El Paso Water Education Series

Mini Distillation Plant - Lesson Plan

Grade 4

Subject
Earth and Space

Duration
Active Classroom Time: 45 minutes
Experiment Run Time: 4-24 hours

Skills
Gathering information (observing), Analyzing information, Interpreting

Vocabulary
condensation
distillation
evaporation

Science TEKS
Grade 4: 4.1(A-B), 4.2(A-D), 4.3 (A-C), 4.4, 4.5 (A-B), 4.6(A)

Social Studies TEKS
Grade 4: 4.8(B) 4.18(B)

Math TEKS
Grade 4: 4.1(A) 4.4€

For more lessons, activities, and to schedule a visit to EPWater's TechH_2O Water Resources Learning Center visit:

tech2o.org

Lesson Overview: Access to safe drinking water is inseparable from the water cycle and something often taken for granted. This lesson will examine principles of the water cycle in a hands-on and experimental way. Students will separate a solution through passive distillation and relate their results to their own water needs.

Objectives:
1. Review and apply water cycle terminology.
2. Relate energy to changes in the physical properties of water.
3. Evaluate a model of distillation in a real-world scenario.

Engagement Question:
1. How can safe drinking water be separated from salty or contaminated water?

Making Connections: Water scarcity is a global concern. The United Nations estimates that over 2 billion people live in water-stressed countries. While water may be abundant, high quality drinking water is not. In El Paso, two large aquifers support the city's population. Both the Mesilla Bolson and Hueco Bolson aquifers have fresh water and salty portions. El Paso Water is a national leader desalting water. The utility built the largest inland desalination plant in the world with the Kay Bailey Hutchison Desalination Plant. Through a pressurized process powered by electricity, raw water passes through the fine membranes that separate salts and other impurities from the water so that it meets quality standards for residents to drink. Though this process is quite different from distillation, the principal of using energy to extract freshwater from a saltwater solution is relevant to this experiment.

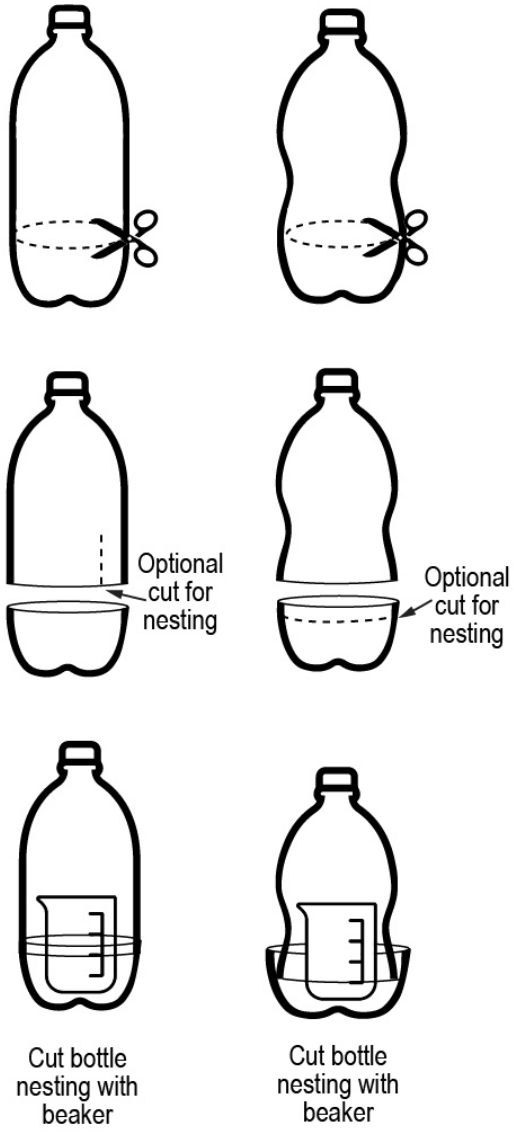
Materials: *(per student)*
(1) clean, empty two-liter plastic bottle with bottle cap
(1) stir
(1) pair of scissors
(1) 100mL graduated cylinder or metric measuring cup
(1) 100mL beaker or cup
100 mL water
2.5g table salt
(1) benchtop balance

Materials: *(instructor use only)*
(1) craft knife

Procedure:
<u>Pre-Activity Preparation (by an adult)</u>
1. Remove any labels from the empty bottle.
2. Pierce the plastic bottle with a craft knife about 2 inches from the bottom to create an entry point large enough to insert scissor blades.

Activity

3. Use scissors to cut the circumference of the bottle starting at the incision made 2 inches from the bottom. *An additional cut may be needed to ensure the top portion of the bottle can nest into the bottom.*
4. Use a graduated cylinder or measuring cup to measure 100 mL of water and transfer into a beaker or cup.
5. Use a benchtop balance to measure 2.5g of table salt.
6. Add salt to water and stir to dissolve salt.
7. Place the beaker/cup of saltwater solution in bottom of the cut bottle.
8. Nest the top portion of the bottle (with cap secure) into the bottom portion.
9. Use the worksheet to record observations.
10. Find a sunny spot to place your bottle setup. *An outdoor location is best.*
11. Allow bottle distillation plant to sit undisturbed for at least 4 hours.
12. Use the worksheet to record observations.
13. Separate the top and bottle sections of the bottle and use a graduated cylinder to measure the amount of water collected in the bottom.
14. Set collected water aside.
15. Use a graduated cylinder to measure the amount of saltwater remaining in the beaker/cup.
16. After taking measurements, students may taste each sample and record their observations.
17. *Optional Extension: Repeat the activity with soda instead of saltwater.*



Check for Understanding:
Did students meet the lesson objectives? Can they answer the engagement questions? Below are some key takeaways and questions that students should be able to answer following the lesson.

Key Takeaways:
- Energy from the sun drives the water cycle and can be used to separate pure water from solution.
- El Paso Water uses technology to remove salt from brackish water to meet El Paso's need for safe drinking water.

Questions:
1. Where does the energy that drives the water cycle come from?
2. Which steps of the water cycle were observed in this experiment?
3. Why is technology to separate water from a saltwater solution important to El Paso?

Mini Distillation Plant - Worksheet

Name: _____ Date: _____

Instructions: Use this worksheet to answer the following questions and record your observations.

Before you begin, you should know:

1. When water is purified or cleaned by heating and cooling, this is called distillation.
2. What step in the water cycle happens when liquid water becomes a gas? _____
3. What step in the water cycle happens when water, as a gas, is cooled and becomes a liquid? _____
4. What step in the water cycle happens when water in the atmosphere returns to earth? _____

Problem:

There is a large amount of salty groundwater in El Paso's aquifers, but saltwater is not safe for people to drink.

Use your knowledge of the water cycle to predict how evaporation and condensation can be used to produce safe drinking water from saltwater.

Prediction/Hypothesis:

Follow your teacher's instructions to set up a distillation plant using recycled materials.

Draw Your Observations

Draw your distillation bottle setup before placing it in the sun.

Describe Your Observations

Describe your distillation experiment setup.

Measurements

Start Date _____

Start Time _____

Amount of saltwater solution prepared _____ mL

Draw Your Observations

Draw your distillation bottle setup after leaving it in the sun.

Instructions:

1. Draw arrows to describe how the water most likely moved within the distillation bottle.
2. Draw yellow arrows to show how light energy from the sun passed through the bottle to reach the water inside.
3. Label where each of the following steps in the water cycle likely happened in your distillation bottle.
    I. Evaporation
    II. Condensation

Describe Your Observations

Describe the changes you observed in your bottle.

Measurements

Stop Date _____

Stop Time _____

Amount of saltwater in beaker/cup _____ mL

Amount of water collected from bottle _____ mL

Taste Test - OPTIONAL

1. Describe the taste of the water collected in the bottle.

2. Describe the taste of the water still in the beaker/cup.

Mini Distillation Plant - Worksheet

Name: _____ Date: _____

Instructions: Use your recorded observations and online research to answer the following questions.

Cultural Application:

People in El Paso get most of their water from underground. Portions of the groundwater are salty.

Online Research:
Name the aquifer located under east El Paso that contains salty (also called "brackish") zones.

Which El Paso Water treatment plant removes salt from brackish groundwater?

What might happen if El Paso Water did not have technology to remove salt from water?

Conservation Application:

Separating salt from water takes time and energy.

When someone wastes water, El Paso Water must spend even more time and energy converting salty groundwater into safe drinking water. Otherwise, there would not be enough water to meet El Paso's needs.

Describe at least one way that you can save water and prevent water waste.

Analyze Your Observations

1. How much salt water did you collect from the bottle? _____mL
2. How much fresh water did you collect? _____mL
3. Does this add up to 100 mL?
4. What step in the water cycle is most likely responsible for a loss of liquid water during this experiment?
5. Where did the energy come from that caused the water in the beaker/cup to evaporate?
6. An adult needs to drink 3,000 mL of water every day. Did you produce enough water to supply an adult's drinking water needs for a whole day?
7. How much MORE water would you need to produce to have enough drinking water for a whole day?

   3,000 mL **-** _____ mL = _____mL
8. How many distillation bottles would you need to produce enough water to supply one adult's daily drinking water?

   Divide 3,000 mL by the amount of water collected in the bottom of your distillation bottle to find the number of distillation bottles you would need to produce one day's worth of water.

   3,000 mL **÷** _____ mL = _____ bottles
9. Explain why the following steps of the water cycle were not observed in this experiment.

   a. Precipitation

   b. Infiltration

   c. Runoff

Mini Planta de Destilación - Hoja de Trabajo

Nombre: _____ Fecha:

Instrucciones: Utiliza ésta hoja de Trabajo para responder las siguientes preguntas y registrar tus observaciones.

Antes de comenzar, debes saber:

1. Cuando el agua se purifica o limpia calentándola y enfriándola, a ésto se le llama destilación.
2. Qué paso en el ciclo del agua ocurre cuando el agua líquida se convierte en gas _____
3. Qué paso en el ciclo del agua ocurre cuando el agua, en forma gaseosa, se enfría y se convierte en líquido? _____
4. Que paso en el ciclo del agua ocurre cuando el agua de la atmósfera regresa a la tierra? _____

Problema:

Hay una gran cantidad de agua subterránea salada en los acuíferos de El Paso, pero el agua salada no es segura para el consumo humano.

Utiliza tú conocimiento del ciclo del agua para predecir cómo se pueden utilizar la evaporación y la condensación para producir agua potable a partir de agua salada.

Predicción/Hipótesis:

Sigue las Instrucciones de tú profesor para hacer una planta de destilación utilizando materiales reciclados.

Dibuja tus Observaciones

Dibuja tu botella de destilación antes de colocarla al sol.

Describe tus observaciones

Describe tu experimento de destilación.

Medidas

Fecha de inicio _____

Hora de inicio _____

Cantidad de solución de agua salada preparada ____ mL

Dibuja tus observaciones

Dibuja tu botella de destilación después de dejarla al sol.

Instrucciones:

1. Dibuja flechas para describir cómo probablemente se movió el agua dentro de la botella de destilación.
2. Dibuja flechas amarillas para mostrar cómo la energía luminosa del sol pasó a través de la botella para llegar al agua del interior.
3. Etiqueta dónde probablemente ocurrió cada uno de los siguientes pasos en el ciclo del agua en su botella de destilación.
    I. Evaporación
    II. Condensación

Describe tus observaciones

Describe los cambios que observaste en tú botella.

Medidas

Fecha de Finalización _____

Tiempo de Finalización _____

Cantidad de agua salada en vaso/taza _____ mL

Cantidad de agua recolectada de la botella ____ mL

Prueba de Sabor - OPCIONAL

1. Describe el sabor del agua recolectada en la botella.

2. Describe el sabor del agua que aún está en el vaso/taza.

Mini Planta de Destilación - Hoja de Trabajo

Nombre: _____ Fecha: _____

Instrucciones: Utiliza tus observaciones anotadas y tu Investigación en línea para responder las siguientes preguntas.

Aplicación Cultural:

La gente en El Paso obtiene casi toda su agua del subsuelo. Porciones del agua del subsuelo son saladas.

Investigación en Línea:

Nombra el acuífero localizado bajo el Oeste de El Paso que contiene zonas de agua salada (tambien llamadas “salobre”).

Cúal planta tratadora de agua que remueve la sal del agua subterránea salobre?

Qué podría pasar si El Paso Water no tuviera la tecnología para remover la sal del agua?

Aplicación de Conservación:

Separar la sal del agua toma tiempo y energía.
Cuando alguien desperdicia el agua, El Paso Water gasta más tiempo y energía convirtiendo el agua salada del subsuelo en agua segura para tomar. De otra manera no habría suficiente agua para cubrir las necesidades de El Paso .
Describe al menos una manera de cómo puedes ahorrar agua y prevenir el desperdicio.

Analiza tus Observaciones

1. Cuánta agua salada recolectaste de la botella? _____mL
2. Cuánta agua fresca recolectaste? _____mL
3. Ésto suma hasta 100 mL?
4. Cuál paso en el ciclo del agua es el responsable por la pérdida de agua?
5. De dónde vino la energía que hizo que el agua en el vaso se evaporara?
6. Un adulto necesita tomar 3,000 mL de agua al dia. Produjiste suficiente agua para abastecer las necesidades de agua potable de un adulto durante todo un día?
7. Cuánta MÁS agua necesitarías producir para tener suficiente agua potable para todo un día?

   3,000 mL **-** _____ mL = _____mL
8. ¿Cuántas botellas de destilación necesitarías para producir suficiente agua para abastecer el agua potable diaria de un adulto ?

   Divide 3,000 mL por la cantidad de agua recolectada en el fondo de tu botella de destilación para encontrar la cantidad de botellas de destilación que necesitarías para producir agua para un día.

   3,000 mL **÷** _____ mL = _____ botellas
9. Explica por qué no se observaron los siguientes pasos del ciclo del agua en éste experimento.
   a. Precipitación
   b. Infiltración
   c. Escurrimiento