TEMPERATURE & EVAPORATION - Teacher's Guide

DESCRIPTION:

Using a simple device set up outside the classroom, students collect data and learn about evaporation, a major water cycle component. They relate evaporation rates to the average temperature. The same materials can also be used to relate evaporation to wind speed, relative humidity, and surface area.

GRADE LEVEL(S):

8th

OBJECTIVES:

Students will:

- Calculate and record the amount of evaporation
- Graph evaporation and temperature data
- Draw conclusions about the relationship between evaporation rate and the average temperature

NEXT GENERATION SCIENCE STANDARDS:

This activity supports the following Performance Expectations:

MS-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

MS-PS3-4. Plan an investigation to determine the relationship among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

MS-ESS2-4. Develop a model to describe the cycling of water through earth's systems driven by energy from the sun and the force of gravity.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Analyzing and Interpreting Data	PS1.A Structure and Properties of Matter PS3.B Conservation of Energy and Energy Transfer ESS2.C The Roles of Water in Earth's Surface Processes	Cause and Effect

COMMON CORE STATE STANDARDS:

English Language Arts

RST.6-8.3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

Mathematics

8.EE.5. Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways.



Figure 1. Pan with Screen Lid

MATERIALS:

- Temperature and Evaporation Student Handout [1 per student]
- Pan with a screen lid (Fig. 1) [1 per group]
- 100 ml graduated cylinder [1 per group]
- Water bottle [1 per group]
- Ruler [1 per group]
- Fine point permanent marker [1 per group]
- Colored pencils [1 set per group]

BACKGROUND:

Despite many people's perceptions, deserts are not characterized by great heat or vast areas of shifting sand dunes. The foremost characteristic of deserts is their aridity (dryness). A simple definition of a desert is any area that receives less than ten inches of precipitation a year. A more accurate definition of a desert is any area that receives less precipitation than could potentially evaporate.

Evaporation is a major part of the earth's water cycle. It is the process of water molecules gaining enough energy to escape the surface of a water layer. In the water cycle, water from lakes, ponds, rivers, streams, and oceans is heated by the sun and converted into water vapor. This vaporrises into the air and may result in the development of clouds.

Many factors can affect evaporation. Heat makes water evaporate more quickly because water molecules move faster when they are warm. Since the molecules are moving faster, more of them can leave the water's surface at one time. The amount of water vapor in the air (humidity) also affects evaporation rates. For evaporation to occur, the humidity of the atmosphere must be less than the evaporation surface (at 100% relative humidity, there is no evaporation). Wind also helps water evaporate more quickly by blowing away moist air from the water surface, thus bringing in less humid air with room for more water molecules. Finally, the surface area of the interface between air and water also affects evaporation. Since evaporation only occurs at the interface between air and water, larger surface areas mean that more water is available for evaporation.

TIPS FOR ENTIRE CLASS PARTICIPATION:

- Divide the class into groups and give each group an evaporation pan setup.
- With multiple groups, it is important that the pans are placed in areas with equal amounts of sunlight.

PROCEDURES:

1) We recommend that this activity is done on three consecutive days, approximately once a month. Readings are taken 48 hours apart. For example, if the experiment is set up on September 8 at 9:30 am, readings are taken on September 10 at 9:30 am. Readings should also be taken in subsequent months to get a variation of average high temperatures.

2) Explain the background, as needed, to the class.

3) Hand out student worksheet packets and have students write down their own hypothesis about what they believe they will observe in reference to the relationship between evaporation rate and the average temperature.

4) Divide the class into groups.

My Observations of Temperature & Evaporation Data Sheet

Date experiment started: April 6, 2022 Date experiment ended: June 10, 2022
Location of experiment: South end of parking lot
Time: 12:15 pm My group number: Sample 3

Volume of water added (in ml): 253 ml

High temperature on day experiment started (in °C): 15.9 °C
High temperature on second day of experiment (in °C): 15.1 °C
Average High Temperature (in °C): 15.5 °C

Surface Area of Pan (length in cm x width in cm= cm^2) 600.25 cm^2 (1 inch =2.54 cm)

Evaporation per unit of surface area (water added divided by surface area) 0.422 ml/cm^2

Class Average Data Table

Group	Volume of water added (ml)	Evaporation /surface area(ml/cm^2)	Average temperature (°C)
1 Sample 1	250 ml	0.416 ml/cm^2	15.5 °C
2 Sample 2	256 ml	0.426 ml/cm^2	15.5 °C
3 Sample 3	253 ml	0.422 ml/cm^2	15.5 °C
4 Sample 4	253 ml	0.422 ml/cm^2	15.5 °C
5			
6			
7			
8			
9			
10			
Class Average	253 ml	0.422 ml/cm^2	15.5 °C

Figure 2. Example Page 1 Temp. & Evap. Data Sheet

5) Give each group a pan and have them use a fine-point permanent marker to make a line 5 centimeters from the bottom of the pan; this will be used to indicate the fill depth of the water in the pan.

6) Have students place the lid on the pan, and place the pan in a sunny area in the schoolyard.

7) Students should slowly add water to the pan until the water level reaches the 5 cm mark on the pan. The position of the viewer's head will affect how the water level is perceived, so view the pan from the same position each time water is added.

Class Temperature & Evaporation Data Sheet

Time: 12:15 pm Location of experiment: South end of parking lot

Dates	Evaporation / surface area (ml/cm^2)	Average High Temperature (°C)
April 6-8, 2022	0.422 ml/cm^2	15.5 °C
May 9-11, 2022	0.444 ml/cm^2	18.5 °C
June 8-10, 2022	0.491 ml/cm^2	23.0 °C

Figure 3. Example Page 2 Temp. & Evap. Data Sheet

8) After 48 hours, students will use the 100 ml graduated cylinder to add water to the pan until it reaches the original mark. Use a plastic water bottle to refill the graduated cylinder when more

than 100 ml are needed. Have students record the date and the volume of water added on page one of the worksheet packet.

9) Have students find the high temperature for the experiment days, either on the internet or in the newspaper. Average the high temperatures and record the average on the "My Observations of Temperature & Evaporation Data Sheet" (page one of their data sheets – see Fig. 2).

10) If it rains during the experiment, stop the experiment and restart it the following day.

11) On the "My Observations of Temperature and Evaporation Data Sheet," have students calculate the pan's surface area in square centimeters (length x width).

12) Divide the evaporation by the surface area of the pan. This will give us the evaporation per unit area of the pan and allow comparisons with others with different-sized pans.

13) All groups report their data and record it on the "Class Temperature & Evaporation Data Sheet" (page two of their data sheets – see Fig. 3). Calculate the classaverage, and record this average on page one of the worksheet packet.

14) Graph the class averages each month to help develop conclusions (see Fig. 4).

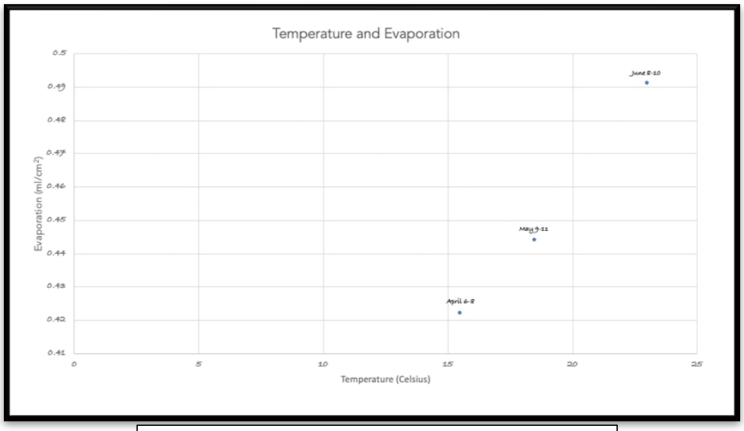


Figure 4. Example Temp. & Evap. Graph

CONCLUSIONS:

Allow students to draw conclusions from the graphs. Students should answer the following:

- How does temperature affect the evaporation rate?
- How does this experiment relate to desert conditions?
- Are there other possible explanations for the different evaporation rates on different days?

EXTENSIONS:

Students can use the same setup to investigate the effects of wind speed, relative humidity, and pan surface area on evaporation. Surface area information can be related to evaporation from lakes, rivers, and even swimming pools in the desert southwest.