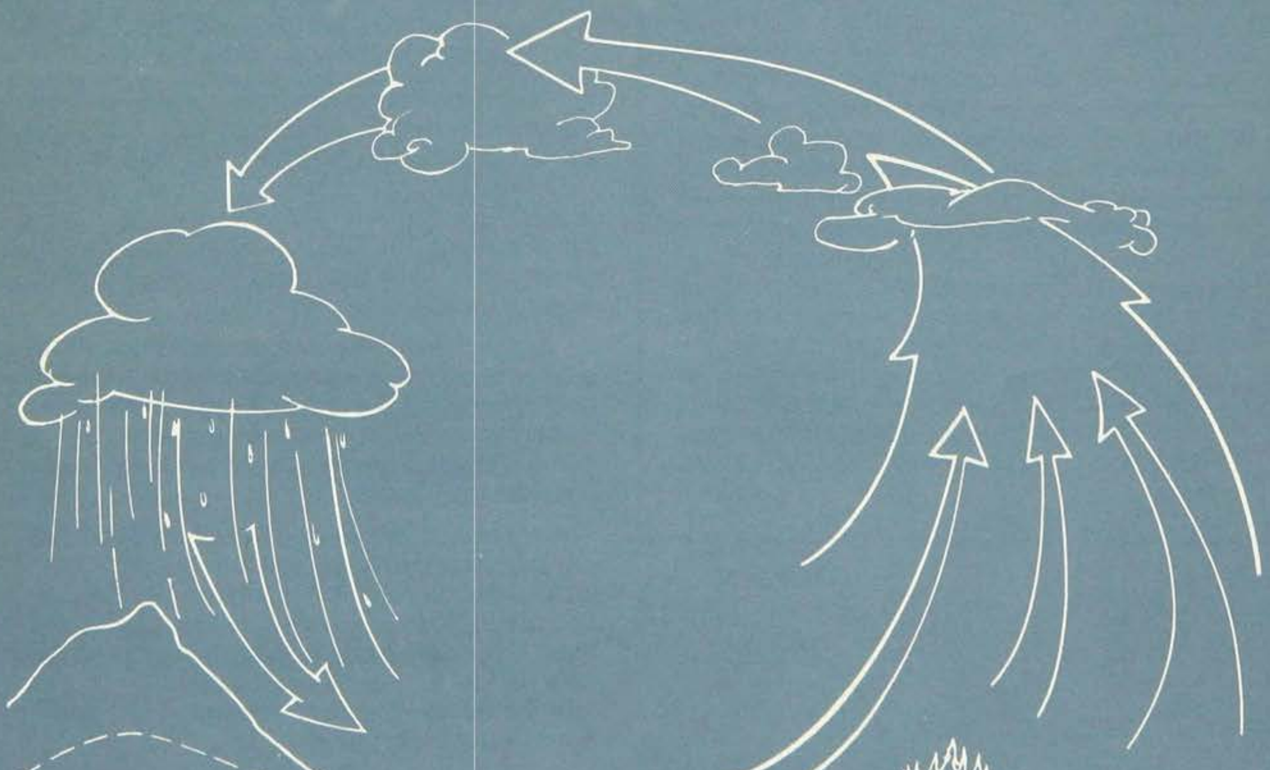
4-H M-240

OUR WORLD OF WATER



AGRICULTURAL EXTENSION SERVICE UNIVERSITY OF MINNESOTA

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Words in bold print throughout this publication are defined in the Glossary on page 18.

INTRODUCTION

The dictionary defines "resource" as "an available supply that can be drawn upon when needed." Water is one of our great natural resources, but how available is it?

As the world's population increases, we need more food, industrial products, and water. Water is needed in the home for drinking, bathing, laundry, dishes, and lawn sprinkling. And more water than you might think is needed to help farmers and industry produce their products; for example:

- it takes nearly 200 gallons of water to produce one dollar's worth of paper.
- we use over 150 billion gallons of water each day in this country for irrigation.

We must seek new sources of water and, more importantly, recycle our current water resources. After all, water is a reusable resource like wood (we recycle newspapers to use fewer trees). When water is used it ends up with salts, **minerals,** and chemicals dissolved in it. This water must be cleaned before it can be used again, and the cost of purifying water is increasing every year.

As the demand for water increases, conflicts arise between neighbors and between nations concerning who has the right to use available water. Wise management of water resources can settle some of these disputes and will result in the best possible use of water.

This project is designed to help you appreciate the importance of water and the need for wise water management. If you are to understand water as a natural resource, you must also understand what it is, where it comes from, and where it goes after we use it. This project should help you see why the future of our water resources depends on how we use them today.

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PHYSICAL PROPERTIES OF WATER

The chemical formula for water is H_2O, which means it is a **molecule** consisting of two **atoms** of hydrogen and one of oxygen. These three atoms are **bonded** tightly together, more so than the atoms of most other substances. This tight bond and arrangement of atoms in the water molecule results in the following five unusual properties:

1. Three Forms

Water is the only substance that occurs naturally on earth in three forms: solid, liquid, and gas. In liquid water, the molecules of hydrogen and oxygen are close together but are able to slip past one another, which is why it flows. Examples of this are a river, a waterfall, or water coming out of your faucet.

When the temperature drops, the water molecules slow down and become sluggish. As it becomes cold enough for the water to freeze, the molecules rearrange themselves into hollow rings. This is why water expands when it freezes, unlike most other substances which contract. This expansion in the solid phase is the reason why ice cubes float in a glass of water. The ice is actually lighter or less dense than the liquid water.

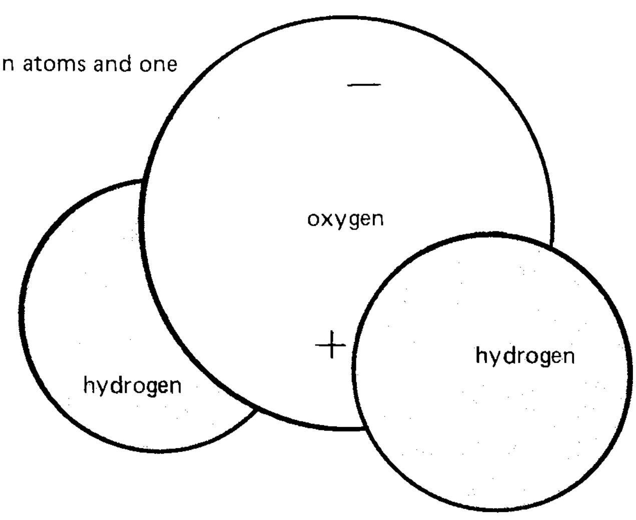
Water also occurs in the gaseous phase, such as steam rising from a boiling tea kettle. As water is heated, the molecules move about violently, colliding with one another, until some break free and form a **vapor,** or gas.

EXPERIMENT #1

To see how easily water can change forms, try the following experiment. First melt some ice cubes in a pan on the stove. Bring the same water to a boil and place a cover on the pan to catch the steam. The steam should condense into small **droplets** of water when it contacts the cover. Next, place the cover with the droplets of water into the freezer until the droplets freeze. Can you think of how man uses this ability of water to change forms? Think of how you change forms of water when you use it. Find out if it is possible for water to change from a solid form (ice) to the gaseous form (vapor) without becoming liquid.

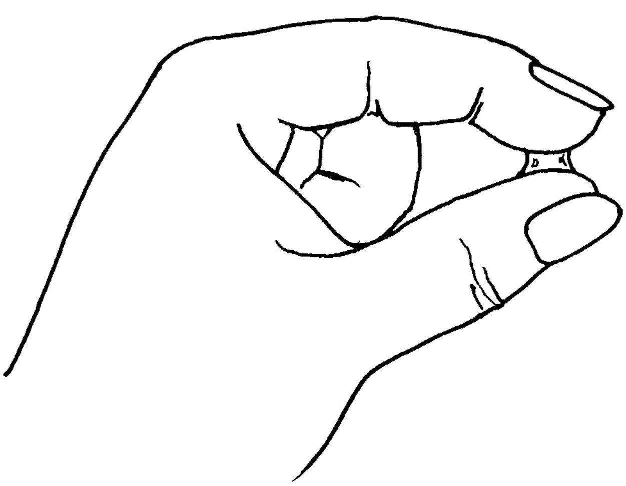
When various materials are dissolved in water, they can change the properties of the water. To see this, take two containers of equal size and put into each the same amount of water. Pour salt into one of the containers, label the container, stir until the salt dissolves and then place both containers in the freezer and mark the time. (Note: do not use large amounts of water because it will take a long time for this to freeze.) See how long it takes for both to freeze. Can you think of why they put salt on icy roads during the winter? Ask your parents why anti-freeze is important for their car.

The water molecule--two hydrogen atoms and one oxygen atom bonded together.



2. Surface Tension

Water has a high surface tension. This is the ability of a substance to stick to itself. A drop of water falling from the rim of a faucet will stretch itself very thin before it drops off. Then it immediately forms a sphere and resists any kind of shape change. This high surface tension enables a water surface to support small objects like waterbugs, because their weight distribution will not permit them to break through.



EXPERIMENT #2

Can a needle float on water? Drop a sewing needle into a container of water and watch it sink. Now, take a strip of paper and make a loop. Carefully rest the needle in the loop and lower it slowly onto the water, being careful not to break the water surface with the needle. Keep pushing the paper down slowly, and gently pull it away after the needle has floated. This may take several tries before it is accomplished. Look very closely at the contact between the needle and the water. Notice the indentation the needle makes on the water surface.

Have you ever held water between your fingers? Place the tips of your thumb and index finger together in water. When you pull them out of the water, slowly open up a small space between them. You should catch some water between your fingers and be able to hold it there no matter how you move your hand. See what happens when you open up your fingers. Does the water stay between your fingers? Try this with very soapy water. Can you still capture some of the soapy water between your thumb and index finger? What does the soap do to the surface tension of the water?

3. Heat Capacity

Another unusual property of water is displayed when it is heated. Water has an extremely high **heat capacity,** which is the ability of a substance to absorb heat without becoming extremely hot itself. This is why it takes a long time for water to boil. An empty pan placed over a hot flame will become red hot and then burn black. However, if some water is placed in the pan over the same flame, the pan will become hot, but not red hot as before since most of the heat will be absorbed from the pan by the water. In like manner, your body cools when you sweat because body heat is absorbed when sweat **evaporates.**

The heat capacity of water enables the oceans to act as huge reservoirs of solar warmth and keeps our weather from going to great extremes of heat or cold. The moderating effect of water is noticeably absent from a desert, where days tend to be very hot and nights cold.

4. Solvent Abilities

The most remarkable aspect of water is its ability to dissolve so many substances; that is, to act as a solvent. For example, some caves form when **acidic** ground water dissolves **limestone bedrock.** The substance that is dissolved is called the **solute,** and the liquid mixture is called a **solution.** Most water on the earth is actually a solution. Rainwater is the purest naturally occurring solution of water and contains few dissolved substances.

EXPERIMENT #3

Collect rainwater in a clean glass or metal container and fill another container of similar shape with an equal amount of water from your faucet. Label the containers and place them in a warm place to evaporate. When all of the water has evaporated from both containers, check them for any residue. Which container has the most residue in it after the water evaporates?

The degree to which water has a distinctive taste or odor depends on the types of substances dissolved in it. Since water is not changed chemically when it acts as a solvent, it can be recovered for reuse after undesirable dissolved substances are removed. The amount of dissolved substances in water is affected by factors such as water temperature and the nature of the material water moves through.

EXPERIMENT #4

Take two containers of equal size and fill one with cold water and the other with hot water from your faucet. Make sure each container has an equal amount of water. Measure a ¼ teaspoon of salt into each container, stir to dissolve. Keep adding salt by the same amount to each container and see which temperature of water will dissolve the most salt. Keep a record of the number of times you added a ¼ teaspoon of salt to each container. Be sure to stir the water each time you add the salt. What would happen if you dissolved as much salt as possible in hot water and let the water cool to near freezing temperatures? Try this. Do you think that instant coffee or cocoa would dissolve as rapidly in cold water as hot water? Think of some environmental problems related to water's ability to dissolve so many substances and the effects of dumping hot water containing dissolved pollutants into cooler river water.

Mix some salt with water until it has a definite salty taste. Pour this into a pot and bring to a boil. Catch some of the steam using a pan lid. When it cools, taste the water collected on the pan lid. What happened to the salt? Find out what distilled water is and how it is prepared. Why is it best to use distilled water in a steam iron? If all the water in the oceans evaporated, what would be left? Look in an encyclopedia and find out how the Bonneville salt flats were formed.

Streams running through areas where there are few people will generally have a better quality of water than streams running through populated areas. Can you tell why? What do you think happens to the quality of polluted water when it evaporates? How would evaporation act as a natural purifier of polluted water?

5. Conductivity

Conductivity is the ability of a substance to carry an electric current. Water will conduct an electric current only if dissolved ions are present because water molecules do not act as a **conductor.** Measuring conductivity is a good way to determine the amount of dissolved solids in a sample of water and, thus, to determine its purity.

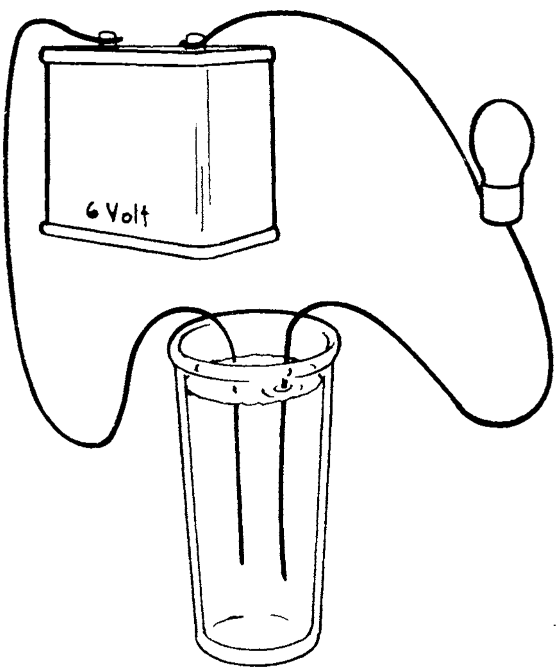
> **EXPERIMENT #5**
>
> Construct an electric circuit using a flashlight bulb, wire, and a 6-volt dry cell battery. Wire the circuit such that two ends of the wire are submerged in a glass of water, as shown in the diagram. See if the bulb will light up when there is only water in the container. Start adding salt to the water, always stirring. Watch and see if the bulb starts to get brighter and brighter. Do you think that seawater would be a good conductor?

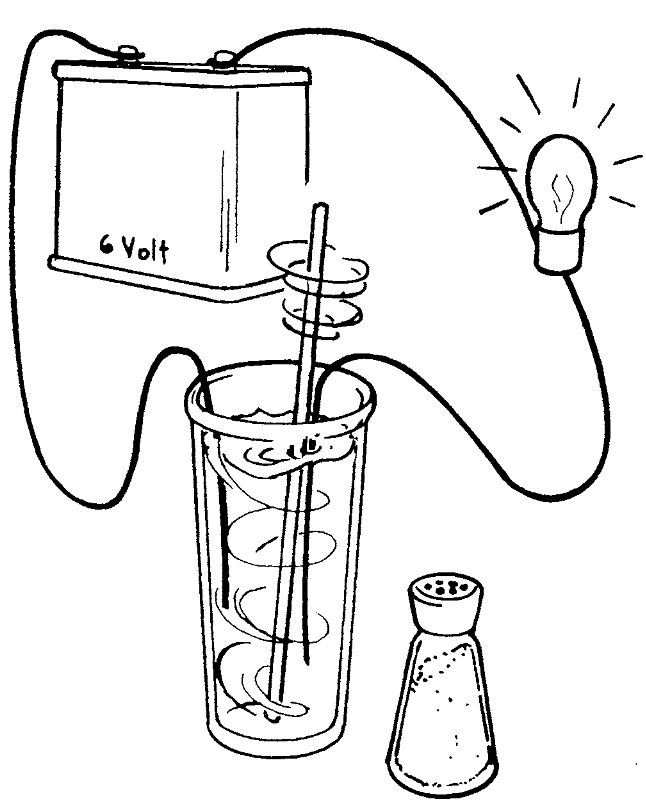
LIVING THINGS DEPEND ON WATER

Water is an essential part of every living thing. Plants use water in deriving some of their **nutrients** from minerals in the soil. These minerals have to be dissolved in water in order to be absorbed by the plants. This is why a desert can be mineral-rich, yet support very little plant life except during brief rainy periods.

To illustrate how much of a plant is actually water, imagine burning a log in a fireplace. The ash that remains after the log is burnt contains nearly all of the nutrients. The greatest part of the log went up the chimney as smoke. This smoke consisted of water vapor and organic material manufactured by the leaves.

Not all of the water taken in by the plant remains there. Much is **transpired,** or given off, by the leaves. At night, little water is lost, but during a hot, dry day there is much water given back to the air. In fact, this is one of the major ways in which water is returned to the atmosphere. For example, an **acre** of corn (20,000 to 25,000 plants) gives off about 3,000 to 4,000 gallons of water each day.





Water is taken into the body by eating plants and meats and by drinking beverages. Humans can go for a month without eating but will die in 3 to 5 days without water because our bodies are made up of about 70 percent water. (That is about 15 gallons for an adult.) The body uses water in maintaining its temperature, breathing, digesting food, and lubricating moving joints.

EXPERIMENT #6

A quart of water weighs about 34 ounces. A package of soft drink mix weighs about ¼ ounce. Compare these weight differences by holding a package of soft drink mix in one hand and a quart of water in the other hand. What does this tell you about the weight percentage of water in soft drinks? Do you think this is also true of other beverages such as coffee, tea, or even milk? Water also is an important ingredient in many of the foods we eat. Look through a cook book and determine how much water is used in many foods such as bread, soup, and oatmeal. Water also is important in preparing foods such as noodles, pot roast, and vegetables.

Since water is so important for all living things, you can understand the concern over pollution of any kind. When we refer to pollution we mean the addition of harmful substances that make an undesirable change in the physical state of clean water. Polluted water cannot safely be used by living things because dissolved substances or water-borne disease organisms may interfere with cell chemistry, causing sickness or death. Poor water management encourages pollution.

THE HYDROLOGIC CYCLE

When you turn on the faucet, where does your water come from? Why can a well supply you with water without running dry? Why does all water run to the oceans, and yet rivers continue flowing and lakes continue to exist after thousands and thousands of years? The answers to these questions can be found in something called the **hydrologic,** or water, **cycle.** This is a continuous exchange of water between the earth and the atmosphere. The ease with which water can participate in this cycle is the result of the physical properties of water, which allow it to change form so readily.

Most of the water is in liquid form and is found in the oceans. This amounts to 97.2 percent of all water. A little over 2 percent is found in solid form, as glaciers and icecaps. The remaining water, with the exception of a small amount of water vapor in the atmosphere, is found in lakes, streams, and undergound. The following chart illustrates this distribution:

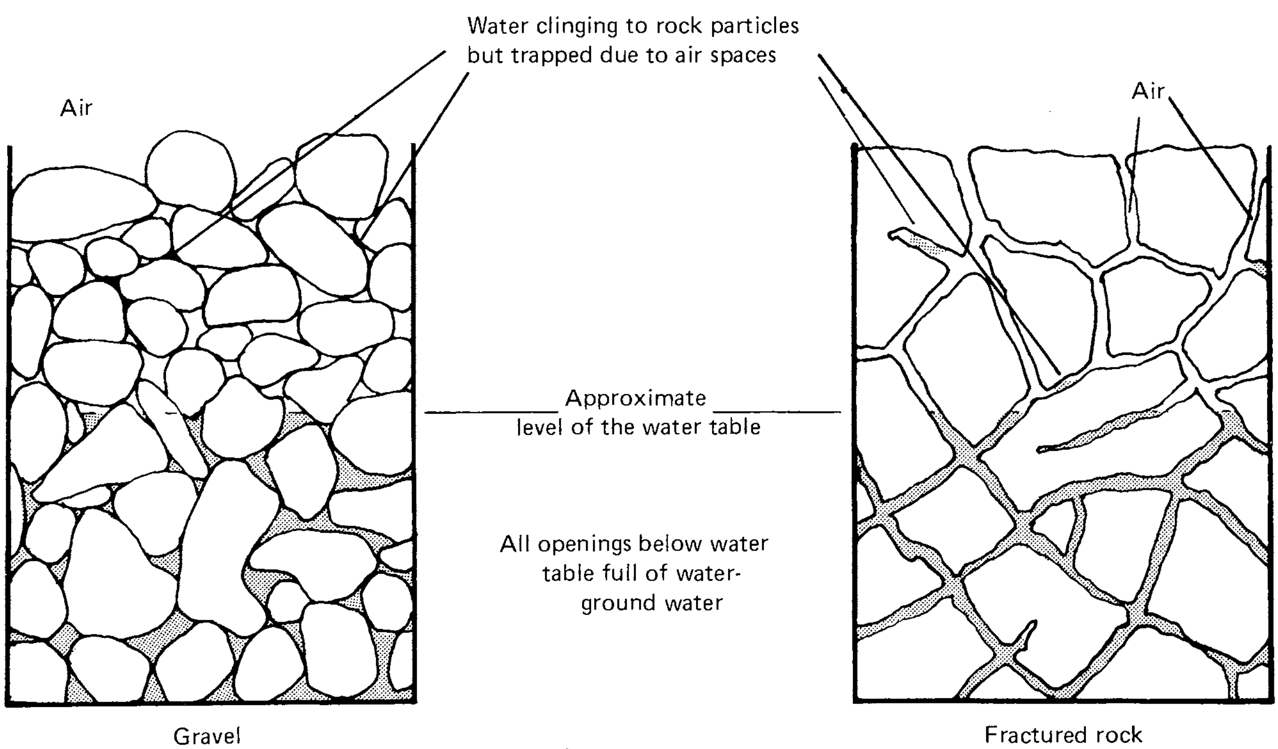
The Earth's Water Supply

Location	Percentage of total water
fresh water lakes	0.009
saline lakes and inland seas	0.008
stream channels	0.0001
underground water	0.625
icecaps and glaciers	2.15
atmosphere (at average sea level)	0.001
oceans	97.2
others (such as living things)	.0069
	100.00

Most of the earth's water is saline, or salty, and contains relatively high concentrations of dissolved substances. The water that people use for drinking, industry, and irrigation is called fresh water. Fresh water also contains a certain amount of dissolved substances, but not as much as the amount contained in saline waters. Most visible fresh water is found in lakes, streams, and glaciers. Surprisingly, only 3 percent of all fresh liquid water is surface water. The rest of the fresh liquid water (97 percent) is found underground as ground water and is obtained from wells.

The Water Table

Why don't wells usually run dry? Are there actually underground lakes and oceans? Not exactly. Ground water is stored in rock or soils, called **aquifers.** Some of these aquifers are composed of tiny grains which resemble a bag of marbles. Ground water is found in the spaces between these grains and also in cracks and **fractures** that occur in solid, dense rock. If these spaces are connected, the water then can move through them. Sometimes the open spaces between grains or cracks are filled with air, and this reduces downward movement of water. Water also clings to the grains (in the same manner as water sticks to your fingers). Water from rain and snow seeps downward through this suspended zone until it reaches the water table. All open spaces below the water table are completely filled with water. Let's try an experiment to help us understand the water table.



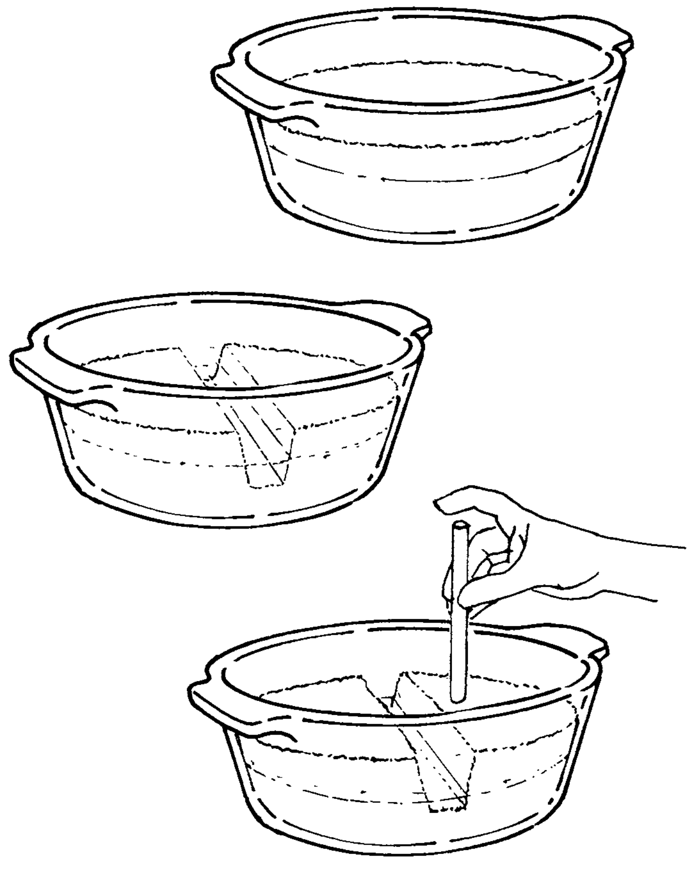
How water occurs in the rocks.

EXPERIMENT #7

Fill a small, clear container (such as an old glass bowl) about halfway with sand. Pour a cup of water onto the sand. Where did the water go? Look at the bottom of your bowl. How did the water work its way to the bottom? The downward movement of water is called **infiltration** and happens whenever water has open spaces in the ground to move through. Notice the level at which the sand is completely filled or **saturated** with water. The top of the water-saturated sand is the water table. The wet sand above your water table is suspending some water between the grains, but not every space is filled with water.

What happens when the water table reaches the land surface? Pour water onto the sand until all the sand is completely saturated with water. Scoop out a little sand. The small puddle of water that forms is the result of the water table reaching the land surface. When the water table is at the land surface lakes, ponds, and swamps can keep filled with water even during dry periods because they are continually resupplied with groundwater. You can make a river by digging a narrow trench. During times of drought, how do you think rivers still are able to flow?

Carefully shove a straw to the bottom of the bowl and gently suck on the straw until water just enters the bottom of the straw. You have just made a water-well. Where does the water come from that enters your straw "well"? Continue to suck on the straw until water almost fills the straw. What happened to the water table level in your bowl? What do you think happens to a water table when a well takes more water out than infiltrates or moves into an underground water supply? Do you know how a well is constructed? Possibly you could check with a local water-well contractor to find out.



Precipitation

About 39 inches of water are evaporated from the oceans each year. About 21 inches of water are evaporated from the surface of fresh water lakes and rivers annually. Plants also transpire water each day. All of this water forms vapor (the gaseous phase) and enters the atmosphere. The amount of water vapor that the air can hold depends upon its temperature. Warm air can hold more water vapor. Why do you think this is so? As moist air cools and is less able to hold water as a vapor, condensation occurs and the water vapor changes back into a liquid. An example of this is what happens when a cool glass comes into contact with warm air on a hot, muggy day. The water droplets on the outside of the glass must have come from the air. This occurs when the warm water vapor in the air was cooled by coming into contact with your cold glass, causing the vapor to condense on the outside of the glass.

Water vapor in the atmosphere condenses on dust particles in the air in the same way it condenses on the outside of a cool glass. For example, have you ever noticed how dusty your family car can be after a rain sprinkle? The rain drops left their dust particles on the car when they evaporated.

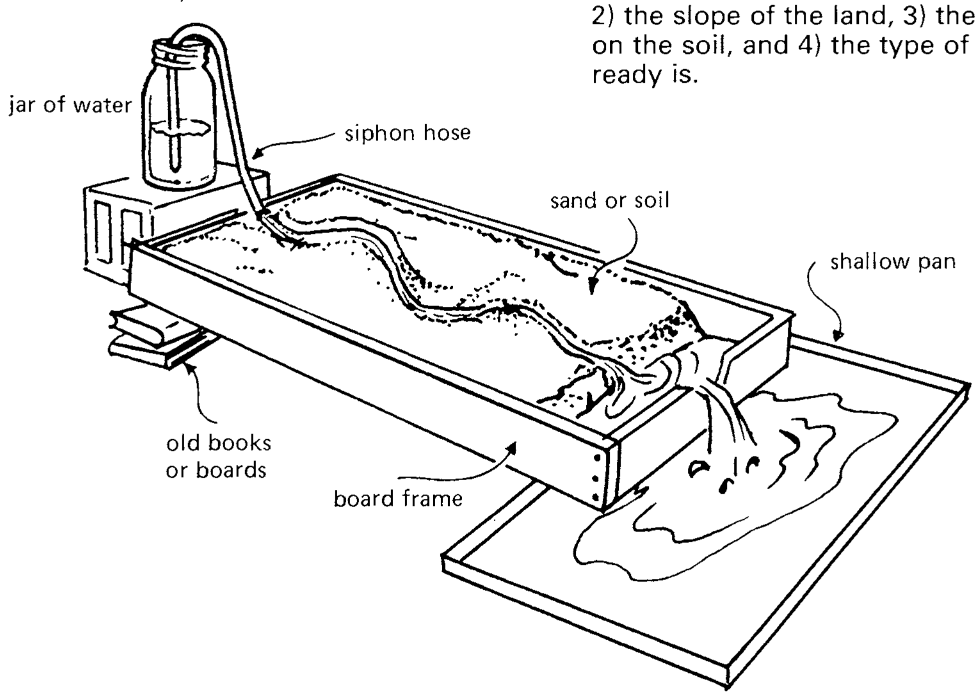
If many tiny drops of water called droplets are concentrated in the atmosphere, clouds form. If the droplets are then frozen, ice or snow is formed. Precipitation occurs when the air becomes super-saturated—that is, when the air can hold no more water droplets. Precipitation can occur in the form of rain, snow, sleet, or hail, depending on the temperature and other conditions.

The amount of precipitation that occurs during the year affects every part of our lives. Because the world's food supplies depend on how much and what kind of precipitation occurs, a lot of money is spent on weather prediction. Some of these funds go toward weather satellites and other sophisticated weather prediction equipment. The weather forecast is an important part of the daily newscasts. Think of how many ways weather conditions affect our lives.

Once precipitation has reached the earth's surface, several things can happen to it. It can fall directly into a lake, river, or ocean and add to that water supply, or it can fall onto the land surface and seep into the ground. Water will slowly work its way downward, mostly due to gravity, through the air spaces in the soil until it reaches the water table.

Runoff

If precipitation occurs in large amounts or the land surface is not porous, most of the water falling as rain or melting from ice and snow will not have time to seep into the ground. Instead, it will run over the surface of the land. This water is called runoff. How much runoff there is depends on four factors: 1) the amount and intensity of precipitation, 2) the slope of the land, 3) the vegetation present on the soil, and 4) the type of soil and how wet it already is.



EXPERIMENT #8

Construct a box such as the one pictured on page 10. If you built a stream table for the 4-H Landforms manual (p. 3), it also will work for this activity.

STEP 1—Fill the box level with wet sand. Tilt the box so that the end *without* the notch is an inch *higher* than the notched end. Place a shallow pan under the notched end (see diagram below).

STEP 2—*Slowly* pour a quart of water into the box at the end *without* the notch. Measure the time from when you first started pouring until no more water runs out of the box. Measure how much water was collected by the shallow pan. Is any water missing? Where did it go?

STEP 3—Now *quickly* pour another quart of water into the box and measure the amount of time until no more water pours out of the notch. Measure the amount of water collected in the pan. Did more water run off the sand this time? Why?

If the water you poured into the box is supposed to represent precipitation and the sand is supposed to represent the earth, what effect does the rate at which rain falls have on how much water will soak into the ground? What effect does the amount of water already in the soil have on the amount of runoff?

STEP 4—Place more blocks under the end without the notch. Repeat, pouring a quart of water first slowly and then another quart quickly, measuring the runoff times and amounts of water collected in the pan. What effect does increasing the slope of the land have on increasing runoff? Was there any increase in the amount of sand washed out of the box when you increase the slope? What effect does the slope of the land have on the rate at which water will erode, or carry away, soil?

If the land is bare, and there is no vegetation, little water will be held back and most of the water will run off. Row crops encourage runoff because of the constant tilling of the soil and the scarcity of vegetation to retain the water. If the soil is sandy or contains much organic material, the amount of runoff will be reduced. Uncontrolled runoff can cause erosion and flooding. It is therefore important to preserve as much of the original vegetation as possible, or substitute suitable alternatives such as contour plowing, **conservation tillage,** terracing, or constructing ponds.

Storage

Runoff eventually reaches the lowest spot on the land surface, where it joins other water that has run off from previous storms or from storms in other areas. These low spots provide temporary storage for surface runoff and usually form lakes and streams. Water which seeps underground is stored in aquifers below the water table.

EXPERIMENT #9

Water does not seep or infiltrate into the ground at the same rate everywhere. Fill, but don't pack, a clear container like an empty pint jar level with sand and another identical container level with a clayey soil. You will probably have to break up the lumps of clay with a hammer until you can obtain enough clayey soil to pour into the container. Slowly pour water into both containers and measure the amount of water and the time to completely saturate the sand and the clay. Which container will absorb the most water? Why? What does this tell you about the amount of runoff coming from sandy soils compared to clayey soils? Which soil would allow the most rainwater to infiltrate? What effect does the "looseness" of the land surface have on the amount of precipitation that can infiltrate it? Repeat your experiment, but pack the sand and clay into the containers if you cannot answer the last question.

Storage is only temporary because water is always moving. For example, rivers are always flowing to the sea, but rivers may contribute to or take water from lakes. Also, ground water is always moving from high areas to lower areas. Along the way, it can be taken out of storage by being discharged into streams or pumped through a well.

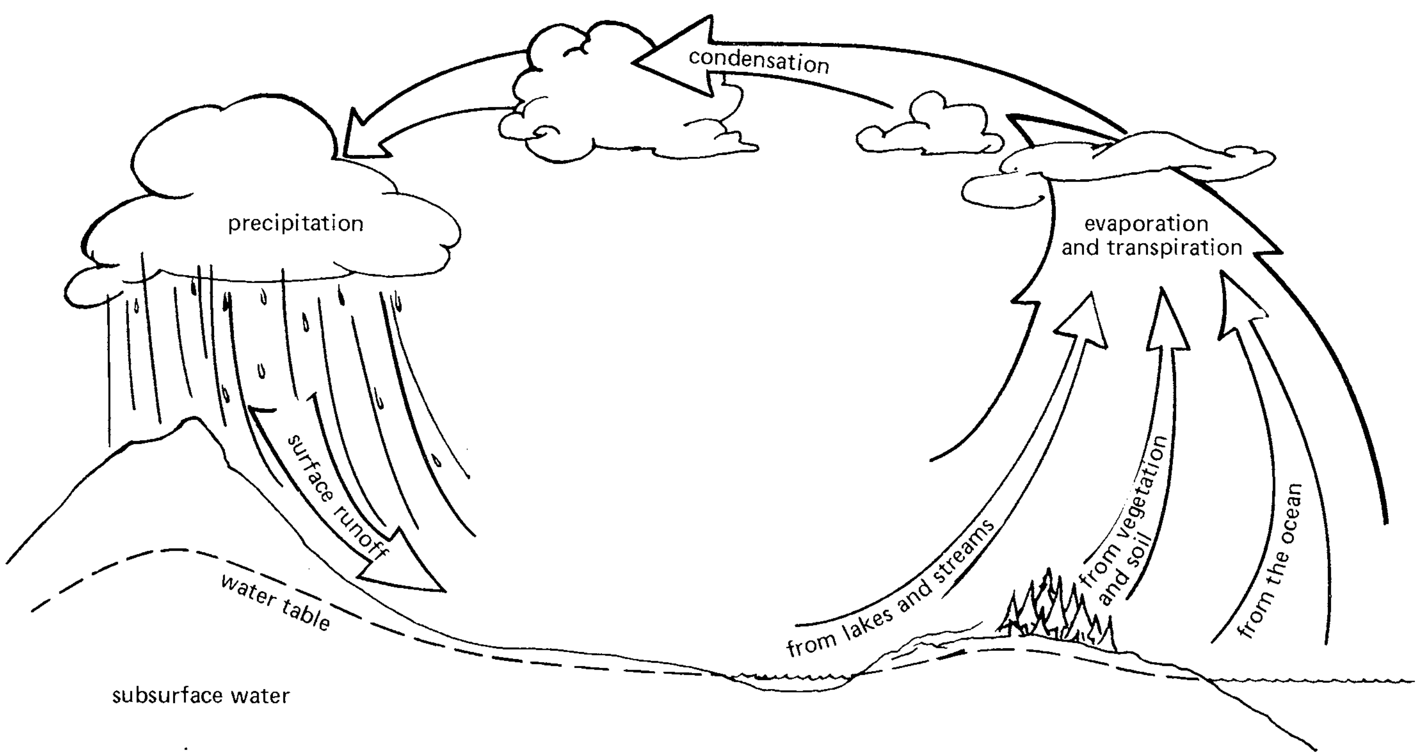
Evaporation

Evaporation and plant usage (including transpiration) account for changes in storage. These processes remove large amounts of water that could be used for recreation or other uses. However, they are important parts of the hydrologic cycle because they recharge the atmosphere with water to keep the cycle going. Several factors influence the rates of evaporation and **transpiration**. The following experiment should demonstrate this.

EXPERIMENT #10

Place a shallow pan of water in direct sunlight and measure the time required to completely evaporate the water. (A good pan to use is an old coffee can plastic lid.) Compare the time needed to evaporate water in direct sunlight to the times required for pans left: 1) in shade, 2) in the sun on a windy day, 3) outside on a cloudy day, and 4) outside on a cloudy, windy day. Under which conditions of sun and wind does water evaporate the fastest? The weather conditions which most quickly evaporate water also cause plants to most rapidly give off or transpire water.

Surface and ground water that is not transpired by plants or evaporated will flow until it eventually reaches the oceans. There the hydrologic cycle begins again when sea water evaporates and enters the atmosphere, only to fall on the land as precipitation. The journey of water to atmosphere and back to earth is a never ending cycle powered by heat from the sun. The hydrologic cycle thus provides us with an everlasting resource.



WATER USE AND CONSERVATION

The United States as a whole receives an average of about 30 inches of precipitation annually. In other words, the annual rainfall would cover the whole country to a uniform depth of 2½ feet. Almost three-fourths of this water is returned to the atmosphere by evaporation and transpiration. The remaining one-fourth contributes to runoff and ground water storage and makes up the water available for use.

Water used for normal household purposes such as bathing, dishwashing, and toilet flushing is not consumed. Most of it is returned to the hydrologic cycle through your sewer system. How water probably is used in your home is shown by the following charts. Consider an average household in Minnesota. If you are like the majority of Minnesotans, here are some typical amounts that you would use:

shower	30 to 60 gallons/time
tub bath	30 gallons/time
flush toilet	6 to 8 gallons/time
washing machine	30 to 50 gallons/time
food preparation and clean up	10 to 20 gallons/time

These figures average at about 50 gallons per person per day. If you live on a farm, the daily use of water by farm animals is added to your family's need.

horse, dry cow, beef animal	12 gallons/day
milking cow	35 gallons/day
hog	4 gallons/day
sheep	2 gallons/day
100 chickens	4 gallons/day

The crops grown on your farm also require a tremendous amount of water. To understand how much water certain crops need, here is a list of what each plant needs during one growing season (6 to 7 months):

corn	54 gallons/plant/season
potato	25 gallons/plant/season
tomato	35 gallons/plant/season
wheat	25 gallons/plant/season
tree (25 to 30 feet)	84,000 gallons/plant/season

Even an undesirable plant like ragweed requires 140 gallons of water during the summer. The water for crops comes from soil moisture, precipitation, or irrigation. Irrigation is becoming increasingly important in Minnesota. According to the Minnesota Department of Agriculture, in 1970 4.5 billion gallons of water were used for irrigation. By 1976 this figure had grown to 8.6 billion gallons and is still rising.

EXPERIMENT #11

To understand the importance of water to you and your family, list all the ways water is used around your home or farm. You also can measure the amount of water used for things we all take for granted. Using a 5 quart ice cream container, fill a sink to the level used to wash dishes keeping track of how many quarts of water this uses. Use your quart container to rinse the dishes and count the number of quarts needed just to wash the soap off. Can you think of other ways to measure the amount of water used around your home to perform chores such as washing clothes, flushing toilets, or taking baths? What would your home be like if you could have only half of the water you now use? What would you do if your water supply were cut off?

In addition to these uses, industry requires a great amount of water. In fact, industry is the largest user of water from municipal water supplies. In order to supply us with their goods and services, average use by commerce and industry is about 70 gallons per person per day. Besides domestic and industrial uses, there are two other main classes of municipal water use. The first is called public use, which includes fire extinguishing, street cleaning, public building use, and maintenance of public parks. Public use accounts for about 10 gallons per person per day. The other class of water consumption is loss or unaccounted-for waste. Leaks from water mains, unmeasured leaks from faucets, and errors of measurement contribute to this loss.

EXPERIMENT #12

In order to realize how much water can be wasted even from the simplest error, measure the length of time a dripping faucet requires to fill a quart container. Multiply this time figure by four to tell you how long until a gallon would be wasted. Then figure how much water would be wasted in a day, a month, a year. How much water would you waste in 1 year if all the faucets in your house were dripping?

Think of ways of conserving water around your home or farm and determine how much water you could save from each method. If water from a family well costs about 15¢ per thousand gallons (according to the Minnesota Department of Health) and water from a municipal supply costs about 59¢ per thousand gallons (St. Paul city rates), how much money could you save in a year if you practiced your conservation ideas?

Though many industries buy water from the public or municipal supply, many large factories put in their own wells or surface reservoirs. If you live in the city or an area with a high concentration of people, you probably get your water from the municipal water system. These systems draw their water either from aquifers or surface reservoirs. If you live in the country, you probably get your water from your own well. Have you ever noticed the difference in taste between your water and other water? Why is this?

EXPERIMENT #13

Determine where your water supply comes from. If you obtain your water from a family well, ask your parents if they know how deep the well is and from what kind of formation the well draws its water. Possibly a local water-well contractor could help answer your questions. If you obtain your water from a city supply, ask if you could visit the water department and see how your water is supplied. The Minnesota Department of Health will test your water for you, if you would like to check its quality. Find out who is responsible for making sure your water is safe to drink. If your present water supply was cut off, what other nearby sources of water could you use?

WATER MANAGEMENT

The amount of water we have now is all the water we're going to get. Because the oceans contain so much of the total water supply, there is really very little fresh water available for our use. In some areas of the world there is too little fresh water, while in others there is too much. The limited amount of fresh water available requires that we live where it is abundant and that we reuse it many times. If water has been contaminated it must be cleaned, because polluted water is unsafe. Polluted water may be not only unhealthy for drinking or for use by industry, but may be hazardous for swimming or boating. Can you think of ways in which water is polluted?

Years ago, there were fewer people living around sources of water. There was enough clean water to dilute the wastes discharged into it. Then nature's self-cleaning processes could take over. Bacteria and other microscopic plants and animals in the water could break down the wastes into harmless substances. For example, algae are actually nature's way of cleaning nutrients out of a lake, even though they make it undesirable for swimming. There are types of bacteria or organisms which cause diseases, however. That is why there is such a need for waste disposal or sewage treatment plants to reduce water-borne, disease-bearing organisms.

Today there are types of wastes nature cannot clean up adequately. Contaminants enter our water supplies not only from "point sources" such as industrial discharge pipes but also from "non-point sources" such as drainage from heavily fertilized fields. Among the most dangerous of pollutants are the chemical wastes such as lead and mercury, given off by our industrial society. Chemical pollutants can be very dangerous to mankind and wildlife. It is up to all of us to see that these wastes do not contaminate our water supplies.

Wise management of our valuable water resources will ensure that there is enough water to meet all future needs. Large users of water and land must be regulated to prevent using up or polluting water supplies. In this way, all water users will be protected. The duty of state and federal governments is to establish suitable water quality standards. There is a need for cooperation between states and countries in this matter, because water knows no political boundaries.

Careers

Because of these urgent and important water problems, large numbers of scientists and government employees today are involved in water management. Some of the careers related to water management include:

biologists — study life and the processes which permit life.

chemists — study the composition, structure, properties, and reactions of matter.

engineers — apply scientific principles to designing, constructing, and operating structures or equipment.

geologists — study the origin, history, and structure of the earth.

government officials — carry out the rules and regulations adopted by the public.

hydrologists — study the properties, distribution, and effects of water on and in the earth and the atmosphere.

lawyers — study and interpret the rules which govern our society.

mathematicians — study number, form, arrangement, and associations.

meteorologists — study the atmosphere, especially weather and weather conditions.

physicists — study matter and energy and how they interact.

planners — develop management guidelines and programs.

soil conservationists — study methods of best using and maintaining soils.

soil scientists — study the origin, distribution, and physical properties of soil.

well-drillers — construct wells and water supply systems.

Can you think of how each of these professions is involved in water management? The people now involved in water management must be far-sighted enough to anticipate future demands on our water supply and be able to devise methods to satisfactorily regulate water use. But the work is just beginning. Learning all we can about water and its conservation will help to supply future generations with all the water they will need.

Agencies

Someday, you may have to make a decision on how to use water or you may have a question concerning some regulation which affects your use of water. The following agencies may be able to assist you:

Minnesota Department of Agriculture
Minnesota Department of Health
Minnesota Department of Natural Resources
Minnesota Geological Survey
Minnesota Pollution Control Agency
Minnesota State Planning Agency
Regional Development Commissions
United States Department of Agriculture, Soil Conservation Service
United States Department of Defense, Corps of Engineers
United States Department of Interior, Geological Survey, Water Resources Division

Demonstrations

Share what you have learned with others in your project group or 4-H club by giving a demonstration or project talk. It will be good practice in expressing yourself and giving you confidence to perform before a group of your friends. The experiments contained in this manual could serve as demonstration topics either in various combinations or singly. For example, a demonstration could be prepared on "physical properties of water" by using experiments #1 through #5, or a demonstration on "conductivity of water" alone could be developed by expanding experiment #5. These experiments might suggest other topics that you might also develop into demonstrations or exhibits.

Exhibits

We would suggest that science exhibits may be the most suitable kind for this unit on geology. You will want to check with your local county extension agent and/or your local county fair premium list for specific guidelines in practice in your county.

A science exhibit is created and evaluated according to the following guidelines:

A. Information - 70 percent
  - Accurate
  - Complete
  - Educational value
  - Overall effectiveness
  - Related to 4-H project

B. Workmanship - 30 percent
  - Neatness of exhibit
  - Easy to read - lettering large enough
  - Wise use of color
  - Attractively arranged
  - Shows some originality

GLOSSARY

acre — a parcel of land containing 43,560 square feet or an area approximately the size of a football field.

acidic — acting like an acid.

aquifer — a formation which readily yields water.

atom — the smallest unit of an element which still retains all the characteristics of that element.

bedrock — solid rock that underlies all soil or loose rock material.

bonded — the joining of atoms caused by differences in their electrical charges.

conductor — a substance which will permit an electrical charge to pass through it.

conservation tillage — plowing and cultivating practices designed to reduce soil erosion.

droplets — tiny drops of water.

evaporates (evaporation) — to change into a vapor.

fractures — cracks or breaks in geological formations.

heat capacity — amount of heat a substance will absorb until it starts to increase its temperature.

hydrologic cycle — total of all the processes which cause water to move above, on or inside of the earth.

infiltrates (infiltration) — to pass into something through pores or cracks.

limestone — a sedimentary rock consisting chiefly of calcium carbonate (lime).

minerals — naturally occurring crystalline substances which are the basic components of rock materials.

molecule — stable arrangement of atoms which are bonded together.

nutrients — substances which are necessary for life.

saturated — to be filled to capacity.

solute — a substance which is dissolved by a solvent.

solution — a mixture formed by a solvent and one or more solutes.

transpired — to be given off in vapor form.

transpiration — the process of discharging vapor or waste through the pores of plants.

vapor — the gaseous form of a substance.

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