Lesson 7
Ocean Resources

Objectives

Students will

- describe several natural resources extracted from sea water and the ocean floor
- extract salt from salt water
- extract water from salt water
- discover the process and expense of distilling water

Vocabulary

desalination—the process of removing salt from ocean water to obtain fresh water for drinking, irrigation, or industrial use

Structuring the Curriculum

You may choose to prepare **Let's Find Out: How Is Salt Extracted from the Ocean?** several days before you teach this lesson if you want students to see a sample of the results right away.

Preparation/Materials

Let's Find Out: How Is Salt Extracted from the Ocean?

√ 44.6 mL of salt in a graduated cylinder, one per group
√ warm water, 1 L per group
√ large jars, one per group
√ stirring rods, one per group
√ flat baking pans, one per group
√ blackline 59, one per student (optional)

Let's Find Out: What Costs Are Involved in Distillation?

√ safety goggles, one pair per student
√ salt, 25 mL per group
√ clean tap water, 1 L per group
√ 1000-mL beakers, one per group
√ 1000-mL flasks, one per group
√ stirring rods, one per group
√ glass funnels with narrow (1/" O.D.) openings, one per group
√ 1/" I.D. high temperature plastic tubing that will fit snugly on the funnel, 1-m length per group
√ rubber bands (optional)
√ hot plates, one per group
√ ring stands with clamps, one per group
√ 500-mL beakers, one per group
√ stopwatches, one per group

- √ graduated cylinders, one per group
- √ heat resistant gloves, one pair per student
- √ materials for solar-powered distillation device: 2-L soda pop bottles, black spray paint, egg, plastic tubing, duct tape, salt, and water (optional)
- √ blackline 60, one per student (optional)

Background

A wide variety of resources are available in the ocean. Offshore coal mining began in the 1500s and is still being achieved through land mine shafts extended into the ocean or shafts lowered from artificial islands. Oil and natural gas are two other resources in the continental shelves. The number of offshore oil and natural gas rigs has increased as the demand for fossil fuels has risen. The first offshore oil well was drilled off a pier along the California coast in 1896. In the 1920s wells were drilled into the Caspian Sea in Russia. The discovery of the large oil field in Lake Maracaibo in Venezuela renewed an interest in offshore drilling, and by the 1940s, steel drilling structures were designed and installed in 7-m (23-foot) waters of the Gulf of Mexico. By 1975 77 offshore wells had been drilled around the world in water up to 200 m (650 feet) deep. The largest offshore oil platform is the Hibernia rig off Newfoundland. This rig is supposed to be iceberg-proof. Today exploration drilling has been accomplished in 2,500 m of water. The world's deepest working oil well is in waters of 1,709 m (5,065 feet) off the coast of Brazil.

The offshore mineral mining industry is currently limited to shallower waters and is therefore relatively small, but it is growing. Sand and gravel are the most important offshore mineral resources. Many countries are dredging minerals mixed up with sediments (placer deposits)—tin in Indonesia, Thailand and Malaysia; gold in the Philippines and Alaska; ilmenite, rutile, zircon and monazite in Australia, Malaysia, India, China, Sri Lanka, South Africa, and the United States; and diamonds in southern Africa. Marine mineral resources in deeper waters, some outside zones of national jurisdiction, offer further possibilities. Considerable research and development is necessary before mining can occur.

Polymetallic sulfides come out of water heated by lava from sea-floor spreading at the bottom of the ocean, where they accumulate nearby as deposits. They contain metals such as iron, gold, silver, and zinc. The hydrothermal vents from which the polymetallic sulfides arise are found at an average depth of about 2,214 m (7,300 feet). Their temperatures reach up to 400 °C (750 °F), yet they offer a habitat to certain organisms. Heat-loving bacteria thrive on hydrogen sulfide (which is deadly to people) and live in nearly boiling water. These species offer the possible use as enzymes in the treatment of industrial heavy metal wastes.

Polymetallic nodules, or manganese nodules, rest on the ocean floor under 550 to 5,500 m of water. These nodules contain various metals such as copper, nickel, cobalt, and manganese. Prospecting, data collection, and research is currently being done on mining, lifting, and processing technologies. Recovery systems will have to be improved before mining of the manganese nodules proves profitable. A suction dredge system and a continuous-line bucket system were once considered promising, but those methods suffer from low recovery rates. A proposed shuttle system lowers a remotely operated vehicle with cameras and powerful lights to collect and crush nodules and resurface. Currently this method is too expensive to be practical.

Desalination is the removal of dissolved salts from salt water so that the water is fit for human consumption, irrigation, and industrial applications. More than 8 million m^3 of fresh water are produced each day by the world's thousands of desalination plants. About half of these plants use distillation, which accounts for about three-fourths of the water that is desalinated. In distillation ocean water is boiled, and the water vapor is collected and condensed. Middle Eastern countries produce 75 percent of desalinated water, and the United States produces 10 percent; most of the rest is produced in Africa and Asia. This process is expensive, but it is necessary in regions that lack a freshwater supply.

Membrane processes are usually used for less salty water (brackish water). Reverse osmosis involves subjecting brine to pressure to force it through a membrane; the fresh water passes through, leaving behind the salts. Another membrane process is electrodialysis, in which electric potential drives the positive and negative ions of the dissolved salts through filters, leaving fresh water between filters.

Salt can be obtained from ocean water by evaporation. When ocean water—an aqueous solution of several salts—is evaporated, each salt precipitates as it reaches its point of saturation in the solution. The different salts in ocean water precipitate at different rates, forming layers on the bottom of the evaporating pond. These layers include calcium carbonate, calcium sulfate, sodium chloride, magnesium sulfate, potassium magnesium chloride, and magnesium chloride. (Evaporation can also be used to obtain phosphorite, which is used in fertilizers and manufactured chemicals.)

7 Ocean Resources

Can you imagine swimming in water filled with gold and precious minerals? If you've ever swum in the ocean, you've already done this! Living things aren't the ocean's only resources. Resources such as gold, diamonds, titanium, and copper are hidden in ocean water and under the ocean floor. Right now taking these treasures from the ocean is too expensive, but we can get other important resources from the ocean. The most important ocean mineral resources are sand and gravel.

Sand and gravel deposits form in the ocean from land erosion. Currents and water action sift these resources and deposit them in layers. Sand and gravel are used on construction sites. Sand is also used to replenish eroding beaches. Beach replenishing projects are designed to replace sand that waves and tidal currents have carried off. These projects are very important to countries with land below sea level, such as the Netherlands, and to barrier islands, such as Ocean City, New Jersey. Sand and weathered coral reefs are also the main source of construction materials for many tropical countries. But mining these resources near the Caribbean islands, especially the Bahamas, stirs up sediment, which can damage fragile coral reefs. So mining sand and gravel requires wisdom!

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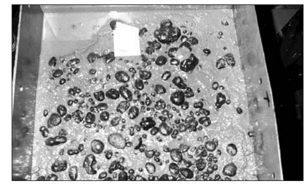
The *HMS Challenger* brought back strange black lumps of minerals from its famous voyage in 1872. These lumps, called manganese nodules, are scattered across the ocean floor, especially in the Pacific Ocean. The primary metal in these nodules is manganese; the nodules also contain copper, iron, nickel, cobalt, and phosphates. Such minerals are used to make products such as steel and fertilizers. These nodules are difficult and expensive to extract because they are found in very deep water, but as we use up the resources found on the land, scientists may develop better ways to retrieve mineral resources from the ocean.



Manganese nodules.

Let's Find Out

How Is Salt Extracted from the Ocean?

You will need

- ✓ 44.6 mL of salt in a graduated cylinder
- ✓ 1 L warm water
- ✓ large jar
- ✓ stirring rod
- ✓ flat baking pan

Do this

1. Pour the salt and water into the jar, and stir vigorously until the salt dissolves. The water now has about the same percentage of salt as ocean water has.
2. Pour the water into the pan, and set the pan in direct sunlight.
3. Observe the results for several days.
4. When the water has evaporated and dried, use the graduated cylinder to measure the salt. Determine whether any salt has evaporated.

Questions

1. Did any of the salt evaporate? Explain your answer.
2. In what climates do you think that this salt extraction method would work best? Design an experiment to test your hypothesis.

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Discover

1. Ask students to name the most valuable resources extracted from the oceans. (Students may mention water and salt; some know that oil and natural gas are found under the oceans; they may be surprised to learn that sand and gravel are also considered valuable resources.)
2. Have students read **Ocean Resources** (page 282) in the student text.

Develop

1. Have students complete **Let's Find Out: How Is Salt Extracted from the Ocean?** (page 283) in the student text or **blackline 59**.
    1. *Did any of the salt evaporate? Explain your answer. (No. Solids such as salt cannot evaporate. [Salt can sometimes be suspended in the atmosphere, but only when turbulent ocean spray sends it into the air.])*
    2. *In what climates do you think that this salt extraction method would work best? Design an experiment to test your hypothesis. (Hot, dry climates would be best. The salt would not dry completely in cold or humid climates.)*
2. Have students complete **Let's Find Out: What Costs Are Involved in Distillation?** (page 285) in the student text or **blackline 60**. Have students suggest ways to create a solar-powered device. You may choose to build such a device as a class. Spray-paint a 2-L soda pop bottle black, and fill it with salt water. (Demonstrate the saltiness first by floating an egg in it.)

Salt is another important ocean resource. Salt can be cheaply taken from ocean water in countries with hot, dry climates such as Spain. Shallow pans are flooded with sea water, which evaporates to leave salt deposits.

Salt from salt water is valuable, but the water is even more valuable. The process of removing salt from ocean water to obtain fresh water for drinking, irrigation, or industrial use is called **desalination**. One way to remove the salt from the water is through reverse osmosis, a process in which a membrane is used to separate the salt from the water. Another method is distillation, a process that involves boiling the water, gathering the water vapor, and condensing the vapor back into liquid. The salt remains in the original container, so the condensed water is pure. This method is very expensive.

Our society depends on oil and natural gas for energy. Both of these are found under the layers of rock that make up the ocean floor. Engineers can drill through this rock to reach the oil and natural gas, but taking oil from the deep water is expensive. It also causes pollution and sometimes results in major oil spills, which can harm or kill living things in the ocean. Some people don't think that offshore drilling is a responsible way for us to use the resources that God offers. What do you think?

We need oil to run our modern society. But drilling oil from beneath the ocean can cause oil spills, which damage the environment and harm or kill living things. How do you think that we can best balance our needs with good stewardship?

BP oil spill in the Gulf of Mexico, April 20, 2010.

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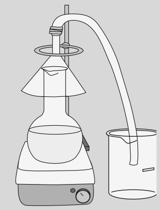
Let's Find Out

What Costs Are Involved in Distillation?

You will need

- ✓ safety goggles
- ✓ 25 mL of salt
- ✓ 1 L of clean tap water
- ✓ 1,000-mL beaker
- ✓ 1,000-mL flask
- ✓ stirring rod
- ✓ glass funnel with narrow (½" O.D.) opening
- ✓ 1-meter length of ½" I.D. high temperature plastic tubing
- ✓ rubber bands (optional)
- ✓ hot plate
- ✓ ring stand with clamp
- ✓ 500-mL beaker
- ✓ stopwatch
- ✓ graduated cylinder
- ✓ heat-resistant gloves

Do this



1. Put on safety goggles.
2. Add 25 mL of salt to 1 L of water in the 1,000-mL beaker. Pour this water into the flask. Stir it.
3. Place one end of the plastic tubing over the narrow end of the funnel. If it does not fit snugly, secure it with rubber bands.
4. Place the flask on the hot plate. Flip the funnel over so that its wide end rests on top of the flask. Hold the funnel in place with the ring stand and clamp. Run the other end of the tubing into the 500-mL beaker.
5. Put on heat-resistant gloves. Record your start time. Turn the hot plate to its highest setting for 15 minutes. Then allow the system to cool for 10 minutes.
6. Use the graduated cylinder to measure how much water collected in the 500-mL beaker.
7. After the hot plate cools, check the bottom to see how many watts of electricity it uses: Divide the wattage by 0.25 hours (15 minutes), then convert the number to kilowatt hours by dividing it by 1,000.
8. Calculate how much electricity would be required to distill one liter of ocean water.
9. Use the electric company's current rate (per kilowatt hour) to determine the cost of this electricity.

Questions

1. How was the water purified?
2. What might be a practical use of this process?
3. Using the average billing rate for electricity in your community, how much would it cost you to make one liter of fresh water from ocean water?
4. Could you improve the design of the mechanism to make it work more efficiently?
5. Do you think that it is possible to use solar power to purify the water like this? If so, how?

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Connect this bottle with another by putting one end of a 30-cm length of plastic tubing in the mouth of each; seal the openings with duct tape. Elevate the black bottle slightly by setting it on a book, and set the bottles in a sunny window. In a few days, the clear bottle will contain fresh water. Demonstrate its freshness by placing an egg in it; the egg will sink.

1. *How was the water purified? (As the water boils, the water vapor travels through the tube and condenses in the small beaker. The salt is left in the original beaker.*
2. *What might be a practical use of this process? (Small tropical islands often have no source of fresh water. [You may want to mention that many islands in the Bahamas and Virgin Islands are uninhabited for this reason.])*
3. *Using the average billing rate for electricity in your community, how much would it cost you to make one liter of fresh water from ocean water? (Answers will vary.)*
4. *Could you improve the design of the mechanism to make it work more efficiently? (Answers will vary.)*
5. *Do you think that it is possible to use solar power to purify the water like this? If so, how? (Answers will vary.)*

3. Assign the section review questions (page 286) in the student text as homework.
   1. *What do you think is the most important nonliving resource found in the ocean? Explain your answer. (Answers will vary.)*
   2. *What is desalination? (Desalination is the process of removing salt from ocean water to obtain fresh water for drinking, irrigation, or industrial use.)*

Waves carry a tremendous amount of energy.

If you've ever been knocked over by a wave, you know that waves carry lots of energy! This energy is another important resource—a renewable one. Wave-power systems rely on continuous wave action. Only areas that have high, continuous waves—such as the Atlantic Ocean near the British Isles—can power these systems.

Tidal energy is another renewable energy source from the ocean. Water during a high tide can be rushed through a narrow passageway, creating enough force to generate electricity. Tidal energy, like wave energy, is practical only in certain areas—areas that have narrow, shallow channels. For example, a tidal generating plant produces energy in the Canadian Bay of Fundy.

Energy is also available from the ocean through ocean thermal energy conversion (OTEC). OTEC systems are based on the temperature difference between deep, cold water and warm surface water. The cold water condenses ammonia fluids, and the warm water causes these liquids to evaporate. The cycle of condensation and evaporation is used to drive turbines.

Review

1. What do you think is the most important non-living resource found in the ocean? Explain your answer.
2. What is desalination?
3. Do you think that it is a good idea to extract oil and natural gas from the ocean? Why or why not?

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Let's Find Out

How is Salt Extracted from the Ocean?

You will need

- ✓ 44.6 mL of salt in a graduated cylinder
- ✓ 1 L warm water
- ✓ large jar
- ✓ stirring rod
- ✓ flat baking pan

Do this

1. Pour the salt and water into the jar, and stir vigorously until the salt dissolves. The water now has about the same percentage of salt as ocean water has.
2. Pour the water into the pan, and set the pan in direct sunlight.
3. Observe the results for several days.
4. When the water has evaporated and dried, use the graduated cylinder to measure the salt. Determine whether any salt has evaporated.

Original volume of salt	
Volume of salt after evaporation	

Questions

1. Did any of the salt evaporate? Explain your answer. **Salt does not evaporate. Salt can sometimes be suspended in the atmosphere, but only when turbulent ocean spray sends it into the air.**
2. In what climates do you think that this salt extraction method would work best? Design an experiment to test your hypothesis. **Hot, dry areas would be best. The salt would not dry completely in cold or humid climates.**

Blackline 59
Unit 3, Chapter 2
Lesson 7

3. *Do you think that it is a good idea to extract oil and natural gas from the ocean? Why or why not? (Answers will vary. Students may suggest that fossil fuels are creating large quantities of pollution and may question the wisdom of spending money looking for more oil reserves instead of developing cleaner alternatives. Offshore oil wells may also damage ocean ecosystems. Other students will suggest that we need this oil and natural gas and that it doesn't make sense let it go unused. They may suggest that improving on extraction methods might be a good solution.)*

Reinforce/Assess

1. Have students conduct further research on offshore drilling and determine whether or not they think that this is good stewardship.
2. Have students write psalms of praise for the oceans and the resources that are offered there.

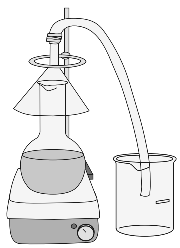
Let's Find Out

What Costs are Involved in Distillation?

You will need

- ✓ safety goggles
- ✓ 25 mL of salt
- ✓ 1 L of clean tap water
- ✓ 1,000-mL beaker
- ✓ 1,000-mL flask
- ✓ stirring rod
- ✓ glass funnel with narrow (½" O.D.) opening
- ✓ 1-meter length of ½" I.D. high temperature plastic tubing
- ✓ rubber bands (optional)
- ✓ hot plate
- ✓ ring stand with clamp
- ✓ 500-mL beaker
- ✓ stopwatch
- ✓ graduated cylinder
- ✓ heat-resistant gloves

Do this



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5. Record your start time. Turn the hot plate to its highest setting for 15 minutes. Then allow the system to cool for 10 minutes.
6. Use the graduated cylinder to measure how much water collected in the 500-mL beaker.
7. Put on heat-resistant gloves. Turn on the hot plate to its highest setting for 15 minutes.
8. After the hot plate cools, check the bottom to see how many watts of electricity it uses: Divide the wattage by 0.25 hours (15 minutes), then convert the number to kilowatt hours by dividing it by 1,000.
9. Calculate how much electricity would be required to distill one liter of ocean water.
10. Use the electric company's current rate (per kilowatt hour) to determine the cost of this electricity.

Start time	
Water collected	
Divide wattage by 0.25 hours	
Convert to kilowatt hours (v 1,000)	
Electricity required to distill one liter of ocean water	
Current electric rate per kilometer hour	
Cost of electricity	

Blackline 60
Unit 3, Chapter 2
Lesson 7

Questions

1. How was the water purified? **As the water boils, the water vapor travels through the tube and condenses in the small beaker. The salt is left in the original beaker.**
2. What might be a practical use of this process? **Small tropical islands often have no source of freshwater. You may want to mention that many islands in the Bahamas and Virgin Islands are uninhabited for this reason.**
3. Using the average billing rate for electricity in your community, how much would it cost you to make one liter of fresh water from ocean water? ____________________
4. Could you improve the design of the mechanism to make it work more efficiently? ____________________
5. Do you think that it is possible to use solar power to purify the water like this? If so, how? ____________________

Extend

- Have students complete **blackline 61**.
- On a class bulletin board, have students draw a map of the oceans. Using different symbols, have them locate important mineral resources, including different metals, diamonds, phosphorites, sulfur, sand, gravel, and fossil fuel reserves. You may want to include offshore oil rigs.
- As a class, research the countries that use desalination processes to obtain pure drinking water, and determine reasons why these countries must use this method to obtain fresh water.
- Determine how successful the beach replenishing programs used in the Netherlands and Ocean City, New Jersey, have been.
- Most people do not view ocean water as a resource, but it is the most abundant material in the biosphere. Scientists are researching ways to use ocean water to irrigate crops and feed the booming worldwide population. Discuss these developments using the facts below.
  - When exposed to ocean water, the top five plants eaten around the world (corn, rice, potatoes, wheat, and soybeans) wither and die.
  - The United Nations Food and Agriculture Organization estimates an additional 200 million hectares (495 million acres) of new cropland will be needed to feed the world's growing population over the next 30 years. This is an area the size of Arizona, New Mexico, Utah, Colorado, Idaho, Wyoming, and Montana combined.
  - Only 93 million hectares are available, and much of that land is rainforest.

Oceans of Words

U	R	B	T	N	W	J	E	I	E	D	I	C	O	F	I	C	H	E	Z
E	I	A	V	B	G	A	C	G	Q	G	L	M	Y	S	O	Y	S	D	V
Y	P	K	B	T	O	S	V	Z	D	W	N	T	A	N	W	B	O	U	S
M	C	J	W	L	C	V	Y	E	Z	I	I	A	T	N	K	I	F	T	E
E	U	N	D	E	R	T	O	W	L	N	R	I	R	G	U	E	R	I	A
H	R	P	L	T	Y	T	I	D	I	E	N	N	G	L	L	S	S	L	M
P	R	N	O	T	K	N	A	L	P	E	N	U	A	B	A	C	T	P	O
A	E	W	E	X	E	P	A	O	N	B	L	G	I	E	U	D	B	M	U
C	N	D	K	H	Z	S	P	T	R	F	Z	S	T	B	C	U	I	A	N
S	T	N	Z	O	N	Z	A	F	S	R	R	Z	A	H	D	O	E	T	T
Y	F	L	E	H	S	L	A	T	N	E	N	I	T	N	O	C	D	P	A
H	H	N	K	A	M	E	R	S	M	M	T	R	E	N	C	H	W	I	F
T	B	H	E	A	P	E	K	B	E	D	I	T	G	N	I	R	P	S	M
A	B	K	R	K	A	T	U	N	E	R	I	T	I	C	Z	O	N	E	C
B	Z	G	N	M	T	S	I	D	X	P	O	H	S	R	P	R	D	T	I
I	I	F	O	O	Y	O	N	D	I	R	P	I	H	E	D	C	U	A	H
N	V	Q	J	Y	M	U	N	Z	E	A	G	H	K	S	G	E	K	O	T
K	G	A	K	F	Z	L	K	R	O	Q	V	T	L	T	F	U	C	U	N
Y	M	E	N	O	Z	L	A	S	S	Y	B	A	N	U	B	B	S	C	E
T	R	O	U	G	H	Z	A	B	Y	S	S	A	L	P	L	A	I	N	B

Find the following words.

abyssal plain
abyssal zone
amplitude
bathyscaphe
benthic
continental margin
continental shelf
crest
Gulf stream
mid-ocean ridge
neap tide
nekton
neritic zone
plankton
rip current
salinity
SCUBA
seamount
spring tide
submersible
tidal range
trench
trough
tsunami
undertow
wavelength

Blackline 61
Unit 3, Chapter 2
Lesson 7

- Using seawater agriculture, salt-tolerant crops can be raised on land irrigated by seawater. This can be done on desert or semiarid lands, which make up 43 percent of the Earth's continents. Scientists estimate saltwater agriculture could open up 130 million hectares of additional farmland.
- The first agricultural experiments were done in 1949 at Eilat on the Red Sea to attract Jewish settlers.
- Many salt-tolerant plants—such as quailbush, pickleweed, sea blite, glasswort, and coast saltbush—can be grown as feed for livestock using seawater agriculture.

7 Ocean Resources

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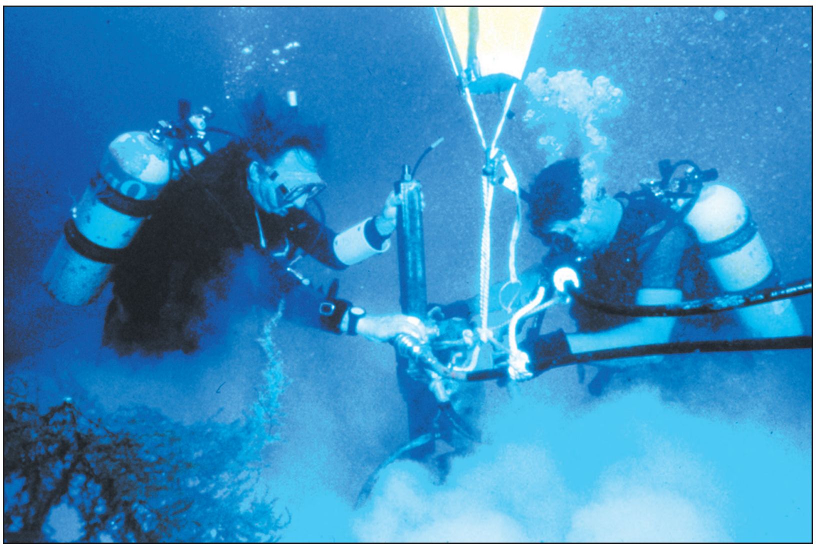

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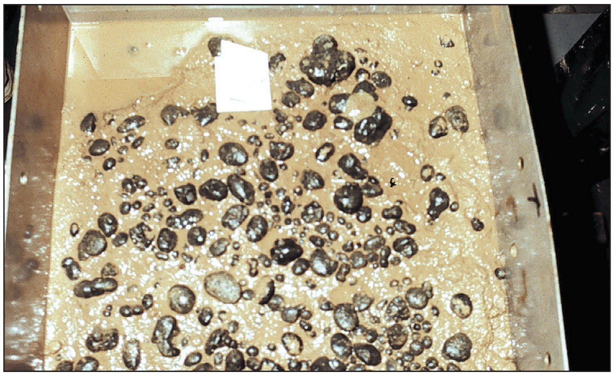

Manganese nodules.

Let's Find Out

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Questions

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BP oil spill in the Gulf of Mexico, April 20, 2010.

Let's Find Out

What Costs Are Involved in Distillation?

You will need

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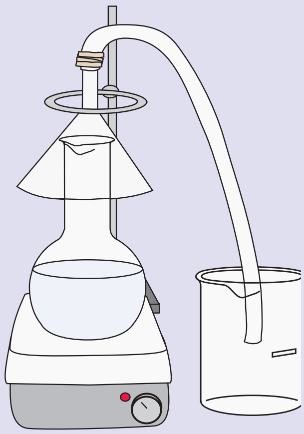
- ✓ 25 mL of salt
- ✓ 1 L of clean tap water
- ✓ 1,000-mL beaker
- ✓ 1,000-mL flask
- ✓ stirring rod
- ✓ glass funnel with narrow (½" O.D.) opening
- ✓ 1-meter length of ½" I.D. high temperature plastic tubing
- ✓ rubber bands (optional)
- ✓ hot plate
- ✓ ring stand with clamp
- ✓ 500-mL beaker
- ✓ stopwatch
- ✓ graduated cylinder
- ✓ heat-resistant gloves

Do this



1. Put on safety goggles.
2. Add 25 mL of salt to 1 L of water in the 1,000-mL beaker. Pour this water into the flask. Stir it.
3. Place one end of the plastic tubing over the narrow end of the funnel. If it does not fit snugly, secure it with rubber bands.
4. Place the flask on the hot plate. Flip the funnel over so that its wide end rests on top of the flask. Hold the funnel in place with the ring stand and clamp. Run the other end of the tubing into the 500-mL beaker.
5. Put on heat-resistant gloves. Record your start time. Turn the hot plate to its highest setting for 15 minutes. Then allow the system to cool for 10 minutes.
6. Use the graduated cylinder to measure how much water collected in the 500-mL beaker.
7. After the hot plate cools, check the bottom to see how many watts of electricity it uses: Divide the wattage by 0.25 hours (15 minutes), then convert the number to kilowatt hours by dividing it by 1,000.
8. Calculate how much electricity would be required to distill one liter of ocean water.
9. Use the electric company's current rate (per kilowatt hour) to determine the cost of this electricity.

Questions

1. How was the water purified?
2. What might be a practical use of this process?
3. Using the average billing rate for electricity in your community, how much would it cost you to make one liter of fresh water from ocean water?
4. Could you improve the design of the mechanism to make it work more efficiently?
5. Do you think that it is possible to use solar power to purify the water like this? If so, how?

Waves carry a tremendous amount of energy.

If you've ever been knocked over by a wave, you know that waves carry lots of energy! This energy is another important resource—a renewable one. Wave-power systems rely on continuous wave action. Only areas that have high, continuous waves—such as the Atlantic Ocean near the British Isles—can power these systems.

Tidal energy is another renewable energy source from the ocean. Water during a high tide can be rushed through a narrow passageway, creating enough force to generate electricity. Tidal energy, like wave energy, is practical only in certain areas—areas that have narrow, shallow channels. For example, a tidal generating plant produces energy in the Canadian Bay of Fundy.

Energy is also available from the ocean through ocean thermal energy conversion (OTEC). OTEC systems are based on the temperature difference between deep, cold water and warm surface water. The cold water condenses ammonia fluids, and the warm water causes these liquids to evaporate. The cycle of condensation and evaporation is used to drive turbines.

Review

1. What do you think is the most important non-living resource found in the ocean? Explain your answer.
2. What is desalination?
3. Do you think that it is a good idea to extract oil and natural gas from the ocean? Why or why not?

Let's Find Out

How Is Salt Extracted from the Ocean?

You will need

- ✓ 44.6 mL of salt in a graduated cylinder
- ✓ 1 L warm water
- ✓ large jar
- ✓ stirring rod
- ✓ flat baking pan

Do this

1. Pour the salt and water into the jar, and stir vigorously until the salt dissolves. The water now has about the same percentage of salt as ocean water has.
2. Pour the water into the pan, and set the pan in direct sunlight.
3. Observe the results for several days.
4. When the water has evaporated and dried, use the graduated cylinder to measure the salt. Determine whether any salt has evaporated.

Original volume of salt	
Volume of salt after evaporation	

Questions

1. Did any of the salt evaporate? Explain your answer. ____________________

____

____

2. In what climates do you think that this salt extraction method would work best? Design an experiment to test your hypothesis. ____________________

____

____

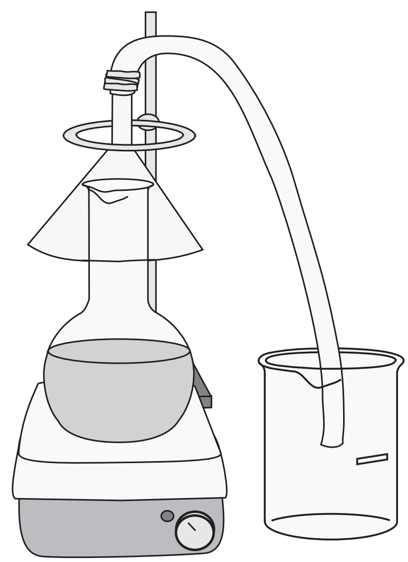
What Costs Are Involved in Distillation?

Let's Find Out

You will need

- ✓ safety goggles
- ✓ 25 mL of salt
- ✓ 1 L of clean tap water
- ✓ 1,000-mL beaker
- ✓ 1,000-mL flask
- ✓ stirring rod
- ✓ glass funnel with narrow (½" O.D.) opening
- ✓ 1-meter length of ½" I.D. high temperature plastic tubing
- ✓ rubber bands (optional)
- ✓ hot plate
- ✓ ring stand with clamp
- ✓ 500-mL beaker
- ✓ stopwatch
- ✓ graduated cylinder
- ✓ heat-resistant gloves

Do this



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5. Record your start time. Turn the hot plate to its highest setting for 15 minutes. Then allow the system to cool for 10 minutes.
6. Use the graduated cylinder to measure how much water collected in the 500-mL beaker.
7. Put on heat-resistant gloves. Turn on the hot plate to its highest setting for 15 minutes.
8. After the hot plate cools, check the bottom to see how many watts of

Start time	
Water collected	
Divide wattage by 0.25 hours	
Convert to kilowatt hours (v 1,000)	
Electricity required to distill one liter of ocean water	
Current electric rate per kilometer hour	
Cost of electricity	

electricity it uses: Divide the wattage by 0.25 hours (15 minutes), then convert the number to kilowatt hours by dividing it by 1,000.

9. Calculate how much electricity would be required to distill one liter of ocean water.
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Questions

1. How was the water purified? ____

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2. What might be a practical use of this process? ________________________________

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3. Using the average billing rate for electricity in your community, how much would it cost you to make one liter of fresh water from ocean water? ______________________________

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