverse osmosis, or activated carbon filter.

5. Your household gets all its water from a private well. You live in an agricultural area and you are concerned about nitrates. A friend suggests you get an activated carbon filter. Do you follow the advice? Why or why not?
   No, activated carbon does not remove nitrates.

6. Which water treatment system is the most effective at improving water quality in homes? What are some disadvantages to this system?
   Reserve osmosis is the most effective water treatment system, but it is also relatively expensive for a point of entry system. The smaller devices can only treat 2-3 gallons per day.

Water Treatment Lab Report **(WS-4)**

Hypotheses *Answers will vary*

Results

Table 1. Testing for Organic Chemicals

Test Tube No.	Color	Contaminant Removed? (Y/N)
1 & 2	*Clear*	*NA*
3 & 4	*Red*	*N*
5 & 6	*Clear*	*Y*
7 & 8	*Red*	*N*

Table 2. Nitrate Testing

Test Tube No.	Nitrate Test Results	Contaminant Removed? (Y/N)
1	*0 ppm*	*NA*
3	*60 ppm**	*N*
5	*60 ppm**	*N*
7	*60 ppm**	*N*

**Nitrate levels will vary.*

Table 3. Water Hardness Testing

Test Tube No.	Soap Test Result (clear, bubbles/cloudy, no bubbles)	Contaminant Removed?(Y/N)
2	*Clear, bubbly*	*NA*
4	*Cloudy, no bubbles*	*N*
6	*Cloudy, no bubbles*	*N*
8	*Clear, bubbly (pink)*	*Y*

Conclusion Questions

1. Why did you test both a negative and a positive control?
   Negative control demonstrates what should be the result with nothing in the water. Positive control demonstrates what should happen when you know the contaminant is in the water.

2. Explain your results from the AC filter treatment.
   AC removes organic chemicals (food coloring). It does not remove nitrates or hard water minerals. The red color was removed but the tests for hard water and nitrate were positive.

3. Explain your results from the WS filter treatment.
   WS removed the magnesium, but not organic chemicals or nitrates. The test results for organic and nitrate was positive.

4. How did your results compare to your hypothesis?
   Answers will vary

Pages to Photocopy

Note: Unless indicated, make one copy per student of all Handouts. For ease of photocopying, Transparency Masters appear first in the student pages.

Handouts and Transparency Masters

Day	What is Needed	Type*
HW	*Water Treatment Solutions for Homes*	BR
	Reading for Understanding Questions	WS-1
1	*Journal Prompt-12*	TM-1
	Water Treatment Lab – Day 1	WS-2
2	*Water Treatment Lab – Day 2*	WS-3
	Ion Exchange in the Water Softening Process	TM-2
	Water Treatment Lab Report	WS-4

* Type = Transparency Master (TM), Background Reading (BR), Worksheet (WS)

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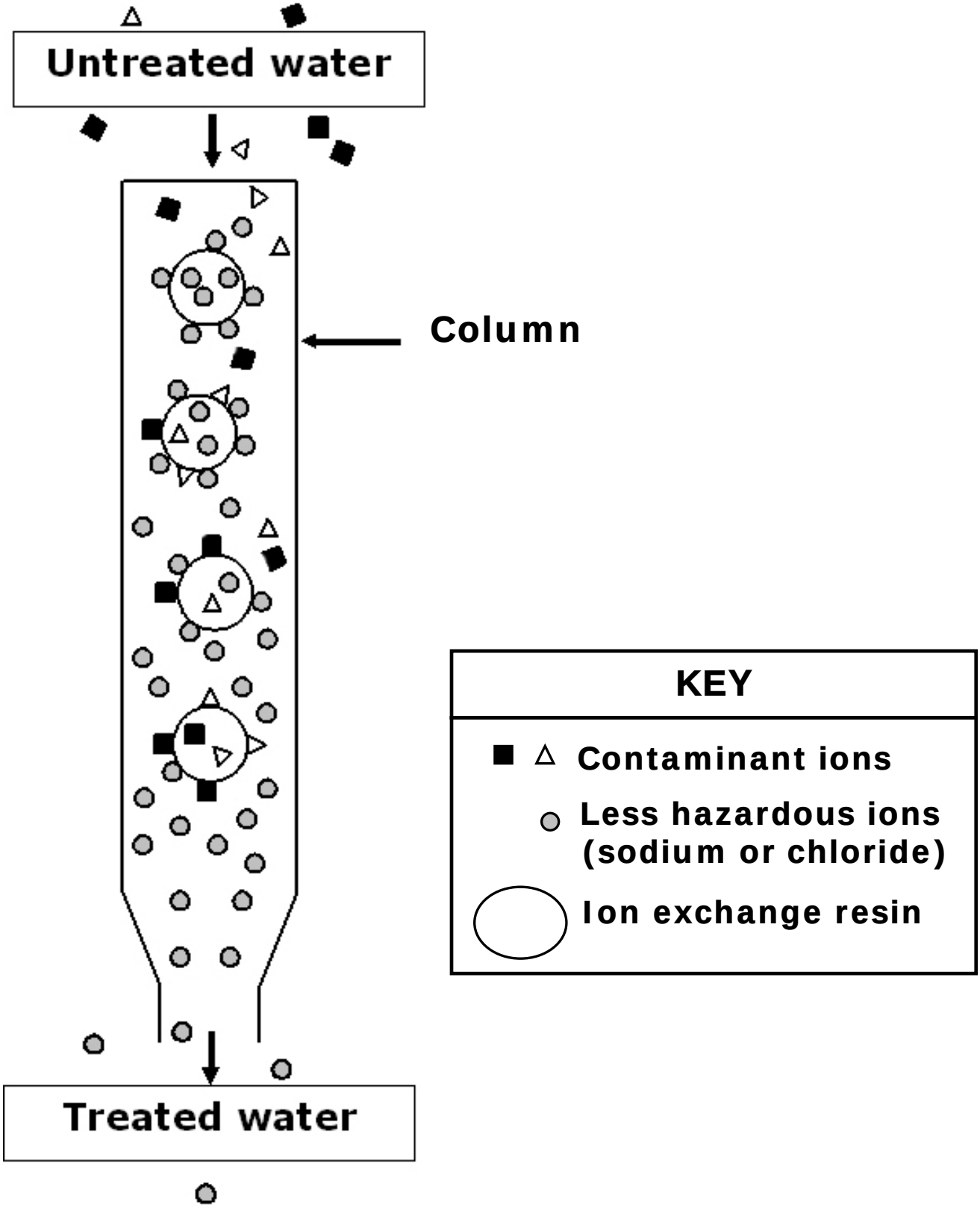
JOURNAL PROMPT-12

1. **Name an example of a water treatment device that is used in homes.**

2. **Why is this treatment device used?**

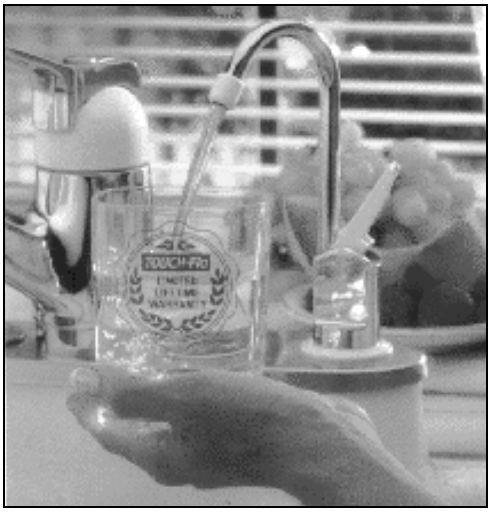
ION EXCHANGE IN A WATER SOFTENER



Name_____
Date_____Period____

BACKGROUND READING: WATER TREATMENT SOLUTIONS FOR HOMES

Household water treatment devices are increasing in popularity. You may even have one in your home attached to your kitchen faucet or a pitcher which you fill with tap water. A water filter is just one example of a household water treatment system.



Why should I treat water at my house?

People treat their water at home for several reasons:

- *To remove contaminants introduced into the water from the distribution system.*

  Water distribution systems and household plumbing can introduce lead, a known health hazard, or copper that can stain sinks and tubs.

- *To supplement the treated water that comes from the treatment plant.*

  Although treated water is safe to drink, chlorine, iron, or other non-hazardous impurities can cause water to taste or smell bad. Some water sources naturally contain high concentrations of calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions and are known as **hard water**. Hard water reduces the cleaning action of soap and causes mineral buildup on faucets, hot water pipes, and water heaters. This mineral buildup may eventually clog pipes and reduce water pressure.

- *To treat groundwater from a private well.*

  Individuals who get their drinking water from a well should be aware that disease-causing microorganisms (usually coliform bacteria), chemical contaminants such as nitrates, pesticides, or total dissolved solids can get into the groundwater from the well.

How do I treat my water?

Treatment devices are usually one of two types:

1. **Point-of-Entry Treatment Device:** Water is treated before it enters the home. As a result, treated water comes from every faucet, showers, toilets, and laundry.

   Advantage: All of the household water is treated so if there are problems such as lead, copper, or bad odors these will be addressed at every point where water is used in the home.

   Disadvantage: These systems are costly because they treat very large volumes of water.

2. **Point-of-Use Treatment Device:** A water treatment device applied to a single tap to reduce contaminants in the drinking water at the one faucet. A pitcher filter system can also treat tap water.

   Advantage: These systems are economical.

   Disadvantage: If there is a problem such as bad odors, it will not be treated at other faucets in the home. These systems may only be able to treat 2-5 gallons/day.

Name_____
Date_____Period____

What water treatment options do I have?

Treatment	How it Works	Removes	Cost
 **Boiling**	Boiling kills microorganisms, but does not remove other contaminants. This treatment is typically used for water quality emergencies only. It is inconvenient and costly to do on a daily basis for large volumes of water.	• kills microorganisms	Energy to heat water
 **Distillation**	**Distillation** devices purify by heating water, collecting the condensed, purified water, and leaving contaminants behind. High temperatures kill microbes. This process can be slow and costly due to high energy use. It is not commonly used. Distillation systems can be point of use devices located at a kitchen sink. Treats 2-3 gallons per day.	• kills microorganisms • organic chemicals • inorganic chemicals • bad odors and tastes	Cost of device $100-$300 Energy to run device
 **Reverse Osmosis (RO)** 	**Reverse osmosis (RO)** uses high pressure to force water through a special membrane. The membrane has microscopic pores that allow water molecules to pass through, while trapping larger molecules. RO is reliable, low maintenance, but requires replacement of filters and membranes. These systems can remove the most types of contaminants, but are not a reliable method for disinfection. A common RO device is a point of use device located near the kitchen sink which can treat 50 gallons per day.	• organic chemicals • inorganic chemicals • Total Dissolved Solids (cloudiness)	Sink model $300-500 Home system $1,000 - $2,500 Replace-ment membrane $80 - $100
 **Activated Carbon (AC) Filters*** 	**Activated charcoal (AC)** filters contain very porous carbon material that is similar to charcoal. AC filters are either granular AC particles or a solid carbon block. **Adsorption** causes contaminants to adsorb or stick to the carbon material. Once the adsorption sites are full, the filter becomes ineffective and must be replaced regularly. These filter systems are typically point of use, located under a kitchen sink, attached to the faucet, and most commonly found in pour-through pitchers.	• organic chemicals • bad odors and tastes • Total Dissolved Solids (cloudiness)	Pour-through pitchers $30 Filters $10 Sink model $150-$400 Filters $50-$100

* Most activated carbon systems also contain other filter media that remove lead, chlorine, and other contaminants.

Name_____
Date_____Period____

Treatment	How it Works	Removes	Cost
 **Ion Exchange** **(Water Softener)**	A **water softener (WS)** is the most common example of an **ion exchange** system. A water softener consists of a large canister packed with tiny resin beads. These beads hold sodium ions (Na^+) on their surface. As water passes around the beads, the $Ca^{2+}$and Mg^{2+} ions in the water stick to the beads and are exchanged for Na^+ ions. Water softeners are typically point-of-entry systems which treat all the water in a home. WS requires very little maintenance, only the addition of NaCl every few weeks.	• calcium (Ca^{2+}) ions • magnesium (Mg^{2+}) ions	WS $400-$700 WS resin $100 Salt pellets $3.50-5.00 for a 40-pound bag Energy to run device

What about bottled water?

If your home has water quality problems and you don't want to add a water treatment system, you could purchase bottled water. Although purchasing bottles of water is convenient, it can be costly when used as the main drinking water source for an entire family. A gallon of bottled water costs about $3.50, but a gallon of tap water costs about five cents. In addition, the production, transportation, and recycling of the bottles requires a lot of energy.

If your home has water quality problems, a better alternative to purchasing small plastic bottles of water is to fill your own large container at treated drinking water refill stations often found at grocery stores or to purchase water supplied by drinking water distributors. Professional water services supply large 5-gallon containers of purified water and reuse the containers many times. However, delivered water is an extra expense and consumes fuel for delivery of the water.

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Name_____
Date_____Period____

WORKSHEET 1: READING FOR UNDERSTANDING QUESTIONS

1. After reading *Water Quality Solutions for Homes*, place an "X" in where the six different treatments are most effective. Leave other boxes blank.

Contaminants	Boiling	Distillation	Reverse Osmosis	Activated Carbon Filter	Water softener (Ion exchange)
Primary Standards					
Microorganisms					
Organic chemicals					
Inorganic chemicals					
Nitrate					
Copper					
Lead					
Secondary Standards					
Bad odors & tastes					
Total Dissolved Solids (cloudiness)					
Hard Water (Mg & Ca)					

2. What water treatment device should you use if an organic chemical is present in your drinking water well?

3. Your plumbing fixtures and pipes have mineral buildup, a sign of hard water. What water treatment method should you use to correct this problem?

4. You live in the city and get your water from the public water system. You want to get rid of the bad taste and odor. What should you use?

5. Your household gets all its water from a private well. You live in an agricultural area and you are concerned about nitrates. A friend suggests you get an activated carbon filter. Do you follow the advice? Why or why not?

6. Which water treatment system is the most effective at improving water quality in homes? What are some disadvantages to this system?

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Name_____
Date_____Period____

WORKSHEET 2: WATER TREATMENT LAB – DAY 1

Introduction

You and a partner will prepare two water treatment devices that are commonly found in homes – an activated carbon (AC) filter and an ionic exchange (water softener) filter. On Day 2, you will be using the filters you made to treat a sample of contaminated water.

Materials (per pair of students)

- Safety equipment: goggles, gloves, lab coat
- 2 20 mL syringes
- Pencil
- 2 regular-sized cotton balls
- 2 large test tubes (25 mm x 220 mm)
- 1000 mL beaker
- Wash bottle with distilled water
- Small funnel
- Wash bottle with saturated salt solution
- Liquid waste container

Class Materials

- Activated carbon (AC)
- Water softening (WS) resin beads

Day 1. Preparing Water Filters

1. Work together with a partner. Be sure to wear your gloves, goggles, and lab coat at all times.

Figure 1. Saturating cotton balls in syringes with distilled water

2. **Preparing Two Syringes ("filters")**

   a. Remove the plungers from two 20 mL syringes and set aside for later. If the syringes have caps over their tips, remove these, and set aside.

   b. Using the non-writing end of a pen or pencil, gently push one cotton ball to the bottom of each syringe. **Do not pack tightly**.

   c. Set each syringe in a large test tube. Both test tubes should stand upright in a 1000 mL beaker.

   d. Using the distilled water wash bottle, saturate each cotton ball. This prevents air bubbles from getting trapped in the cotton ball later. See Figure 1.

   e. Allow water to drain into large test tubes. Then discard water into liquid waste container.

Name_____
Date_____Period____

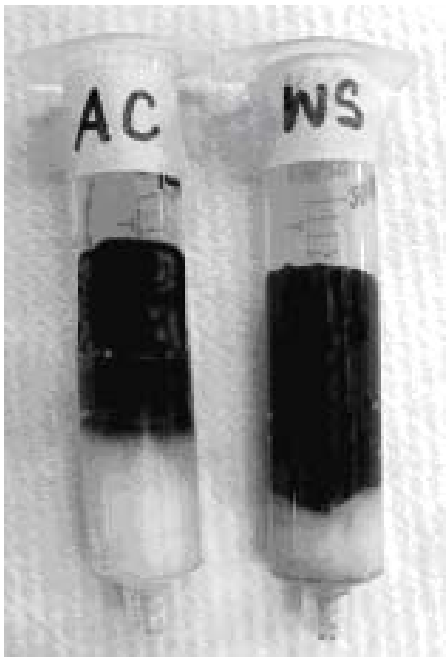

Figure 2. Syringes representing activated charcoal (AC) and water softener (WS) filters

3. **Preparing the Activated Charcoal (AC) Filter**
   a. Using a small funnel, add 2 teaspoons of AC to one syringe. (See Figure 2)
   b. Rinse any AC dust from the funnel into the syringe with your distilled water wash bottle.
   c. Slowly saturate the AC in the filter with distilled water to pre-moisten the filter and improve water flow.
   d. Continue rinsing the AC until the water runs out clear at the bottom.
   e. Dump out the water from the test tube into the liquid waste container.
   f. Replace the tip cap at the bottom of the syringe.
   g. Replace the plunger into the top of the syringe. Do not push down.
   h. Store syringe upright in test tube and set in beaker. (See Figure 3)

4. **Preparing the Water Softener (WS) Filter**
   a. Using the funnel, add 2 teaspoons of WS resin beads to the other syringe. (See Figure 2)
   b. Gently rinse any beads
   c. Slowly saturate the beads in the filter with the **salt water solution** to recharge the resin so that is full of Na ions.
   d. Rinse the beads at least five more times with the saturated salt water solution.
   e. Rinse the beads with distilled water at least five times.
   f. Dump out the water from the test tube into the liquid waste beaker.
   g. Replace the tip cap at the bottom of the syringe. Replace the plunger into the top of the syringe. Do not push down.
   h. Store syringe upright in test tube and set in beaker. (See Figure 3)

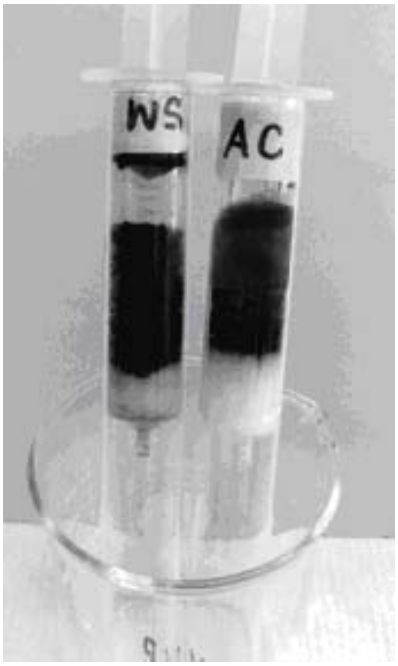

Figure 3. Prepared syringes ready for Day 2

5. **Clean Your Area and Prepare for Day 2**
   a. Label the beaker with your name and class period.
   b. Place your filters in a safe location where they will not be disturbed.

Name_____
Date_____Period____

WORKSHEET 3: WATER TREATMENT LAB – DAY 2

Introduction

You and your partner will use the AC and WS filters that you made on Day 1 to treat a contaminated water sample. The water sample contains three contaminants:

- Organic chemical
- Magnesium (Mg^{2+}, a component of hard water)
- Nitrate (NO_3^-)

After treating the water using the water filters, you will test the treated water to check if the contaminants were removed. You will also test a **negative control** (distilled water ONLY) and a **positive control** (contaminated water). You will compare your treated water results to the negative and positive controls. You and your partner will develop hypotheses about your treatment methods and the test results you expect to observe.

Materials (per pair of students)

- Activated carbon (AC) filter and water softener (WS) filter prepared on Day 1
- 8 small test tubes (16 mm diameter) in a test tube rack
- 4 rubber stoppers to fit test tubes
- 10 mL graduated cylinder
- 25 mL graduated cylinder
- Wash bottle with distilled water
- Masking tape
- 100 mL beaker
- 100 mL graduated cylinder
- White sheet of paper
- Worksheet 3: *Water Treatment Lab Report*

Class Materials

- Contaminated water sample
- Nitrate test kit
- Soap solution
- Liquid waste container

Part I. Preparing Controls

1. With your partner, write down your hypotheses on Worksheet 3. What contaminants do you predict each of the filters will remove?

2. Set up eight test tubes in a test tube rack. Label your test tubes 1 through 8 using masking tape. These will represent the following:

Test Tube No.	Treatment
1 & 2	distilled water (negative control)
3 & 4	contaminated water sample (positive control)
5 & 6	AC filtered water
7 & 8	WS filtered water

Name_____
Date_____Period____

3. Use a 10 mL graduated cylinder to measure 5 mL distilled water. Pour 5 mL into test tube 1 and another 5 mL into test tube 2. This is your **negative control** (distilled water ONLY).

4. Use tape to label a 100 mL beaker "contaminated water sample." Use a 100 mL graduated cylinder to measure 60 mL of contaminated water and pour into beaker.

5. Measure 5 mL of the contaminated water sample into test tube 3 and another 5 mL into test tube 4. This is your **positive control** (contaminated water).

   Note: You will compare your treated water samples to the negative and positive controls.

6. Rinse out the graduated cylinder with distilled water.

Part II. Treating the Water Sample

1. Remove the plungers and tip caps from the syringes (activated charcoal and water softener filters). Be sure that the test tubes beneath the filters are empty.

2. Use a 100 mL graduate cylinder to measure 25 mL of contaminated water. Slowly pour the water sample into the AC filter. You may need to do this in several small batches. Collect the filtered water in the large test tube and save.

3. Pour 5 mL AC filtered water from the large test tube into test tube 5 and another 5 mL into test tube 6.

4. Rinse out the graduated cylinder with distilled water.

5. Slowly pour 25 mL of contaminated water into the water softener filter. Again, you may need to do this in several small batches. Collect the filtered water in the large test tube and save.

6. Pour 5 mL of the WS filtered water into test tube 7 and another 5 mL into test tube 8.

Part III. Testing the Treated Water

Testing Organic Chemicals

1. Hold a sheet of white paper behind the test tube rack.

2. Compare the colors of the distilled water, contaminated water, AC filtered, and water softener filtered water. Observe if the red food color (organic chemical) has been removed from the water.

3. Record your observations in Table 1 on Worksheet 3.

Name_____
Date_____Period____

Nitrate Testing

1. Test the untreated water (test tubes 1 & 3) and treated water (test tubes 5 & 7) for nitrate.

2. Follow the nitrate test directions provided by your teacher. Observe test results to determine if nitrate has been removed.

3. Compare your results and record your observations in Table 2 on Worksheet 3.

Water Hardness Testing

1. Test the untreated water (test tubes 2 & 4) and treated water (test tubes 6 & 8) for water hardness.

2. Add 2 drops of soap solution to test tubes 2, 4, 6 and 8. Securely place rubber stopper in each test tube.

3. Gently shake the test tubes. Make observations.
   - If the magnesium has been removed, the water remains clear and will form bubbles.
   - If magnesium is present, the water becomes cloudy (soap scum) and does not form bubbles.

4. Compare your results and record your observations in Table 3 on Worksheet 3.

5. Complete Conclusion Questions on Worksheet 3.

6. Follow your teacher's instructions to clean up after this experiment.
   a. Dispose of liquid solutions down the drain.
   b. Place used activated charcoal in the trash.
   c. Use a straightened paperclip or piece of stiff wire to push the cotton ball out of the syringe. Toss in the trash.
   d. Water softening resin is re-useable. Dump the resin into a designated waste container for re-use.

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Name_____
Date_____Period____

WORKSHEET 4: WATER TREATMENT LAB REPORT

Hypotheses

Based on what you know about activated carbon and water softener ion exchange resins complete the following statement to write your hypothesis for each filter. What do you think is going to happen?

We think that the activated carbon filter will remove [*insert contaminant(s)*] because …

We think that the ion exchange filter (water softener) will remove [*insert contaminant(s)*] because …

Results

KEY

Test Tube No.	Treatment
1 & 2	distilled water (negative control)
3 & 4	contaminated water (positive control)
5 & 6	AC filtered water
7 & 8	WS filtered water

Table 1. Testing for Organic Chemicals

Test Tube No.	Color	Contaminant Removed? (Y/N)
1 & 2		NA
3 & 4		
5 & 6		
7 & 8		

Name_____
Date_____Period____

Results – continued

Table 2. Nitrate Testing

Test Tube No.	Nitrate Test Results	Contaminant Removed? (Y/N)
1		NA
3		
5		
7		

Table 3. Water Hardness Testing

Test Tube No.	Soap Test Result (clear, bubbles/cloudy, no bubbles)	Contaminant Removed? (Y/N)
2		NA
4		
6		
8		

Conclusion Questions

1. Why did you test both a negative and a positive control?

2. Explain your results from the AC filter treatment.

3. Explain your results from the WS filter treatment.

4. How did your results compare to your hypothesis?