673-0090 (45-050)
Water Cycle Kit

Each complete kit will contain enough materials for up to 32 students working in groups.

Quantity	Description	Item Number
	Teacher pages	24-5050
	Student instruction pages	24-5050
	Student journal pages	24-5050
16	Thermometers	032020
8	Aluminum cans	10-7120
16	Sample containers, clear	020246
1	Sponge	032022
1	Tablespoon	032024
8	Plastic plates	032025

Making Dew: Evaporation and Condensation: Student Instructions, Journal Page,Teacher Edition
Making Dew: Humidity and Dewpoint: Student Instructions, Journal Page, Teacher Edition
Making Dew: Deposition and Sublimation: Student Instructions, Journal Page, Teacher Edition
Weather: Terms and Factors of Weather

Warranty and Parts:

We replace all defective or missing parts free of charge. Additional replacement parts may be ordered toll-free. We accept MasterCard, Visa, checks and School P.O.s. All products warranted to be free from defect for 90 days. Does not apply to accident, misuse or normal wear and tear. Intended for children 13 years of age and up. This item is not a toy. It may contain small parts that can be choking hazards. Adult supervision is required.

P/N 24-5050

Making Dew: Evaporation and Condensation

Objectives

- To discover why wet clothes dry on their own and why cold beverage glasses get wet on the outside
- To learn the difference between evaporation and condensation

Materials

- Plastic plate, 1
- Different colored crayons, 2 (per group)
- Salt water (per group)
- 1 can of cold soda pop (per group)
- Student Journal Pages
- Balance

Background

Water exists in three forms on the Earth - solid (ice), liquid (water) and gas (water vapor). Solid objects have little space between the molecules and so the molecules can't move around. Liquids have more room to move around and the molecules can flow past one another. Gases have lots of space between the molecules and they can move around the room at high speeds. Which phase do you think has the most energy in it?

Because ice, water and water vapor are all made of water molecules, they can change from one form to another. You have probably watched ice melt on a hot summer day. There are six (6) main phase changes that any material can undergo. Your teacher may show you a diagram that shows these changes.

In this activity, we will be learning about evaporation and condensation.

During, **evaporation**, liquid water molecules absorb heat energy to speed up and spread out to become water vapor molecules.

During **condensation,** water vapor molecules give off heat energy, come closer together and slow down to become liquid water molecules. Condensation is the opposite of evaporation.

Procedure

1. The teacher will open class with a discussion. Write the topic on your Journal Sheet. Then, fill in the section on what you know about this topic

Section 1 - Evaporation

2. Your group must select a location for your evaporation experiment. Your teacher will write all the locations on the board. You should record these locations on your Journal Sheet.

3. Put a small puddle of salt water on the plate. Draw a circle around the puddle with one of your crayons. Write a hypothesis about what you think will happen to the puddle. Leave the plate for a few hours. (You can do the next activity while you wait.) Circle the puddle with the other crayon at the end of the day.

Section 2 - Condensation

4. Obtain an unopened can of cold soda pop. Weight the can immediately and record the mass on your Journal Sheet. Set the can on the table or desk. Leave the can on the desk or table for twenty (20) minutes, then re-weigh and record the mass.

5. While you are waiting, make a hypothesis about the weight of the can before and after the 20 minutes. Will the can weight more, less or the same as it did at the beginning of the experiment?

6. Be sure to record observations on your Journal Sheet as well. Does the can have any cracks or holes? What other things do you notice happening? What explanations do you have for these changes?

Conclusions

7. When you have finished both sections of this activity, answer the Think It Over questions on your Journal Sheet.

Name _____ Date _____

Class _____

Investigating

Evaporation and Condensation

Discussion Topic: _____

What you know	What you learned	Questions you still have

Section 1: Evaporation

Location	Results

Hypothesis:

The puddle will look_____ after a few hours.

The puddle will look _____ if we leave it overnight.

Results: _____

_____

_____

Section 2: Condensation

Mass of soda pop can at beginning of experiment	**grams**
Mass of soda pop can after 20 minutes	**grams**

Hypothesis:

I think the can will weigh_____ after 20 minutes of sitting out on the table or desk.

Observations: _____

_____

_____

Think It Over

1. Explain why wet clothes dry on their own if left hanging on a clothesline _____

_____

2. Why do clothes dry faster on a hot, sunny day than on a cold, cloudy day? _____

_____

3. What other examples of evaporation can you think of? _____

_____

4. Explain why a cold drinking glass gets wet on the outside. Where does the liquid come from? _____

_____

5. What other examples of condensation can you think of? _____

_____

Making Dew:

Humidity and Dewpoint

Objectives

- To create dew and measure the dew points of different air samples.
- To discover how humidity affects dew point.

Materials

- Dry sponge
- Teaspoon and cup of water
- Two (2) clear jars or bottles (per group)
- Two (2) thermometers (per group)
- Weather report for today
- Boiling water (steamy air)
- Cool water bath
- Ice bath
- Student Journal Pages

Background

Rain is common in most parts of the country. Do you know why? Today we will explore the concepts of dew point and humidity and discover how they are related.

The term **humidity** means the amount of water vapor in the air. Warm air can hold more vapor than colder air. Humidity is usually given as a percentage of the total amount of water vapor the air can hold at that particular temperature. This percentage is called **relative humidity.** Precipitation (rain) occurs when the relative humidity reaches 100% and the air is holding all of the moisture it can hold. Since warm air can hold more moisture than colder air, some of the vapor must turn back into water when a warm air sample is cooled.

Dew point is the temperature at which water vapor in the air turns into liquid water droplets (condensation begins to occur). Dry air (holding less moisture) has a different dew point than air that is moist or humid. If you live near the ocean, you have probably noticed that the air is usually moist or humid, and it rains quite often. If you live in the Midwest or desert areas, where there are not many lakes, streams and water around, you probably experience the opposite - dry air and little rain. So when warm air rises, it cools and some of the water vapor condenses and stays up in the air. Do you know what this is called?_____ (If you said a cloud, you are right.) Do you know what we call a cloud that forms close to the ground? _____

Follow the directions below to discover all about the water around you that you never notice - water vapor in the air!

Procedure

1. Read over your Journal Sheet. Fill in the current weather and weather report sections - many schools have weather stations you can use. Be sure to note things like:
   Temperature (current temperature if available - you can use your thermometer out a window)
   Humidity or relative humidity
   Conditions (cloudy, sunny, rainy)
   Visibility
   Any other information you have available. The more information, the better!

2. Your teacher has a dry sponge to which water will be added until it overflows.
   How many teaspoons of water do you think the sponge will hold before it overflows?
   Record this on your Journal Sheet.
   How many spoonfuls did it actually hold before it leaked all over?
   Record on your Journal Sheet.
   Create a hypothesis to answer this question on your Journal Sheet:
   "As humidity increases, how does dew point change?"

3. Label your clear containers "regular air" and "steamy air."
   In the "regular air" container, collect air from a location in the room away from the boiling water.
   Be sure to insert the thermometer halfway into the jar before sealing it and returning to your experiment area.

4. Hold your bottle by the neck and push it down into a cool water bath so that only the neck of the bottle is above water. Watch the temperature on your thermometer go down until water droplets form on the inside of the jar. Record the temperature when these water droplets form. This is the dew point for your air sample.
   If no water droplets form, put the bottle into the ice bath, checking every 10 seconds for water droplet formation.

5. In your "steamy air" bottle, collect some steamy air from **near** the boiling water.
   CAUTION: Water vapor can easily burn your skin badly. It is extremely hot! Do NOT get too close to the boiling water container.
   Be sure to seal the bottle and insert the thermometer half-way into the jar before bringing it back to your experiment area.

6. Repeat Step 4 with the steamy air sample. Record the dew point on your Journal Sheet.

7. Compare the dew points of the two air samples to answer the questions:
   "As humidity increases, how does dew point change?" in your conclusion.

Name _____ Date _____

Class _____

Investigating Humidity and Dew Point

Look out the window and describe today's weather right now.

_____

_____

_____

Record today's weather report here, including high and low temperature, forecast, humidity, dew point and any other available information.

_____

_____

_____

How many spoonfuls of water **will** the sponge hold before it starts to drip all over? _____

_____

How many spoonfuls **did** the sponge **actually** hold before it started to drip all over? _____

_____

Hypothesis:

As humidity increases, dew point _____

Data:

Air Sample	Observations	Dew Point (° C)
Regular air		
Steamy air		

Conclusion:

As humidity increases, dew point _____. Was your hypothesis correct?

Draw a graph to represent the relationship between dew point and humidity.

Think It Over:

1. How can we apply this investigation in terms of "saturation"? Think of a hot sunny day in Florida. The air feels "sticky" because the humidity is very high (it seems to "stick" to your skin) and your sweat drips from your forehead, instead of evaporating away. What type of weather occurs when the air becomes saturated with water vapor?

   _____

2. Why does it rain nearly every day in Southeastern U.S. cities? _____
   ___

   _____

   _____

Challenge:

3. Do you think that people will someday invent a weather-changing machine? Why or why not? What factors would this machine have to control in order to be successful in changing natural weather patterns?

   _____

   _____

   _____

   _____

   _____

Making Dew: Deposition and Sublimation

Objectives

- To discover how and why frost occurs
- To learn the difference between sublimation and deposition

Materials

- One aluminum can (per group)
- One thermometer (per group)
- Ice (not included)
- Stirring rods (optional)
- Rock salt
- Video clip of sublimation (optional)
- Student Journal Pages

Background

Today you will be learning about the phase changes that convert gases to solids and solids to gases. Because these changes skip over the liquid phase, they are much more rare and usually don't occur with all substances. Let's investigate more.

Some of you may have heard of "dry ice." Dry ice is the common name for solid carbon dioxide (CO_2). It is called this because the solid CO_2 does not melt into its liquid form but turns directly into a gas. This transformation is called **sublimation.**

Can you think of why it might be advantageous to use dry ice instead of "regular" ice? _____
_____

The sublimation of dry ice occurs because the solid CO_2 is very cold and is formed under high pressures (forcing the molecules to become tightly packed, as in all solids). Once the pressure is lowered (open to the air outside its container), or the temperature is raised (outside on a hot summer day), the molecules gain a lot of energy all at once and break free of the forces holding them so close together.

Of course, every process in the water cycle has an opposite process. The opposite of sublimation is deposition.

Deposition is the technical name given to a phase change from a gas directly to a solid. Again, we skip the liquid phase completely. This can be seen in nature as snow. Snow forms in clouds high above the land, where it is very cold (especially in the wintertime). The water vapor that gets trapped inside a cloud gets super-cooled and forms ice crystals instead of rain drops. Deposition occurs when the dew point of the air is below the freezing temperature of a gas (in this case, water vapor).

Today we will demonstrate the process of deposition by changing water vapor into ice crystals - we will make frost.

Procedure:

1. If your teacher has access to a video clip of sublimation, watch it and write down any observations you have about the process. Be careful to note its appearance before, after and during the change; the temperature (if available - otherwise, make a hypothesis and have it checked by your teacher) of the solid, the surrounding air and the gas; and any other information you can gather.

2. If a video clip is not available, your teacher may have a discussion prepared with photographs or other visual aids.

3. Fill your can with ice and add five (5) handfuls of rock salt. Then fill the can half-way with cold weather.
   Use your stirring rod (or thermometer) to **gently** stir the water in the can.
   Watch the temperature on the thermometer drop to below 0° C.
   If the temperature doesn't get that low within two (2) minutes, add more rock salt to the can.

Conclusions:

4. When you have finished this activity, answer the "Think it Over" questions on your Journal Sheet.

Name _____ Date _____

Class _____

Investigating

Sublimation and Deposition

Appearance Before Change	Appearance During Change	Appearance After Change
Temperature of Solid	**Temperature of Surrounding Air**	**Temperature of Gas**
Other observations:		

Making Frost:

Temperature when ice crystals started to form: _____

Observations during and after the formation of frost: _____

___

_____

_____

_____

Think It Over:

1. Why must the ice water be colder than 0° C? What if it was warmer than 0°?

_____

_____

_____

2. Describe the flow of heat between the following items: can, ice water, water vapor.
(Which item is the coldest and what is it directly cooling?)

_____

_____

_____

3. Using your answer to Question 2, state why frost only forms on the outside of the can and not everywhere in the room.

_____

_____

_____

4. What happens to the frost on a car window on a sunny day? Where does it go?

_____

_____

_____

The Water Cycle

Teacher Pages

Benchmarks and Standards

This investigation provides support for the *Benchmarks for Science Literacy* and *National Science Education Standards* shown in the table below.

Benchmarks for Science Literacy			*National Science Education Standard*	
Grades K-2 **The Physical Setting**	**4B.1**	"Water can be a liquid or a solid and can go back and forth from one to the other."	Grades K-4 **Physical Science Content Standard B.1 -** Properties of Objects and Materials	"Materials can exist in different states - solid, liquid and gas. Some common materials, such as water, can be changed from one state to another by heating or cooling."
Grades 3-5 **The Physical Setting**	**4B.2**	"When liquid water disappears, it turns into a gas (vapor) in the air and can reappear as a liquid when cooled, or a solid if cooled below the freezing point of water. Clouds and fog are made by tiny droplets of water.	Grades K-4 **Physical Science Content Standard D.1** - Changes in the Earth and Sky	"The surface of the earth changes. Some changes are cyclic due to slow processes, such as weathering and erosion, and some changes are due to rapid processes such as landslides, volcanic eruptions and earthquakes."
Grades 6-8: **The Physical Setting**	**4B.3**	"The cycling of water through the atmosphere plays an important role in determining climatic patterns. Water evaporates from the surface of the earth, rises and cools, condenses into rain or snow, and falls again to the surface. Water falling on land collects in rivers and lakes, soil and porous rocky layers. Much of it flows back into the ocean."	Grades 5-8 **Physical Science Content Standard B.1 -** Properties and Changes of Properties in Matter	"A substance has characteristic properties such as...boiling point...all of which are independent of the size of the sample."
			Grades 5-8 **Physical Science Content Standard d.1** - Structure of the Earth System	"Water, which covers a majority of the earth's surface, circulates through the crust, oceans and atmosphere in what is known as the water cycle..."

Notes:

This lab kit was designed to aid teachers in the presentation and demonstration of the physical state changes associated with the water cycle. These activities work best in the following progressions:

Evaporation and condensation
Humidity and dew point
Sublimation and deposition

These activities were mainly focused for sixth to eighth grade students but can easily be simplified for younger student. Any preliminary discussions involving phase changes students may be familiar with are helpful as anticipatory Sets or even as introductory lessons, if you don't wish to utilize these activities as inquiry teaching tools.

Discussion topic suggestions:

Condensation on a cold beverage glass or a bathroom mirror
Properties of fog/ dew/ frost
Why are you cold when you're wet?
Sweating as a means to cool the body
Properties of dry ice and clouds-
Breath condensation ("seeing your breath") in the cold winter air
Warm climates' versus cold climates' "wet air" (higher humidity in warmer climates, typically).

Beginning demonstrations:

1. Use a wet sponge to wet students' hands, then ask them to make observations on where the water goes and how their hand feels (cold)
2. Wash the chalkboard and ask where the water went
3. Use the sponge to demonstrate the concept of saturation.
   Have students make predictions.
   Then add one (1) teaspoonful of water at a time until it starts to "rain"
4. Use today's weather map to point out where it is raining.
   Ask: "Why are some areas more rainy than others?"

Brief lesson plan:

1. Choose a discussion topic and write it on the board. Have students copy it onto their Journal Page and fill in the "What I know" column for this topic.
2. Have students work in groups to complete the procedure and fill in the rest of the Journal Sheet.
3. Feel free to add additional questions at the end as Homework or Challenge questions. Many of these activities build on previous observations.

Before they begin:

Have students read the background section of their labs and go over any necessary vocabulary terms for the topic.

Setup Needed:

For the Evaporation and Condensation activity:

You will need one can of **cold** soda pop for each group to observe for twenty (20) minutes. Since they don't need to open them, you can reuse them for successive classes, provided you re-chill them between classes.

Salt water can be easily prepared for this activity. You can add about ten (10) grams to 100 mL of water.

You will also need balances so the students can weigh the pop cans before and after they starting "sweating." Some electronic balances cannot accommodate the cans because they are too heavy - be sure to check before the activity.

Students should notice the can getting heavier to indicate that vapor from the air is condensing on the can and adding more mass to the balance.

For the Humidity and Dew Point activity:

The "Background: section asks the students what we call a cloud that forms close to the ground (fog).

You will need to set up a cool water bath and an ice bath in basins about 5-6" deep. You should also bring some water to a boil on a hot plate in one corner of the room. Also, for younger students, the teacher should collect the "steamy air" for the students.

There is a demonstration at the beginning of the lesson so be prepared with your dry sponge, spoon and cup of water handy.

For the Sublimation and Deposition activity:

The "Background" session asks students to identify some benefits to the use of dry ice (colder; no wet puddle; less dense, or lighter, than ice) or any other facts they could find that are relevant to this topic.

You will need access to water, lots of ice and a bag of rock salt.

Stirring rods are optional but suggested to preserve your thermometers.

Extensions of this activity:

These topics can easily springboard into discussions and investigations of weather, meteorology (predicting weather), climate, and other natural phenomena such as flooding, hurricanes, and tornadoes.

Assessment:

Collect or review the Journal sheets to be certain students are not misinterpreting their observations. It is important that the teacher guide student discoveries to lead to a correct conclusion.

Answers to "Think It Over" Questions

For the Evaporation and Condensation activity:

1. The water evaporates
2. The air has a higher temperature and more energy to "share" with the wet clothes
3. Any other evaporation examples
4. Water vapor from the air condenses on the cold soda pop can.
5. Any other condensation examples.

For the Humidity and Dewpoint activity:

1. It rains.
2. The air can only hold so much moisture. Where there is more water vapor in the air than it can hold, it rains.
3. Students should state their opinion yes/ no and defend it. They should cite that the machine would have to control many factors, including, among others, humidity and air currents (air pressure).

For Sublimation and Deposition activity:

1. The freezing point of water is 0° C; all ice is at, or colder than, 0° C. If it were warmer, water droplets would form on the can instead of ice.
2. The ice water cools the can and the can cools the water vapor in the air.
3. The water vapor molecules must touch the can in order to be cooled.
4. It sublimes or melts into liquid water.

Weather: Terms to Learn

Weather
The condition of the earth's atmosphere at a particular time and place.

Climate
The average, year after year conditions of temperature, precipitation, winds and clouds in an area.

Atmosphere
The layer of gases that surrounds the planet. Earth's atmosphere makes conditions on earth suitable for living things.

Composition of our Atmosphere
Mostly nitrogen and oxygen. Contains smaller amounts of carbon dioxide, water vapor and other gases.

Water Vapor
Water in the form of gas. It is measured as humidity.

Air Pollution
The result of burning fossil fuels such as coal, oil and gasoline. Other natural sources such as volcanic eruptions and forest fires will also put particles into our air.

Air Pressure
The weight of the air pushing down on a given area.

Barometer
A device that measures air pressure.

Altitude
The distance above sea level. Air pressure decreases as altitude increases.
Temperature decreases as altitude increases.

Wind
The horizontal movement of air from an area of high pressure to an area of lower pressure. All winds are caused by differences in air pressure.

Water cycle
The movement of water between the atmosphere and earth's surface. The four stages of the water cycle are:
1. Evaporation
2. Condensation
3. Precipitation
4. Surface runoff

Evaporation
The process of liquid water turning to water vapor (water in gas form) and entering the air around it.

Condensation
The process of water vapor (water in gas form) turning to liquid form.

Precipitation
Any form of water that falls from clouds and reaches the earth's surface.

Surface Runoff
The water that runs off the surface of the earth or moves back through the ground and into oceans, lakes and streams.

Types of precipitation
The five main types of precipitation are:
1. Rain
2. Snow
3. Sleet
4. Hail
5. Freezing Rain

Factors of Weather: Moisture

The Water Cycle

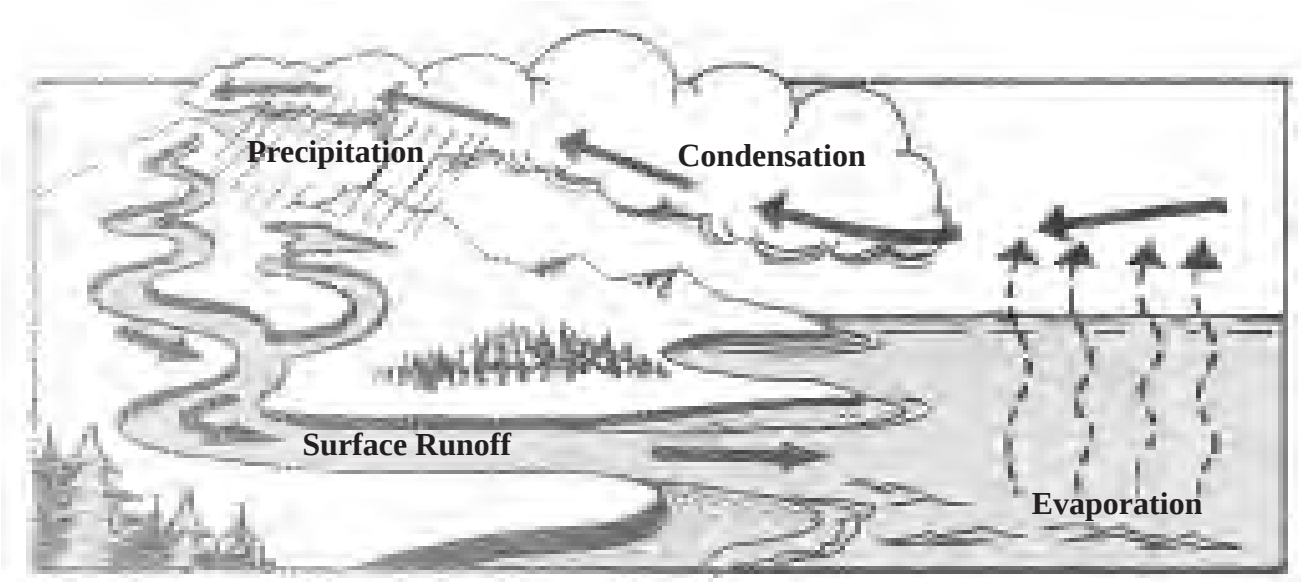
Moisture is another property of air that affects weather. Moisture in the atmosphere occurs in its solid, liquid and gaseous states. Let's take a look at how moisture becomes part of the air.

Water enters the atmosphere by evaporation. Most of the moisture evaporates from oceans and seas. However, water also evaporates from lakes, streams, ponds, puddles, and from the soil. Water evaporates from the leaves of plants and from animals as they sweat or exhale. It even evaporates from laundry hanging out to dry. The water vapor that is in the air is called humidity. This is the gaseous state of water.

Moisture is affected by temperature. Warm air is able to hold more water vapor than cold air can. In many areas, warm summer days are very humid, while cold winter days are very dry.

As you may remember, warm air is less dense than cooler air. The warm air rises. As the warm, humid air meets colder air in higher parts of the atmosphere, the water vapor may begin to condense. Clouds form as droplets of condensed water collect and remain suspended in the air. Some water droplets may combine. The cooler, higher air is not able to hold as much water as the warmer air below it. The larger, heavier water droplets return to earth as precipitation. Precipitation may be in the form of rain, sleet, hail or snow. These are the liquid and solid states of water.

As precipitation enters the oceans, lakes, streams, soil etc. it begins to evaporate. The water cycle continues, allowing earth's water to be used over and over again.



As water travels through the cycle, it may be found in its solid, liquid and gaseous forms.