

# Water Filtration

**Brief Overview of Lesson:** This lesson is presented for 6<sup>th</sup>, 7<sup>th</sup>, & 8<sup>th</sup> grade classes as one section on environmental engineering. The lesson is intended teach students the importance of clean water, how to create individual water filters, or how to use the engineering design process to create a chlorine focused filtration system.

**Prior Knowledge Required:** 6<sup>th</sup> grade – None, 8<sup>th</sup> grade - prior knowledge of the water cycle, groundwater movement and how current day municipal water treatment plants operate.

**Estimated Time:** 160 mins (4 classes)

**Objectives:** By the end of the section, you should be able to:

- (a) Describe the effects humans have on the quality of water on Earth.
- (b) Apply the steps of the engineering design process while designing and building prototype devices to filter contaminants from a liquid solution.
- (c) Create and evaluate multiple water filters.

**Standard(s)/Unit Goal(s) to be addressed in this lesson:**

Topic	STE Standard
Sustainability: Water Filtration	ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution. Include potential impacts on people and the natural environment that may limit possible solutions; ETS2-2. Given a design task, select appropriate materials based on specific properties needed in the construction of a solution; ETS1-5. Create visual representations of solutions to a design problem. Accurately interpret and apply scale and proportion to visual representations.*

## Resources for Lesson:

### 6<sup>th</sup> Grade Teacher Materials

#### The following materials are needed by the teacher:

- 1 L of dirty water (mix 1 teaspoon of finely pulverized soil/dirt in 1 L of tap water in a large container)
- 2-3 drops of food coloring (red or blue)
- 1 large plastic spoon
- Scissors
- Coffee filter
- Rubber band
- 9oz. plastic cup
- 16oz. clear plastic water bottle, with bottom cut off
- 1 domed "slushie" lid (can substitute another 9oz. plastic cup, with a hole cut in the bottom)
- 1 permanent marker\*
- Approximately ½ cup of aquarium pebbles, washed (refill: can be purchased at discount pet store)
- Approximately ½ cup fine aquarium sand, washed (refill: can be purchased at discount pet store)
- Approximately 2-3 tablespoons of activated granular charcoal (refill: can be purchased at discount pet store)
- 1 plastic colander for separating filter materials to reuse in future labs
- Supply of fresh tap water\*

## Student Materials

#### Each team of 4 students should have:

- 100 mL of dirty water in a plastic cup
- 1 clear 16oz. water bottle with the bottom cut off\*
- 1 9oz. plastic cup (to collect filtered water)
- 1 domed "slushie" lid (can substitute another 9oz. plastic cup, with a hole cut in the bottom)
- 1 coffee filter
- 1 rubber band
- 1 sheet of plain white paper\*
- Supply of paper towels for potential spills\*
- 4 copies of the Student Activity Packet
- 4 pairs of safety goggles\*

#### Access to the following filtering materials for use in their filter apparatus:

- Cheese cloth
- Cotton balls\*
- Cotton cloth\*
- Panty hose\*
- ScotchBrite pad\* (or any flat green scouring pad)
- Supply of aquarium pebbles, washed
- Supply of fine aquarium sand, washed•
- Supply of activated granular charcoal

## 8<sup>th</sup> Grade Materials

### Each group needs:

- 1.5 foot (.46 m) plastic tubing or PVC pipe with 1.5 inch (3.81 cm) or greater inner diameter; available at hardware stores (see Figure 1, which shows an example tube that is longer than 1.5 feet; it is recommend to cut tubes to 1.5 feet to avoid difficulties in removing filter materials)
- 2 250-ml beakers
- 50-100 ml chlorinated water; this 200 ppm solution is prepared by the teacher using Clorox® germicidal bleach; see instructions in the Procedure section
- 50-ml graduated cylinder
- plastic spoon, to load sands and activated carbon
- sieve, to separate small materials
- lab safety gloves, one pair per student per day, such as disposable nitrile gloves available at [http://www.amazon.com/s/ref=nb\\_sb\\_noss\\_1?url=node%3D4954444011&field-keywords=disposable+nitrile+gloves&rh=n%3A4954444011%2Ck%3A%3Adisposable+nitrile+gloves](http://www.amazon.com/s/ref=nb_sb_noss_1?url=node%3D4954444011&field-keywords=disposable+nitrile+gloves&rh=n%3A4954444011%2Ck%3A%3Adisposable+nitrile+gloves)
- lab book or notebook, one per student; alternatively, have students record all necessary information throughout the activity on blank sheets of paper and staple them together to serve as a lab "book" for the activity
- safety goggles, enough so that each student in a team can wear goggles while handling and testing the chlorinated solution
- [Engineering Design Process and Water Filtration Pre/Post-Test](#), two per student
- [Engineering Design Report Scoring Rubric](#), one per student

### To share with the entire class:

- activated carbon, either granules or pellets; for cleanup, pellets are easier to separate with a sieve at activity end; see material life expectations note, below
- filter media, such as cotton balls, fish filter media, carbon infused filter media, 50 micron felt pad, cheesecloth, cotton cloth or whatever is available
- fine-grained sand
- (for teacher use only!) Clorox® germicidal bleach; used to make a chlorinated water solution; 2 teaspoons bleach per gallon of water
- pitcher or other container large enough to hold a gallon of water, for preparing the chlorinated water
- "free" and total low-level chlorine water quality test strips, such as Hach's "Free & Total Chlorine Test Strips, 0-10 mg/l," 50 strips, 0-10 ppm, for \$16.65 at <http://www.hach.com/free-total-chlorine-test-strips-0-10-mg-l/product-details?id=7640211603>
- sanitizer-strength chlorine test strips, such as LaMotte's "4250-BJ sanitizer strength chlorine test strips," 200 strips, 0-200 ppm, for \$7.10 from Cole-Parmer at [http://www.coleparmer.com/Product/LaMotte\\_4250\\_BJ\\_Chlorine\\_Test\\_Strips\\_Sanitizer\\_Strength/EW-99532-31?referred\\_id=20965&gclid=CPPEiLDcgMYCFYgAaQod5SMAVg](http://www.coleparmer.com/Product/LaMotte_4250_BJ_Chlorine_Test_Strips_Sanitizer_Strength/EW-99532-31?referred_id=20965&gclid=CPPEiLDcgMYCFYgAaQod5SMAVg)
- stopwatch
- sink, tap water, soap, towels

Note: A pound of activated carbon can remove 200 ppm chlorine from 843 gallons, as calculated from <http://www.waterprofessionals.com/process-water/dechlorination.html>. Thus, a supply of activated carbon is reusable for several years of experiments.

### Targeted Academic Language

<b><i>Vocabulary</i></b>	<b><i>Definition</i></b>
Aeration	Mixing air with a substance.
Anthropogenic:	Caused or produced by humans.
coagulation	The clumping of a material into larger particles. Example: Blood coagulates to stop a cut from bleeding.
Nutrient	A substance that, when consumed, aids in growth and energy.
Pollutant	Any substance, as certain chemicals or waste products, that renders the air, soil, water, or other natural resource harmful or unsuitable for a specific purpose.
Prototype	A first attempt or early model of a new product or creation. May be revised many times
Sediment	Any particulate matter that can be transported by fluid flow, and which eventually is deposited as a layer of solid particles on the bed or bottom of a body of water or other liquid.
Sphagnum moss	Mosses of the genus Sphagnum that grow in wet or hydric soil and whose decomposed remains together with other material form peat.
Water Filtration	A process that removes impurities from water by means of a fine physical barrier, chemical processes, and/or biological process.

### Sources:

1. [https://www.teachengineering.org/activities/view/wpi\\_protect\\_activity1](https://www.teachengineering.org/activities/view/wpi_protect_activity1)
2. <http://safewaterscience.org/>
3. [www.tryengineering.org](http://www.tryengineering.org)