Lesson One: Desalination Introduction and Experiment

Course(s)/Subject(s): Chemistry/Earth Science
Lesson duration: 1 day
Grade(s): 8-9 (late middle school; early high school)
Lesson: 1 of 2
Topic: Desalination (Overview and Experiment)

Objectives:
- Students will be able to define desalination.
- SWBAT describe the process of desalination.
- SWBAT to perform, in pairs or small groups, a simple desalination demonstration/experiment.
- SWBAT describe the scarcity of water resources.

Lesson context:
- This lesson is designed for use in a science, chemistry, ecology, earth science, geography, or current events class. It explores the process of desalinization as a method of mitigating water scarcity. In the first lesson, students perform a desalination exercise to demonstrate one technique for desalination.
- Essential question: What are some causes, consequences, and solutions to global water scarcity?

Resources Needed:
- Experiment: large glass beaker (250 ml); beaker small enough to fit in the glass container, but heavy enough to float (50 ml); hydrometer; coarse salt; water; plastic wrap; rubber bands; nut, bolt, or washer (to serve as a small weight); Bunsen burner (if a Bunsen burner is not available, the experiment can be conducted using solar energy, but will take longer)
- Additional materials referenced throughout this lesson plan located in the Appendix.

Introduction (15 minutes):
- Pass out, or project onto the wall/board, the article “Water Dispute Claims Two More Lives in Taiz,” which is located in the Appendix of this lesson.
- Ask students to read the article.
- Ask students to respond to the Article Response Questions in their journals, or as a class. Alternatively, pass out a copy to each student and allow students to turn the questions in for a grade.

Activity (45 minutes):
Pass out the Desalination Experiment Instructions for students to perform experiments with lab partners or small groups. Before students leave for the day, ask them to write a response to the conclusion section of the experiment to share with the class the next day.

If students still need practice performing experiments independently, the teacher can read through the instructions with the class and clarify as necessary.
Lesson Two: Thinking Critically about Desalination

Course(s)/Subject(s): Chemistry/Earth Science
Lesson duration: 2 days
Grade(s): 8-9 (late middle school; early high school)
Lesson: 2 of 2
Topic: Desalination (Comparative Reading Exercise)

Objectives:
• Students will be able to describe the scarcity of water resources.
• SWBAT evaluate two documents related to desalination.
• SWBAT to create an advertisement to gain support for or resistance to desalination plants.

Lesson context:
• This lesson is designed for use in a science, chemistry, ecology, earth science, geography, or current events class. It explores the process of desalination as a method of mitigating water scarcity. In the first lesson, students perform a desalination exercise to demonstrate one technique for desalination.
• Essential question: What are some causes, consequences, and solutions to global water scarcity?

Resources Needed:
• large or poster-sized paper; colored markers, pens, and pencils
• Additional materials referenced throughout this lesson plan located in the Appendix.

Introduction (5-10 minutes):
• Review key concepts from yesterday.
  o Ask for a volunteer to summarize the article from the previous lesson (“Water Dispute Claims Two More Lives in Taiz”).
  o Ask for a volunteer to read a response to each of the Article Response Questions.
  o Ask for a volunteer to provide a short summary of the experiment and results from the desalination experiment.

Activity (35 minutes):
• Show students the Water Goes Global poster. It can be used as a reference when reading the articles and performing the writing activity. A full-sized version is available at [http://environment.newscientist.com/data/images/archive/2670/26700101.jpg].
• Pass out the two sources students will be comparing (“Desalination: A Global Solution to Water Scarcity” and “Water in Crisis – Middle East”)
• Pass out two Primary Source Analysis worksheets to each student. Ask students to read the provided sources and fill in the Primary Source Analysis sheets.
• Ask students to use what they learned from the articles and their own perspectives to create a poster advertising either the benefits or the drawbacks of building a desalination plant in Taiz, Yemen (the Yemeni city from the article in lesson one).
• Display posters outside of the classroom, if possible, for other teachers and students to see.
Appendix: “Water Dispute Claims Two More Lives in Taiz”


Photograph caption: In Taiz, where water is an especially precious resource, neighboring villages exchange fire over access to a natural spring.

TAIZ, March 27 – Despite an increase in security measures announced earlier this month, two more men were killed on Friday in an ongoing dispute between the neighboring villages of Qurada and Al-Mirzah.

The villages—which are in the outskirts of the city, in Sabir district—have been fighting sporadically for nearly a decade over access to a natural spring which lies between the two. One man from each village was killed: Akram Abdulrahman Qatan, from Qurada, and Abdullah Sadeq Mohammad, from Al-Mirzah.

Following the latest deaths, Dirhm Abu Fare’, Security Manager of Sabir district said local forces would once more be intensifying their efforts. Suspects were apprehended and taken to a penal court in Taiz, Abu Fare’ said.

“Law will take its course, and investigations are underway,” he said, adding that tribal mediation is also playing a major role in resolving the dispute.

Though a judicial verdict in 2003 ruled that access to the spring would be mutual (with the lion’s share going to Qurada), recent events have caused authorities to fear that there could be more violence. Taiz—one of the driest and most populated cities in the country—is facing a serious water crisis. Abdu Al-Samd, the head of General Authority of Water Resources in Taiz, said that water consumption is on the rise. Few residents have access to information about how they can do their part and conserve water, he said.

The government is looking for solutions to this country-wide water shortage.
Yemen’s first water desalination facility is expected to finish construction this year in Mocha, according to the Ministry of Water and Environment. Yemen has the longest sea coast in the Middle East (over 2,000 kilometers of shoreline), and it’s expected this desalination project will provide much-needed fresh water to this parched country.
Appendix: Article Response Questions

After reading the article “Water Dispute Claims Two More Lives in Taiz” from the Yemen Times, respond to the following questions.

1. Locate Yemen on a map. Why might two villages in Yemen be fighting over use of a natural water spring?

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2. List two factors contributing to what the author of the article calls a “water crisis” in Yemen.

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3. Look up the word desalination. In what way might the “water desalination facility” mentioned in the article help Yemen to deal with its water crisis? In what way might it not help?

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4. Locate Yemen on a map. Why might two villages in Yemen be fighting over use of a natural water spring?

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Appendix: Desalination Experiment Instructions

Materials:
250 mL beaker
50 mL beaker
plastic wrap
rubber band
Bunsen burner
55 g coarse salt
100 mL water
small washer or bolt
hydrometer

Procedure:

1. Pour 100 mL water into the larger beaker.
2. Mix the water in the beaker with 55 grams of coarse salt and stir to mix. Measure the salinity of the mixture and record it in the box (do not forget to record it in the proper units).

3. Carefully place the smaller beaker inside the larger beaker, ensuring it floats and does not get any water in it.
4. Drape the plastic wrap over top of the larger beaker and secure it with a rubber band. Be sure not to drape it too tightly (this is important for the next step).
5. Place the small washer or bolt on top of the plastic wrap directly over the center of the smaller beaker.
6. Slowly ignite your Bunsen burner under the larger beaker. Steam should collect and condense under the plastic wrap and drip into the smaller beaker. Once enough water has collected in the small beaker to be measured by the hydrometer, turn off your Bunsen burner.
7. Once your beaker has cooled enough to touch, carefully remove the plastic wrap and measure the salinity of the water in the larger and smaller beakers. Record your measurements in the boxes below.

<table>
<thead>
<tr>
<th>SMALLER BEAKER</th>
<th>LARGER BEAKER</th>
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Conclusion:
Describe what occurred in your experiment. Did you successfully desalinate water?
Appendix: Water Goes Global Poster

Source:
http://environment.newscientist.com/data/images/archive/2670/26700101.jpg
Appendix: Desalination: A Global Solution to Water Scarcity

Appendix: Water in Crisis – Middle East


The Middle East has experienced many environmental concerns lately. Water resources are becoming increasingly scarce, especially for the millions there who already lack access to sanitary water. Some of these countries, including Yemen, the United Arab Emirates, Saudi Arabia, and Iraq, are facing unique problems that require global, immediate attention. Beside their neighboring location, one shared factor of all these countries is their lack of water resources and poor water management.

The Middle East has some of the largest oil reserves in the world, which produces most of the area's wealth. Even so, the region's climate and environment make living harsh. The Middle East requires water resources and suitable land for agriculture. Much of the land that is available for producing food is destroyed by increasing desertification.

Desertification is a sweeping environmental problem, with vast effects in countries such as Syria, Jordan, Iraq, and Iran. Universal causes for a spread of arid environment are unsustainable agriculture practices and overgrazing. Agriculture uses 85 percent of water in this region. It is common to misuse land by heavy irrigation in the Middle East. In the area droughts are more frequent, and contribute to the changing landscape. The overuse of water in agriculture is affecting the countries' already undersized water resources.

Jordan, located in the Syrian Desert, and Yemen, on the southern tip of the Arabian Peninsula, both endure severe water scarcity in the Middle East. For example, Jordan's average freshwater withdrawal is less than ten percent of Portugal's average, despite being the same size. The cost of water in Jordan increased thirty percent in ten years, due to a quick shortage of groundwater. Yemen has one of the highest worldwide rates of malnutrition; over thirty percent of its population does not meet their food needs. In recent years, Yemen has not been able to produce enough food to sustain its populations. Water scarcity has damaged the standard of living for inhabitants of the Middle East.

The United Arab Emirates, located on the Arabian Peninsula, is famous for its luxurious cities filled with lavish resorts, shopping, and attractions. The livelihoods of these extravagant emirates might create the assumption that water scarcity is not a problem for these rich states. In reality, however, the UAE is confronted with a serious depletion of their available water resources. A report from the Emirates Industrial Bank in 2005 said that the UAE had the highest per capita consumption of water in the world. Additionally, for the past thirty years the water table of this region has dropped about one meter per year. At this current rate, the UAE will deplete its natural freshwater resources in about fifty years. Even with a large amount of
desalination plants to reduce water deficiency, the UAE needs to adjust its water use habits before its energy consumption doubles in 2020.

Desalination plants are an overuse of water resources in the Middle East. Seventy percent of desalination plants in the world are located in this area, found mostly in Saudi Arabia, the United Arab Emirates, Kuwait, and Bahrain. While the plants produce water needed for the arid region, they can manufacture problems for health and the environment. The seawater used most in desalination plants has high amounts of boron and bromide, and the process can also remove essential minerals like calcium. Also, the concentrated salt is often dumped back into oceans where the increased salinity affects the ocean's environment. The plants harm local wildlife and add pollutants to the region's climate. In addition, desalination is the most energy-costing water resource. The Pacific Institute explains that the high use of energy results in raised energy prices and higher prices on water produced, hurting the consumer. The water produced can be beneficial towards substituting any lack of freshwater, but these areas have tendencies towards overuse of their natural resources.

Concerns with the large amount of desalination plants in the Middle East focus on the improper dependency they will cause, instead of encouraging alternate forms of water and energy and conserving freshwater.

The Middle East has numerous struggles with its current water resources, and the region needs more than one solution to generate an optimistic environmental position for the future.
Appendix: Primary Source Analysis

1. What type of document is it?

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____________________________________________________________________

2. Who authored the document? Was the document created by an individual? A company? An organization?

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____________________________________________________________________
____________________________________________________________________

3. Who was, or who might be, the audience for this document?

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4. Why do you think it was written?

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5. What evidence in the document helps you know why it was written? Consider providing a quotation from the document.

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6. List three things about the document's contents that you think are important.

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____________________________________________________________________
7. Write a question to the author that is left unanswered by the document.