Key: Yellow highlight = required component

Clean up your Water!

Subject Area(s) **Biology, Life Science, Science and Technology** (Select from TE Subject Areas)

Associated Unit **What's in your water?**

Lesson Title **Clean up your water!**

Header

Image 1 **Image file:** ___? **ADA Description:** ___? *(Write as if describing the image to a blind person; do not repeat any caption content.)* **Source/Rights:** Copyright © ___? **Caption:** ___?

Grade Level **12** (8-12)

Lesson # _2_ of _2_

Lesson Dependency **What's in your water?**

Time Required **90** minutes

Summary

In the previous lesson, students first discussed the types of substances that may be found in a given sample of water and then examined the biota in a sample of pond water using a compound light microscope. In this lesson students discuss and then learn how water is treated for the substances of concern. Then they are challenged to design their own water treatment system to clean a "contaminated" sample of water.

When discussing the types of pollutants found in water, add the following to a bin of clean water: dirt and leaves, food coloring, cheap perfume or essential oil, and pool chlorine to simulate suspended solids, sludge, and other water pollutants.

Students are given a water bottle with the bottom removed. They are also given $7 imaginary dollars to buy supplies for their water treatment system. These supplies may include fine and coarse grain sands, coffee filters, cotton balls, and activated carbon. Each material has a cost associated, with activated carbon being the most expensive. The $7 are not quite enough to buy all of the materials, and it may be preferable to buy a larger quantity of some materials over others. The teams much successfully remove debris, color, odor, and chlorine (evaluated with chlorine test strips) from a 100 mL sample of "polluted" water. The winning team will be the first to obtain 80 mL of "clean" water in the shortest amount of time.

Engineering Connection

Water used for municipal, industrial, and agricultural purposes must all be treated before returning to the natural water cycle. Engineers need to design water treatment systems that can handle multiple water quality constituents. They also need to take into account time and cost. This includes accounting for the cost of materials as well as the time necessary to assemble the treatment apparatus. An additional optimization goal is obtaining the fastest treatment time while still providing sufficient contact time with each type of filter media.

Engineering Category = 3

Choose the category that best describes this lesson's amount/depth of engineering content:

1. Relating science and/or math concept(s) to engineering
2. Engineering analysis or partial design
3. Engineering design process

Keywords
Water, water quality, water treatment, activated carbon, filtration

Educational Standards (List 2-4)
Source, year, standard number(s)/letter(s), grade band and text (its unique ID# is optional)
State STEM Standard (required)

Texas: Science [2010] ...show

- Subchapter C. High School (9-12) ...show
(69 lessons/activities/units aligned)

  - Environmental Systems (11-12) ...show
  (5 lessons/activities/units aligned)

    - Science concepts. The student knows the impact of human activities on the environment. The student is expected to: (11-12) ...show
    (5 lessons/activities/units aligned)

      Current Standard:
      - identify causes of air, soil, and water pollution, including point and nonpoint sources; (11-12)

      (no curriculum aligned)

      Current Standard:
      - investigate the types of air, soil, and water pollution such as chlorofluorocarbons, carbon dioxide, pH, pesticide runoff, thermal variations, metallic ions, heavy metals, and nuclear waste; (11-12)

      (no curriculum aligned)

    - Scientific processes. The student uses scientific methods during laboratory and field investigations. The student is expected to: (11-12) ...show
    (no curriculum aligned)

      Current Standard:
      - follow or plan and implement investigative procedures, including making observations, asking questions, formulating testable hypotheses, and selecting equipment and technology; (11-12)

      (no curriculum aligned)

  - Aquatic Science (10-12) ...show
  (5 lessons/activities/units aligned)

    Current Standard:
    - Science concepts. The student knows the origin and use of water in a watershed. The student is expected to: (10-12)

    (no curriculum aligned)

    Standard's Subset:

- identify factors that contribute to how water flows through a watershed; and (10-12) ...show

(no curriculum aligned)

- identify sources and determine the amounts of water in a watershed, including rainfall, groundwater, and surface water; (10-12) ...show

(no curriculum aligned)

- identify water quantity and quality in a local watershed. (10-12) ...show

(no curriculum aligned)

ITEEA Standard (required)

- The Nature of Technology (K-12) ...show
(556 lessons/activities/units aligned)
  - Standard 2. Students will develop an understanding of the core concepts of technology. (K-12) ...show
  (143 lessons/activities/units aligned)
    - In order to comprehend the core concepts of technology, students should learn that: (K-12) ...show
    (142 lessons/activities/units aligned)

Current Standard:
- BB. Optimization is an ongoing process or methodology of designing or making a product and is dependent on criteria and constraints. (9-12)

Current Standard:
- DD Quality control is a planned process to ensure that a product, service, or system meets established criteria. (9-12)

Current Standard:
- W. Systems thinking applies logic and creativity with appropriate compromises in complex real-life problems. (9-12)

Current Standard:
- Z. Selecting resources involves trade-offs between competing values, such as availability, cost, desirability, and waste. (9-12)

NGSS Standard (strongly recommended)

- Disciplinary Core Ideas (K-12) ...show
(4 lessons/activities/units aligned)
  - Optimizing the Design Solution (K-12) ...show
  (no curriculum aligned)

Current Standard:
- Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (9-12)

(no curriculum aligned)

CCSS Standard (strongly recommended)

Pre-Requisite Knowledge

- Have basic understanding of common water contaminants and general understanding of what environmental engineers do
- Prior completion of "what's in your water?" lesson

Learning Objectives

After this lesson, students should be able to:

- **Explain the basic processes of drinking and wastewater treatment and what substances they are designed to treat for**
- **Design their own water treatment system for several substances at a competitive cost**
- **Understand the concept of filter pore size and its influence on successful water treatment**
- **Understand adsorption to activated carbon**

Introduction / Motivation

We learned before what is in the water, now let's treat it!

What are some situations in which humans want to treat water? *Students will generate a list of several scenarios.*

Next have students create a Venn diagram of the substances (or pollutants) that need to be treated in wastewater, drinking water, or both.

Afterwards, go over the steps in both drinking and wastewater treatment processes using notes or internet videos. Tell students they will need this information in order to design the best treatment system.

Lesson Background & Concepts for Teachers

Water treatment is a necessary process employed before discharging wastewater back into the hydrologic system and before using water for human consumption. The processes of drinking and wastewater treatment are fairly similar in that they both involve steps for pretreatment, clarification, sedimentation and disinfection. Additional steps are often necessary for wastewater treatment due to higher concentrations of water quality constituents. Drinking water treatment also includes steps for fluoride addition. Common substances to be treated are dissolved and suspended solids, bacteria, chlorine, and heavy metals.

Sand is necessary to remove the large debris and dirt from the sample and should be the top layer. The color, odor, and chlorine can all be removed by activated carbon due to its enormous surface area. In order to fully remove these species, a double order of activated carbon is necessary. Many students won't choose this option because of the cost. The additional materials are not all necessary although the coffee filter and similar materials (cheese cloth also works) are needed to hold all materials in place. Students and instructors can add many additional materials to the "store."

Image Insert Image # or Figure # here [use Figure # if referenced in text]

Figure 1

Image file: ___?

ADA Description: ___? *(Write as if describing the image to a blind person; do not repeat any caption content.)*

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Caption: Figure 1. ___?

Vocabulary / Definitions

Word	Definition
coagulation	Process to destabilize colloidal suspensions
Clarification	Sedimentation of impurities and sludge
Disinfection	Removal of micro-organisms with method s such as chlorine, ozone, reverse osmosis, or ultraviolet radiation
Adsorption	the adhesion of atoms, ions, or molecules from a gas, liquid, or dissolved solid to a surface.

Associated Activities

What's in your water pond study

Lesson Closure

After all groups have competed, the effluent water will be judged based on its quality and treatment time. The students can compare data to determine the winning team. Have the winning team describe their design to the class and discuss why it worked and where further improvement can be made.

Discuss different filtration media and the importance of pore size. Show the size of the water pollutants in the exercise compared to the pore size of different filter media. Have student identify which filtration media would be necessary to remove all the pollutants.

Finally, describe the method of action of activated carbon removal of pollutants.

Assessment

Pre-Lesson Assessment
Descriptive Title: ___?

Lead a brief class discussion to develop a list of all the situations in which water will need to be treated.

Post-Introduction Assessment
Descriptive Title: ___?

Next have students create a Venn diagram of the substances (or pollutants) that need to be treated in wastewater, drinking water, or both.

Lesson Summary Assessment
Descriptive Title: ___?

Lead a discussion on how the original water filtration designs can be improved for better results.

Homework
Descriptive Title: ___?

Lesson Extension Activities

Apply the engineering design process to runoff in a watershed.

Students can design Low-Impact Development systems in a paint tray filled with sand or soil.

The same "polluted" water can be poured at the top end of the tray and then collect the water that runs off the bottom of the tray.

The goal is to have the cleanest water that has the slowest travel time.

Additional Multimedia Support

References

http://www.eschooltoday.com/global-water-scarcity/images/drinking-water-treatment-process.jpg

http://www.sswm.info/sites/default/files/toolbox/EAWAG%20ny%20Membrane%20Filtration.gif

http://www.sswm.info/sites/default/files/toolbox/RADCLIFF%202004%20Filtration%20Spectrum.png

http://www.sushrutchemicals.com/images/diagramedimage.jpg

Attachments

Other

Redirect URL

Contributors

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Supporting Program

GK-12 program, College of Engineering, University of Houston

Acknowledgements

Classroom Testing Information