# Minnesota WEATHERGUIDE

## CURRICULUM

GRADES 4 - 8

HANDS-ON ACTIVITIES

STEP-BY-STEP INSTRUCTIONS

FRESHWATER SOCIETY

KARE 11

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# LETTER FROM THE CHAIRMAN

FRESHWATER SOCIETY

Dear Teacher:

This *Minnesota Weatherguide Curriculum Guide* was developed to provide you with hands-on activities to interest your students in the natural world around them. When used in conjunction with the Freshwater Society's *Minnesota Weatherguide Environment Calendar®*, it becomes a step-by-step guide that you can incorporate into your daily curriculum.

In addition to its use in the classroom along with the Curriculum Guide, many student groups sell the *Minnesota Weatherguide Environment Calendar* as a fundraiser for class trips or other special projects. And, because the *Minnesota Weatherguide Environment Calendar* is the best selling calendar in the region, people want to buy the calendar so students are successful in raising money for their important projects while they learn about weather, climate, phenology, and astronomy!

We encourage your questions and comments about this guide as well as the *Minnesota Weatherguide Environment Calendars*. Please contact us at 651.313.5800 to learn more about Freshwater Society, our publications, and programs.

Sincerely,

John Packard
Chairman of the Board of Directors
Freshwater Society

# INTRODUCTION

The *Minnesota Weatherguide Environment Calendar®*, published annually by Freshwater Society in collaboration with KARE 11 and Minnesota Public Radio, is a valuable resource for teachers and students. It can be used along with this *Minnesota Weatherguide Curriculum Guide* to help teachers guide their students toward a greater understanding of the environment. The Weatherguide curriculum is designed to enhance the knowledge of interrelationships and interdependency among natural biological and physical events and seasonal changes as well as to foster a better understanding of weather and its effects on both nature and humans.

The *Minnesota Weatherguide Environment Calendar* includes sunrise/sunset and moonrise/set data for the region, monthly planet visibility charts, moon phases, morning and evening star information, meteor shower peaks, average high, mean, and low temperatures, daily records and wind direction graphics. Following each month are weekly journal entries of notable phenological events that occurred during that week, and an extensive glossary and cloud identification charts.

The original *Minnesota Weatherguide Resource Book* was developed for Freshwater Society in 1993, by Rachel M. Westermeyer. This edition has been updated and revised by Ann Conrad, Executive Editor, *Minnesota Weatherguide Environment Calendar*, and has been reviewed by:

Jerry Backlund - Hamline University
Jim Gilbert - Gustavus Adolphus College
Nils Halker - Science Museum of Minnesota
Rod Nerdahl - Minneapolis Planetarium
Jonathan Yuhas – KARE 11

Although the activities in this guide can be adapted for any age, they are most appropriate for grades four through eight. With minor modifications the activities could be extended students in high school.

For further information about this guide, please contact Freshwater Society, 2424 Territorial Road W Ste B, St. Paul, MN 55114, 651.313.5800. freshwater@freshwater.org, or through our website at www.weatherguide.org.

# Eyeing the Environment

**Subjects**
Language arts
Science

**Time**
Day 1  30 minutes
Day 2  40 minutes

**Objective**
After participating in this activity, students will be able to state five biological and physical events of nature that relate to climate and weather.

**Concept**
Biological and physical events have links to weather and climate.

**Skills**
Critical thinking
Writing
Observing
Recording

**Materials**
Whiteboard
Paper and pencils
*Minnesota Weatherguide Environment Calendar*
Dictionary

**Key Words**
Astronomy, biology, meteorology, phenologist, phenology. (See Vocabulary in Appendix.)

**Day 1:  Observations**

1. Ask students to take out a piece of paper and a pencil or pen. Have them fold their paper into three equal sections. Starting with the section at the bottom of the paper, ask them to write everything they see from floor level to desktop level.

*Examples:  a brown wooden floor with scuff marks or a pair of white tennis shoes. Give them five minutes to complete this task.*

2. Ask three students to read their observations, review them, and comment on other things that could be observed at that level.

3. In the middle section of the paper, have students write everything they see from desktop level to the tops of their heads. Give them five minutes to complete this task. Repeat step #2.

4. In the remaining section of their paper, have students write everything they see from the tops of their heads to the ceiling. Give them five minutes to complete this task. Repeat step #2.

5. Prior to going outdoors, ask students to relate what kinds of things are necessary to become a good observer or phenologist and briefly discuss their answers. Also see Questions For Discussion on the following page. Review phenological events that they may observe outside the classroom, such as leaf color.

6. Have students take their papers and regroup outdoors. Encourage them to look in all directions and carefully observe their surroundings, looking at the dirt, grass, ants, grasshoppers, birds, trees, flowers, clouds, sun, rain, and wind. Using the opposite side of their papers, have them write in the bottom section what they observe from ground level to waist level; in the middle section what they observe from waist level to the tops of their heads; in the last section what they observe from the tops of their heads to the sky.

7. After completing this exercise, have students share what they have written and discuss observations that have included some relationship between events. An example might be that the days are getting shorter and the leaves are changing color.

**Day 2: Discussion**

1. Write the word phenology on the whiteboard and ask students to come up with ideas about what it means. Write six of their answers (both correct and incorrect) on the board. Afterwards, ask one student to look up the word in a dictionary and read the definition aloud.

2. After writing the correct definition on the board, as a group decide which answers given can be linked to the correct definition. Leave those answers on the whiteboard and erase those that appear to have no link to the definition.

*Words like "study of something;" words that refer to nature, weather, wind, climate; words that have to do with seasons or seasonal changes such as fall, winter, spring, and summer; words that link events such as migration, storms, tornadoes, and hibernation should be kept.*

3. Take time to explain how the word phenology encompasses both biotic factors (biological events of nature, e.g., birth of animals, predation, and shade from plants) and abiotic factors (physical events of nature, e.g. rainstorms, heat waves, river currents.) Describe how these events are linked to climactic conditions.

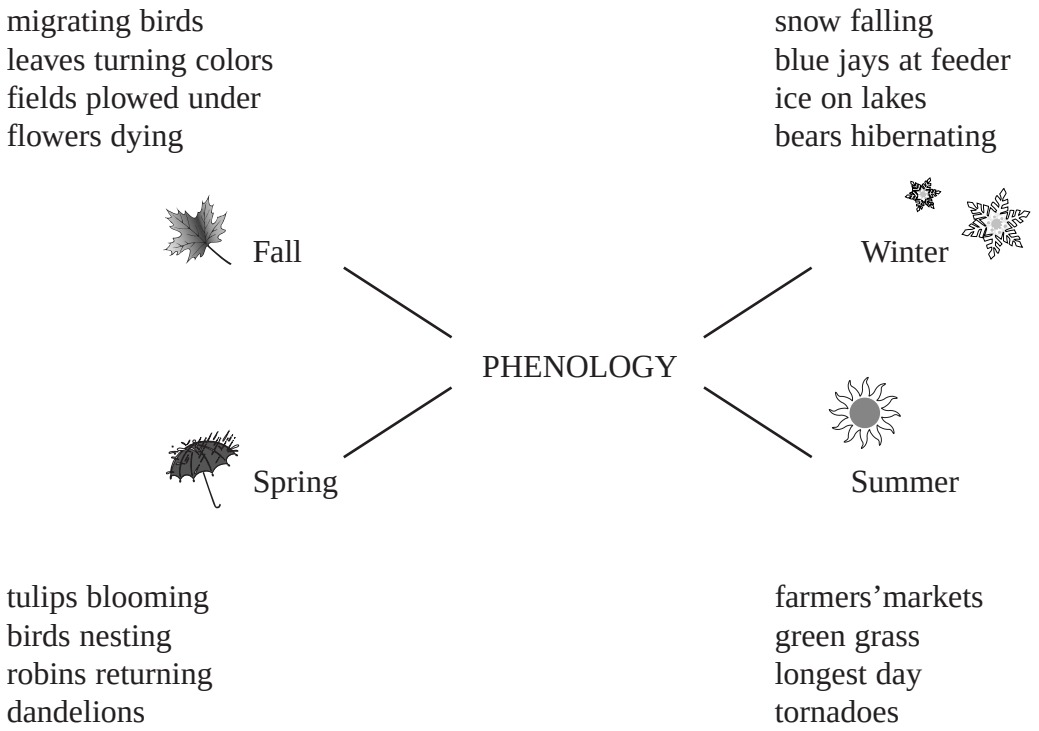
4. Start connecting some of these phenological events through a webbing activity (see diagram below for examples.) First, write the word phenology on the board as well as the words fall, winter, spring, and summer. Connect these seasonal words to the word phenology, as shown on the diagram. By asking open-ended questions, flesh out events that are related to these seasons. Try to list four to six events for each season.

*A sample open-ended question for autumn could be: "What things happen in nature in the fall?" Possible answers are the leaves change color and fall from the trees; squirrels start to gather food for the winter; hunting season opens for various types of wild game; birds fly through on their way south; some local birds start their migration; the weather begins to turn colder; and the days become shorter.*

*Similar open-ended questions can be asked for winter, summer, and spring until the web is complete for events in all four seasons.*

*For further information, see the Phenology Checklists in the Appendix.*

**Phenology Diagram**



5. When the web for all four seasons is complete, sum up the events that have been listed. Add some of your own if the list is too small.

6. Ask students how they could track and study the events they have listed in the web. See Questions For Discussion for the answer.

7. Review the definition of phenology and its relationship to the webbed words.

**Questions For Discussion**

**What does it take to track and study environmental events?** Tracking events takes time and patience. First, you have to learn to be good observers. Second, you have to become accurate recorders of what you observe. Third, you have to become critical thinkers, finding links among the phenomena you are observing. For example, when you observe birds leaving and the weather becoming colder, you can consider that bird migration may be linked to weather changes.

**What kinds of special tools does a phenologist need?**
A phenologist needs to use his/her senses and curiosity about the world. A notebook and pencil increase accuracy; details can be jotted down easily.

**Why do students vary in what they have observed when they all are looking in the same place?**
Each person sees things in his or her own way, even though everyone is looking in the same general area.

**Taking It Further**

Have students do the same outside observation at home as they have done at school following the activity format for Day 1. Ask them to bring their observation sheets to class for discussion.

Tell students to cut a hole in the center of a piece of paper. Ask them to observe the environment either inside the classroom or outside in the schoolyard looking through the hole. Have them write down only what they observe through the opening. Do the same activity using a paper rolled up as a telescope. Discuss the impact of a narrower view on students' observations.

# The Weather News Board

**Subjects**
Art
Mathematics
Science

**Time**

| | |
|---|---|
| Day 1 | 15 minutes |
| Per week | 10 minutes |

**Objective**
After hearing what kinds of articles and events will be displayed on the weather news board, students will be able to find and categorize articles or pictures relating to phenological and meteorological events.

**Concepts**
New or unusual natural and biological events are shared with interested public through electronic and/or printed means such as TV, radio, newspapers, and magazines.

But natural events don't follow human-made boundaries; things that happen in one place often have a direct or indirect bearing on other places.

**Skills**
Reading
Data collecting
Drawing

**Materials**
Bulletin board
Tacks or pins
Scissors
Paper
Art supplies – crayons, markers
Local newspaper
National magazines and newspapers
*Minnesota Weatherguide Environment Calendar*

# ACTIVITIES

**Day 1: Introduction**

1. Choose a day soon after you have completed the *Eyeing the Environment* lesson. Explain that as a class you are going to start a seasonal Weather News Board on which articles on phenological, meteorological, or appropriate seasonal events will be displayed. Point out the designated board or area. Discuss how students will have an opportunity to review newspapers and magazines to collect appropriate articles for the fall season, starting about September 21 and ending on December 20. You can either have the board already decorated with fall leaves and the word fall prominently displayed or you can make the decorating a class project, having students make leaves or other fall-related things. See *Taking it Further*.

2. Discuss the kinds of articles that will be acceptable. Articles about extremely hot or cold temperatures, unusual rainfall, floods, tornadoes, first frost or snow, wildlife events such as hunting season opener or bird migrations, or plant or tree changes such as fall color, or harvesting events. Decide as a class whether to accept only articles about events in Minnesota or to accept articles with national significance. If the class decides to accept articles nationwide, divide the Weather News Board into *Minnesota Events* and *National Events*. Such a division will give students an opportunity to compare and contrast local and national events.

3. Ask students to check with their parents and others to determine the highest and lowest temperatures they have observed in their lifetime, and report to the class.

4. Designate the day each week you will expect articles for the bulletin board and ask students to cut out articles and bring them to class that day. Encourage them to be sure the article includes the source and date.

You may want to have a few samples to illustrate the types of articles you want them to search for and to show them how to identify the source properly.

**Per Week**

1. One day each week set aside five or 10 minutes to review the articles that students have brought in. If one or more articles have special significance to your class, you may want to take this opportunity to start a discussion.

**Questions For Discussion**

**What is the point of bringing in articles about events happening in other communities?**
Understanding larger weather/climate patterns will be helpful in explaining what is happening throughout the United States and around the world. For example, a crop failure due to a climatic event in any part of the country or world often has a significant bearing on both food availability and prices in all communities.

**Taking It Further**

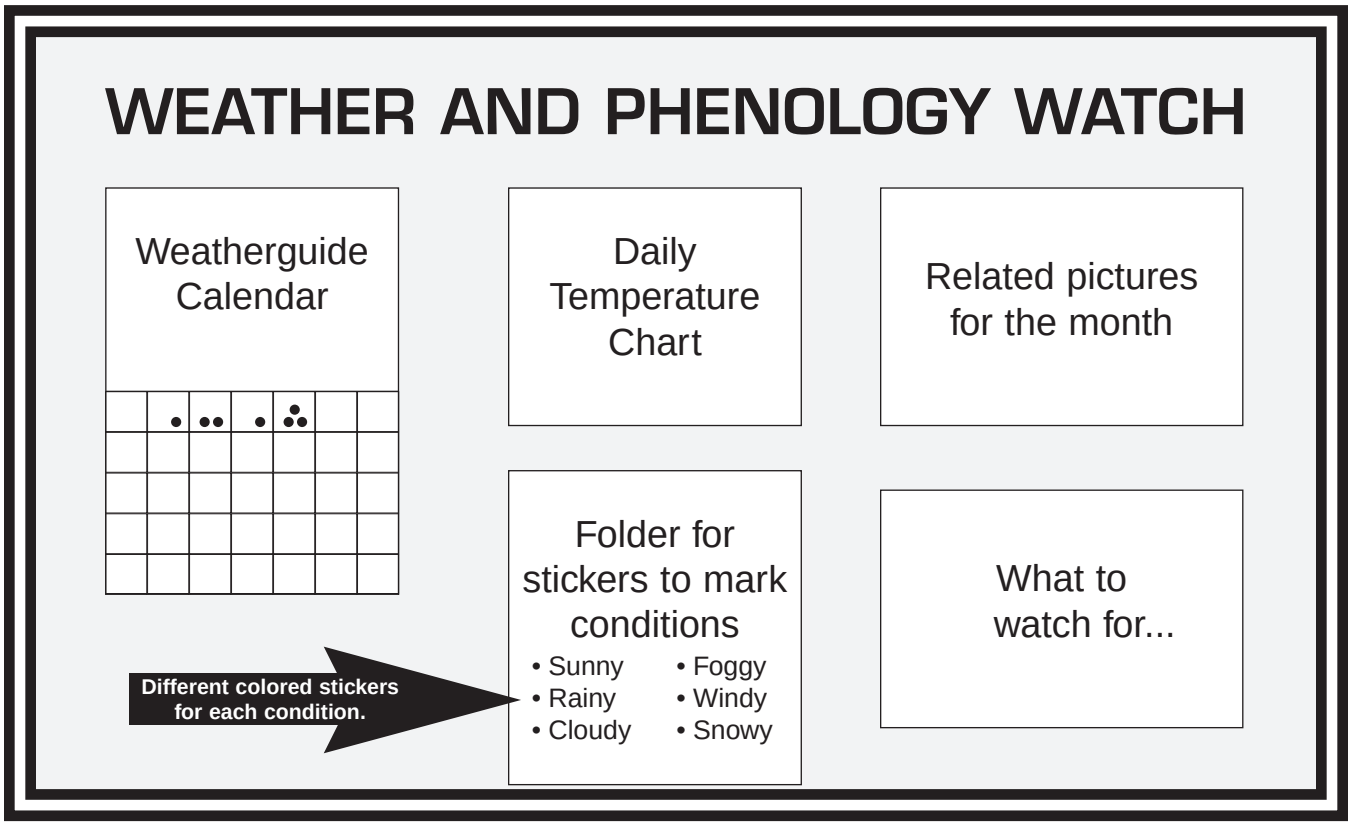
During an art lesson have students design the artwork for the fall Weather News Board. See Weather News Board Template illustrating layout ideas.

Continue the Weather News Board activity for the winter (December 21 - March 21) and spring (March 21 – June 21) seasons. Take down old articles and ask for new ones. Change the heading and borders.

Add a monthly calendar to the Weather News Board. Each week, appoint a student to be responsible for writing in data about sunrise, sunset, moon rise, wind direction, temperature, and cloud information on a daily basis as these activities are studied.

Make a temperature graph for each month using the information gathered for the monthly calendar. Chart the temperature at two predetermined times during the school day, preferably early morning and midday. After collecting this data for one month, add the high temperatures to calculate the average high temperature for the month. Do the same computation for the low temperatures.

**Weather and Phenology Bulletin Board Ideas**




**Additional ideas for the bulletin board:**

1. Get an extra Weatherguide to cut out pictures or charts.
2. Have students bring photos or magazine pictures for the month.
3. Use information page material as it relates to the month/season.

# Journal Jottings

**Subjects**
Language arts
Science

**Time**

| | |
|---|---|
| Day 1 | 45 minutes |
| Day 2 | 15-20 minutes |
| Per week | 15-20 minutes |

**Objective**
After reviewing the elements of creative writing, students will be able to observe and categorize environmental events that occur in their homes, school, and community.

**Concept**
With guidance, it is possible to write so that a reader can visualize the event that has occurred.

**Skills**
Observing
Writing creatively

**Materials**
Whiteboard
Pens or pencils
Personal journal
*Minnesota Weatherguide Environment Calendar*

**Day 1: Introduction**

*Prior to starting this activity, tell students (or send a note home) that they need to purchase a three-subject notebook for keeping a journal of phenological events and give the date that they will need the notebook in class.*

1. Start a discussion with students on what a journal is, why they should be interested in keeping a journal, and what value it has in documenting information.

2. Begin a lesson on creative writing techniques by asking the students to think of "nature" words that could be used as noun subjects for sentences in their journal. Write the words given on the whiteboard under a category titled *Possible Nouns*. *Examples may include snow, sun, wind, squirrel, deer, rain, moon, clouds, robin, loon, geese, leaves, and pumpkins.*

3. Ask for a list of action verbs for the subjects already listed on the board. Write these action verbs on the board under a category titled, *Possible Verbs*. At the same time incorporate two additional categories, *Possible Adjectives* and *Possible Adverbs*.

4. Discuss how words can be linked creatively to get a visual image of an event being described. Have students discuss the difference between active voice and passive voice. Ask them to give several reasons why using active voice will make their journal writing more alive.

5. In another area of the whiteboard, write one of the subject words and ask a student to help complete the sentence. Stress the use of the active voice. For example, write the word "moon" on the whiteboard and ask students to complete the sentences telling about the moon using the verbs they have listed. Write down four or five sentences using the word "moon." Talk about each of the sentences and review how each one conveys a different message about the moon.

6. Point out the moon sentences that are more visually descriptive than others and ask students to keep these kinds of sentences in mind when they are jotting in their journals.

7. Sum up this activity with a discussion about how and when students will make journal entries and what kinds of events they will write down in their journals. Discuss why each journal entry should include the month, day, and year. Stress that each entry needs to tell about a particular phenological or naturally occurring event they have observed. Also, each entry should include who, or what, the action that has happened, and possibly the where and/or why of this event. Encourage students to enter as many events as they observe on a particular day. Discuss the fact that these events do not necessarily have to be related to one another.

8. Have them open their journal notebooks and make the first entry by putting in the day's date. As homework, assign a journal entry due at the next class meeting.

**Day 2: Journal Readings and Review**

1. Have students open their journals to their entries from the previous class meeting time. Ask several students to read their entries aloud. Discuss the entries and point out the ones that are particularly well written. If there are entries read that are not appropriate, tactfully discuss them and steer students away from entries that do not belong in this particular journal.

Per Week: Journal Readings and Review

1. Once each week take the time to repeat the activity of Day 2 above.

2. Collect the journals for personal review and correction.

**Questions For Discussion:**

**Why keep a journal?**
Keeping a journal helps the writer sharpen his or her observation and writing skills. The writer is forced to articulate often-subtle events, which will lead the writer to notice details that might have been missed otherwise.

**Why do the journal entries have to be dated?**
Part of this lesson is to teach that events in nature are linked in some fashion. One way they are linked is to the season and the seasonal changes. If the entries are dated, at a future time anyone reading this particular journal will know the season the event being described occurred. It also gives one the ability to compare events from year to year, leading to a greater understanding of climate change and global warming.

**What is the purpose of using active tense?** Passive tense tells about the event too, but active tense is just that: active. If the sentence sounds active, the more real and alive the event becomes in the reader's mind. Thus, most experienced writers use the active tense so that they can involve the reader in the experience.

**Taking It Further:**

To sharpen observation skills, have students use a copy of the Journal Jottings Weekly Diary to write down their phenological observations every day for a week. Have them share what they have written for the week and compare what different students have observed.

Have students continue their journal jottings in the other two sections of their notebook, one section for winter entries and one section for spring entries.

Ask students to take a significant event that they entered in their journal during a particular month and write a paragraph about this entry, sharing how or why the event was significant.

Read selections from the weekly phenology pages of the *Minnesota Weatherguide Environment Calendar* and compare those entries with student observations. How are they alike and how are they different?

Read aloud to your class from published journals and nature observations, e.g. Henry David Thoreau's *On Walden Pond*, Henry Beston's *The Outermost House*, Aldo Leopold's *Sand County Almanac*, Noah Adams' *St Croix Notes*, Dick Gray's *Passwords for All Seasons*, or Sigurd Olson's *Wilderness Days*.

## Journal Jottings Weekly Diary

Week of _____

SUNDAY _____

MONDAY _____

TUESDAY _____

WEDNESDAY _____

THURSDAY _____

FRIDAY _____

SATURDAY _____

# Nature's News

**Subjects**
Art
Language arts
Science

**Time**

| | |
|---|---|
| Day 1 | 15-30 minutes |
| Weeks 2-12 | Varies according to project |

**Objective**
After reviewing the process of creating either a newsletter or newspaper, students will prepare the written material and artwork, design the layout, and complete their own newsletter or newspaper.

**Concepts**
Newsworthy events can be collected and shared through a printed medium, such as a newsletter or newspaper.

Because not all written material is ready for publication, students can learn the art of diplomacy, careful editing, and creative layout to bring a project like this to completion.

**Skills**
Writing
Interviewing
Designing
Drawing
Thinking critically
Team building

**Materials**

| | |
|---|---|
| Whiteboard | Paper |
| Writing and drawing utensils | Paste |
| Computer or typewriter | Newsletter samples |

**Week 1: Introduction to the Newspaper**

1. Discuss creating a newspaper four to eight double pages long. (Bring a copy of a local newspaper to class so students can review both the layout and types of articles.)

2. Tell students their newspaper articles need to relate to the present season. Ask students for input on the job positions needed to complete this assignment. Possibilities include an editor or coeditors, reporters, staff writers, special assignment writers, guest writers or columnists, graphic artists, layout designers, and printers.

3. Begin brainstorming possible names for the newspaper and the types of articles, interviews, surveys, poems, artwork, editorials, views and opinions, and human interest stories students can anticipate including. Write the possibilities on the whiteboard.

4. After brainstorming for 10-15 minutes, make a group decision (vote) on a name for the newspaper and make editor and staff assignments. Assign each person responsible for bringing a draft of their assigned material to the next newspaper meeting.

**Weeks 2-8: Completing the Newspaper**

1. Continue checking on the assigned materials and setting new deadlines until newspaper is ready for final edit, layout, pasting of the mock-up.

2. Prior to copying have the editor do a final edit.

3. Distribute.

**Questions For Discussion**

**When is it better to ask an open-ended question versus a close-ended question?** When you are looking for opinions or for greater amounts of information, it is better to ask open-ended questions because it allows a person to elaborate or give examples. A close-ended question is asked when you want a limited response and need to tabulate large amounts of data. For example, answers to yes-no questions are easy to tabulate.

**What are the ways nature and weather enter the news?** Sometimes, if an event is particularly noteworthy, such as a tornado, it will make headlines of its own. Weather often is an underlying event in other news stories. For example, a house fire may be fought in sub-zero temperatures, or the effects weather may have on marathon participants. Most newspapers have an extensive weather section that describes local and national weather including drawings, graphs, and scientific information.

**Taking It Further**

Have students complete a newsletter or newspaper during each of the seasons.

Invite a newspaper person to visit your classroom and talk about his or her job.

Have students find a historical newspaper article relating to an extreme weather event, such as the 1991 Halloween blizzard, the winter of 1984 snowfall record, or the spring floods of 2001. Check in the *Minnesota Weatherguide Environment Calendar* for other dates. Ask them to take notes about the event they find and bring the notes to class for discussion.

# The Water Cycle

**Subjects**
Earth Science
Language Arts

**Time**
Two 30-minute periods, with a two waiting periods at one hour and three hours.

**Objective**
Students will make a model to explain the phases of the water cycle in a closed system. Students will be able to identify the states of water as it moves through the water cycle.

**Concept**
Students will understand the process of the water cycle, and that energy from the sun is the driving force behind the water cycle.

**Skills**
Observing
Predicting
Critical thinking
Interpreting

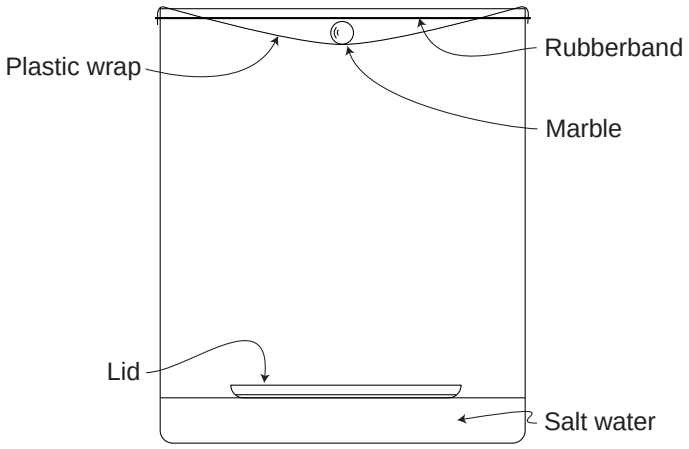
**Materials**
Large jar (quart size)
Small plastic lid to fit inside the jar
Plastic wrap
Rubber band
Goose-neck lamp with 100-150 watt bulb
Marble
Salt water
Whiteboard

**Key Words**
Water cycle, evaporation, condensation, transpiration, precipitation, percolation

Directions:

1. Introduce students to the water cycle. Describe how the cycle works, defining the words "condensation, evaporation," and "transpiration." (See Water Cycle Graphic in Appendices)

2 . Set up experiment as shown in the following illustration.




3. Have students predict what will happen after the jar is placed in sunlight or under the lamp.

4. Within one hour, depending on the temperature, changes in the jar should be noticed. Ask students to describe what they observe.

5. Leave the experiment for about three hours and observe once again.

**Questions For Discussion:**

**Is there anything in the lid? If so, what is it and how did it get there?** Yes, fresh water which dropped from the plastic covering the jar.

**Was the lower surface of the plastic wet before the experiment began? How did it become wet?** No, water evaporated from the salt water and condensed on the lower surface of the plastic.

**Why do the drops of liquid fall from the plastic?** The water droplets become large enough for gravity to pull them down.

**What will the liquid in the lid taste* like?** (salty or not?) Not salty.

** teachers -- be sure that the glassware, plastic, etc., is clean. Note also that in most lab situations students should not taste chemicals.*

**Taking It Further:**

Have students design other experiments to make evaporation happen faster. Hint: increase temperature, increase surface area, use a fan or hairdryer to make air move faster.

If possible, show how water evaporates by heating some in the classroom, or heat it elsewhere and bring it to the classroom to demonstrate. Have students watch for condensation on the lid of the heated container as the water cools.

# Curiosity About Clouds

**Subjects**
Art
Science

**Time**
30-40 Minutes

**Objectives**
After studying cloud types, students will be able to identify the three major cloud types and tell what significant weather event may be linked to each type.

Students will be able to draw and explain the water cycle.

**Concepts**
Clouds transfer energy from the ocean to the atmosphere and to the earth's surface.

Rain, drizzle, and snow occur when cloud particles grow to a size that no longer can be supported by vertical wind currents. Snow occurs when ice crystals grow. Rain occurs when snowflakes melt on their way to the ground. Drizzle may occur when tiny snowflakes melt, or when liquid water particles in clouds gather together.

**Skills**
Observing
Drawing
Forecasting
Drawing conclusions

**Materials**
*Minnesota Weatherguide Environment Calendar*
Whiteboard
Drawing paper and drawing utensils
Bibliography (for cloud and weather reference books)

**Key Words**
Cirrus clouds, cloud, condensation, cumulus clouds, cumulonimbus clouds, evaporation, fog, jet stream, precipitation, stratus clouds, transpiration, and water cycle. (See Vocabulary in Appendix.)

**Directions**

1. Using the Water Cycle graphic (Appendix), as a guide, show how water moves from surface water to land and back through a continuous cycle involving specific steps. Explain how water is transferred to the air from oceans and surface water evaporating, from animals and humans perspiring, and from plants transpiring. Water is condensed in the air as clouds, returned to the earth through precipitation, and returned to the oceans as runoff from rivers and streams. Explain that this is a continuous cycle worldwide, with only a portion of any given cycle taking place in Minnesota. In addition, places not directly near an ocean participate in the cycle.

2. Have several students explain the water cycle so you can evaluate how well they understand the concept.

3. Discuss and define clouds and review the features of the three main cloud types: cumulus, stratus, and cirrus. Refer to the cloud pictures in the *Minnesota Weatherguide Environment Calendar*. Ask students what kind of weather is usually linked to these three cloud types. Include in the discussion the relationships among weather, cloud type, and wind direction. *For example, if cirrus clouds are visible and the wind is from the west, the weather, most likely will remain good. If cirrus clouds are visible and the winds are from the east, there may be some precipitation within a 24-hour period.*

4. Ask several students to tell how various types of clouds fit into the water cycle. (See Questions For Discussion.) All cloud types fit; they just have different roles. Have students reflect on what their lives would be like without clouds.

5. Discuss the effect of the water cycle on a community. For example, what is the impact, both constructive and destructive, of a thunderstorm, a tornado, a flood, a heavy snowfall, a drought, a sunny day, a heat wave, fog, thunder, lightning, and a hurricane? Point out to students that what one person may view as constructive another may view a destructive or inconvenient. For example a farmer may rely on a good thunderstorm to deliver water to crops, but a parade official may have to make alternate plans. As an aid, you may want to list columns on the whiteboard as indicated by this example and fill in the answers as a class activity. Be sure students realize that even the most severe and large-scale storms are merely nature's way of transferring energy in the earth's atmosphere and of spreading water over the earth.

| | Constructive effects | Destructive effects |
|---|---|---|
| Thunderstorm | | |
| Drought | | |
| Sunny day | | |
| Snowfall | | |
| Flood | | |

6. Following this activity, have students observe the sky each day. Appoint one student to draw or name the observed cloud type on the weather calendar on the Weather News Board each day.

7. Have students forecast the daily weather based on their cloud and wind information.

**Questions For Discussion:**

**Where do clouds fit into the water cycle?** Clouds provide the vehicle for returning water to the earth through condensation and precipitation. Some clouds, such as cumulus, provide relief on a sunny day and reduce transpiration and evaporation. Other clouds, such as cumulonimbus and some stratus, provide direct precipitation.

**Do some cloud types bring us rain and snow? Which ones?** Cumulonimbus clouds bring showers, lightning, and occasionally high winds and tornadoes. Stratus clouds bring dull overcasts and may evolve into nimbostratus, which bring rain, drizzle, or snow.

**How can we identify clouds?** Cumulus clouds are flat on the bottom and bumpy on the top. Cumulus clouds grow vertically due to heat from the ground. If they grow, their tops may spread to form altostratus or altocumulus or, if their vertical growth exceeds six kilometers, they may spread on top and become cumulonimbus.

Stratus clouds have flat tops as well as flat bottoms because they spread under a stable layer of air. Stable air prevents clouds from rising. Stratocumulus clouds form when cumulus-type clouds cannot grow because of a stable air layer.

Cirrus clouds are different from other clouds in that they are composed of tiny ice crystals. In Minnesota you may see these ice crystals sparkling in the sun at ground level when the temperature drops well below zero. A joke is that we then have “cirrus near us.”

Castellanus, which means castle, is a cumulus-type cloud that forms independent of surface heating. They look like little turrets on castles. Rarely seen alone, they are not uncommon when there are numerous cumulonimbus in the sky.

An altostratus cloud is a stratus cloud more than two kilometers (about 6,500 feet) above the ground. An altocumulus cloud is a stratocumulus cloud more than two kilometers above the ground. Cirrostratus is a stratus-type cloud more than six kilometers above the ground.

**Taking It Further:**

Plan a class trip to the Science Museum of Minnesota's hands-on Experiment Gallery, which includes weather-related exhibits on clouds, tornadoes, and more. The Mississippi Gallery also has an exhibit about the "Big Blow-down" in the Boundary Waters Canoe Area Wilderness (BWCAW). See Resources in Appendix for more information.

Invite a meteorologist to your class to talk about the weather and weather forecasting.

Take time to explain how water becomes a gas and a solid. Discuss the symbol for water, $H_2O$, two hydrogen atoms plus one oxygen atom.

# Tree, Plant, and Wildlife Watch

**Subjects**
Art
Science

**Time**
30-40 minutes

**Objectives**
Upon completion of this activity, students will be able to distinguish between annual and perennial plants and coniferous and deciduous trees and will be able to name three plants or trees that belong in each category.

After studying and observing animals in their environment, students will be able to name three animals that hibernate, migrate, or stay active in Minnesota's varying seasons. They also will be able to state two reasons why animals hibernate rather than migrate.

**Concepts**
Some animals are true hibernators, while others, depending on the weather, are in stages of a deep sleep.

Trees that remain green in the winter landscape provide shelter and protection, while their deciduous counterparts allow sun to warm the houses and land.

**Skills**
Drawing
Observing
Thinking critically
Drawing conclusions

**Materials**
Whiteboard
Reference material on energy saving landscapes (optional)
Paper and pencil

**Key Words**
Annual, coniferous, deciduous, evergreen, hibernation, migration, perennials, and shelterbelt. (See Vocabulary in Appendix.)

**Directions**

1. Before beginning this lesson, write the following categories on the whiteboard, leaving space to write ideas that coordinate with each one underneath: evergreen (coniferous), deciduous, perennials, annuals, migratory animals, hibernators, and special adapters. See the table below for a possible layout.

2. Start a discussion focusing on the role of plants, animals, and trees in the school and community life and how humans are dependent on these things for existence. Bring out ways in which students are dependent on these things.

3. Focusing on one category at a time, ask students to describe a coniferous tree and some of its identifying features and possible uses. Write answers given in the section designated as coniferous. Ask them to identify a deciduous tree and note some of its identifying features.

4. Using the same format, continue the discussion for the other categories using the questions for discussion to elicit ideas from students. Also discuss how the weather affects various plants and animals.

| Coniferous (Evergreen) | Deciduous |
|---|---|
| green all year (exception:tamarack) | loses leaves in the fall and goes dormant |
| flat or rounded needles | buds become larger in the spring |
| has cones with seeds | can regenerate from nuts and other seeds |
| protects from wind | provides shade in the summer |
| permits snow accumulation | provides open area for sun in the winter |
| provides food for animals | provides food and nesting materials |
| provides shelter for birds | provides hibernating homes |
| source of fuel | source of fuel |
| source of decoration | fallen leaves are good mulch |
| | colorful fall colors on foliage |

| Perennials | Annuals |
|---|---|
| lasts for several seasons | survive only one growing season |
| food source for animals | food source for animals and humans |
| aesthetically pleasing | aesthetically pleasing |
| some expand over the years | die off each year |
| flowers: daisies, mums, peonies | flowers: petunias, marigolds |
| food: raspberries, strawberries | food: corn, potatoes, lettuce |

| Migrators | Hibernators | Special Adapters |
|---|---|---|
| seasonally move | sleep through the winter | stay active through the year |
| cannot acclimate | acclimatize by becoming dormant | can acclimate, but some become inactive |
| | unable to migrate | may die in harsh weather |

5. Upon completion of all seven categories, ask students to evaluate what they have learned about the relationship between the categories and themselves. Discuss how some of these things provide energy and help conserve energy. Relate this to the ways proper planting techniques can conserve both water and soil. Discuss wildlife habitat and improvement. Consider how various plants and animals are affected by climactic changes, global warming, drought, floods, etc.

6. End with a discussion on how plants, trees, and animals fit into the water cycle. For example, trees and plants take water from the soil and release it through their leaves in a process called transpiration.

**Questions For Discussion**

**What is the advantage of growing coniferous versus deciduous trees?** Having both trees in our landscapes is advantageous. Conifers, because they remain green all year, have the advantage of providing a shelter that exists at all times. However, deciduous trees, planted to shade the house in summer and allow the sun to shine through in the winter, provide seasonal energy savings. In addition, having some of each type provides a more aesthetically pleasing landscape throughout the seasons.

**Why do some animals hibernate while others migrate?** Some animals, such as ducks, geese, and monarch butterflies, are adapted to go to a place where the climate is more suitable for survival. These animals have their flying machines on board, so to speak. For others, such as bears, snakes, turtles, and toads, going the long distance required to find a climactically suitable environment would not be feasible. Thus, these animals remain close to home, but accommodate to the more severe winter weather by either burrowing into the ground, as toads do, or lowering their body temperatures, as bears do, so they can become dormant until the weather becomes more suitable.

**What about those that stay active?** The animals that stay active in their year-round environment have adapted to the Minnesota climate by storing food, relocating dens or nests, and shoring their dens or nests to tough it out on environmentally rigorous days.

**Taking It Further:**

Group students together in teams of three or four and tell each team to design an energy-efficient landscape for the school. Evaluate the drawings produced by the various teams for energy conservation, wildlife habitat, and visual appeal. Have the class vote on the team with the best design and give the winning team a prize.

Have students make bird feeders out of milk cartons. (Appendix). Have each student take his or her feeder home, fill it with birdseed, and place it outside the home. Ask students to observe their feeders for one week and record the birds they see. Make several bird feeders for an art project, fill them with birdseed and set them outside the classroom window to observe and identify birds as a class project.

Have students observe the birds at their feeders beginning in September and observe what birds use it throughout the winter and the following spring. Compare spring arrivals to the phenology notes in the *Minnesota Weatherguide Environment Calendar.*

Invite a forester or tree farmer to class to talk about preservation of our forests for wildlife habitats and proper planting and harvesting techniques.

# Sun, Moon, and Star Gazing

**Subjects**
Art
Science

**Time**

| | |
|---|---|
| Day 1 | 30-40 minutes |
| Weekly | Varies according to project |

**Objectives**
After reviewing the daily path of the earth, students will be able to observe and record the rising and setting times of the sun and relate the changes in these times to the seasons.

Students also will be able to draw the moon in its monthly cycle and explain why there are distinctive phases.

After studying the star templates, students will be able to observe the Big Bear and the Little Bear and draw the Big Dipper and the Little Dipper, which lie within these constellations.

**Concepts**
The earth rotates around its axis once every 24 hours, creating day and night. It revolves around the sun once every year. As it revolves around the sun, it is tilted on its axis, and it is this tilt that creates the seasonal variation in the length of day and night.

The moon completes its cycle of phases every 29 and one-half days, giving us 12 and one-half complete cycles a year.

Stars appear to rise and set four minutes earlier every day. After one full year they rise and set at the same time they did 365 days earlier.

**Skills**
Observing
Recording
Drawing

**Materials**
Paper and pencil
*Minnesota Weatherguide Environment Calendar*
Star templates for a month of study – one per student

**Key Words**
Astronomy, constellation, equinox, meteor, solstice, Ursa Major, Ursa Minor, waning moon, and waxing moon. (See Vocabulary in Appendix.)

# ACTIVITIES

**Directions:**

Since most of this lesson involves the moon and the stars, which are mostly observable after school hours, you may want to send a note home enlisting parental help so each student can successfully complete the moon- and star-gazing parts of this lesson.

1. Start the class by asking students to review these facts about the sun: it is a star; it is very bright because it is closer to the earth than other stars; it rises and sets at specific points on the horizon; it rises and sets at specific times each day, and because the earth is tilted on its axis the sunrise and sunset times vary throughout the year.

2. Ask students to share how the variation with the sun's rising and setting time affects them personally and how it affects others in the community. Include the effects of daylight savings time in your discussion.

3. After this discussion, have students track and record the sunrise and sunset times. The *Minnesota Weatherguide Environment Calendar* has sunrise/set times for the Twin Cities. Appoint a student to be responsible for adding this data to the Weather News Board calendar each day. Have students compare Twin Cities sunrise/set times with other cities in Minnesota. For example, using the Minnesota maps on the calendar pages of the Weatherguide, have them compare what time the sun rises and sets in St. Paul with the time it rises and sets in southwestern Minnesota. Have them discuss what differences they notice.

4. Discuss the moon and its cycle as it waxes from new to full and wanes from full back to new. (See Vocabulary.) Ask students to contribute what they already know about the moon's monthly cycle. Include in your discussion in which direction in the sky they need to look for the moon each night. (Look in the *Minnesota Weatherguide Environment Calendar* for reviewing the position of the moon each month.)

5. Explain that each student is going to track the moon's cycle by drawing on a sheet of paper how the moon looks each night for a month. Have them start their drawing in class by placing the directional letters N, S, E, and W on a piece of plain paper. Tell them that the assignment for tonight and each night throughout this month is to draw the moon on this piece of paper, in the proper compass direction, as they see it at 8 p.m.

6. Check the drawings to make sure that students are drawing the moon correctly in relationship to proper compass location and in the appropriate phases. During this part of the activity, you may want to show them a 3D visual of the moon in relation to the sun so they have a better understanding of why the moon shows different phases and appears to wax and wane. See Taking It Further for directions.

7. When you are assured that students have a good understanding of the moon's cycle, start a discussion on stars and their cycles so they can understand the sun, moon, and stars all have cycles but that the length of their cycles varies.

8. Review general information about the stars: they rise and set four minutes earlier each day and take one year to complete a cycle; some are brighter than others, the sun being the brightest; all of the stars appear in constellations; there are myths connected with some constellations; some are easier to track than others.

9. Review the star template showing the Big Dipper (January). Take time to show the features of this set of stars: there are seven stars that form what look like a giant Big Dipper, thus its name; two of the stars in the cup, known as "pointer stars," point to the North Star. If necessary, draw the Big Dipper on the board as it will appear to them on this particular night. Especially show the position of the handle and cup in relation to north. Tell them that in order to find this set of stars they must look in the northern sky.

10. Tell students to take the star template home to use as a guide for finding and drawing the Big Dipper in the night sky. Ask them to draw the Big Dipper on a clean piece of paper marked N, S, E, and W as they did for their moon drawings. Encourage them to ask their parents for help in this activity.

11. In the following class; check the drawings of the Big Dipper. Discuss the relationship of the Big Dipper to the Little Dipper. Start and complete a similar drawing project for the Little Dipper with the North Star at the end of its handle.

12. After completing the drawings of the Big Dipper and the Little Dipper, have students observe and draw the entire Big Bear and Little Bear constellations.

**Questions For Discussion**

**Does the moon actually change shape during the month?** Although it appears to change shape, it actually stays the same. The moon is a sphere – like the Earth. However, how it is viewed in relationship to the sun determines the shape we see.

**Why do some stars appear some times of the year and not others?** Each star is on a cycle that takes a year to complete. As each rises and sets on its annual cycle, some may become difficult to view when they lie in the same direction as the Sun, as seen from Earth. This annual schedule is the reason some stars appear as evening stars during one season and as morning stars during another.

**Taking It Further**

Plan a class trip to the planetarium. See Resources in Appendix for further information.

Add the sunrise and sunset times and drawings of the new, waxing, full, and waning moon throughout the month and appropriate star drawings to the Weather News Board monthly calendar.

# ACTIVITIES

Do a sun declination drawing activity, using a specific area of the schoolyard for measurement. Each month on a scheduled day at noon, measure the length of the shadow on the north side of the school building. Write down the measurement each month and note over a several month period how the shadow lengthens as the days become shorter in the winter and shortens as the days become longer in the spring. This shadow is caused by the sun's gradual lowering path in the fall sky and its gradual rising path during winter and spring.

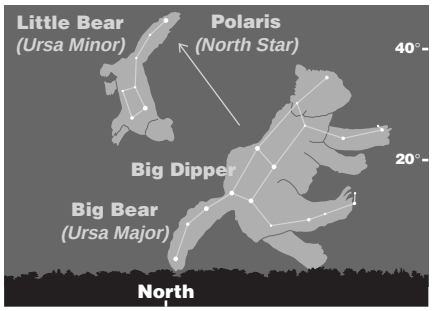
Using the *Minnesota Weatherguide Environment Calendar*, have students track and draw a constellation each season; "Cassiopeia" for fall, "Orion" for winter, "Leo" for spring, and "Scorpius" for summer.

Create a classroom moon lab by taking three to five six-inch Styrofoam balls and attaching string to them with paper clips. Tape or hook these hanging moon models to the classroom ceiling. After darkening the room, take a slide projector and shine its light on one of the moons. Have the students tell what moon phase they see. The students directly in line with the projector light should see a full moon. Those directly behind the moon ball should see a new moon. Those students sitting at a 45-degree angle to the light beam should witness either a waxing or waning moon. Those students sitting at a 90-degree angle from the projector light will see a quarter- or half-moon phase. Move the projector around to the other hanging moons so students in various classroom locations can view the moon phases.

After creating the moon lab, ask students what direction they would need to face to look at a rising full moon (in the east) and what direction they would need to face to find a new moon (in the west.) Discuss why this is so. Answers should relate to the fact the rising full moon in the east is in opposition to the sun, which is setting in the west. Thus, the sun is shining directly on the moon and that is what we see. The new moon cannot be seen; it's in the west hidden beside the setting sun, thus we cannot see it.

Assign teams to learn about selected constellations and their myths. Have each team share their myth with the class.

## Star Templates

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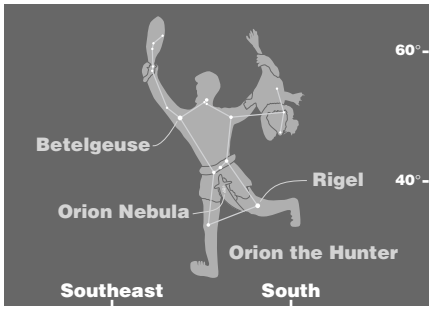


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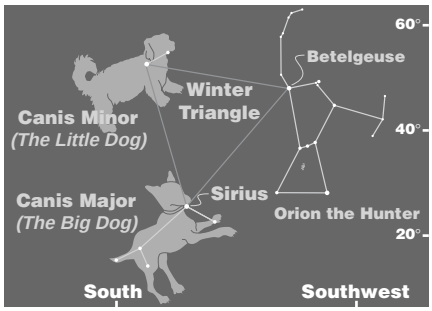


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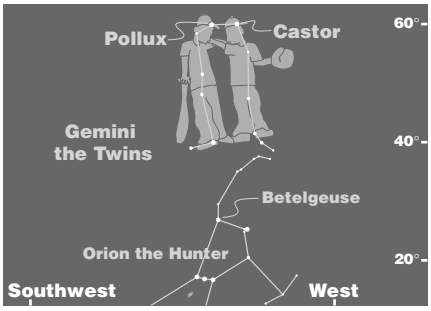


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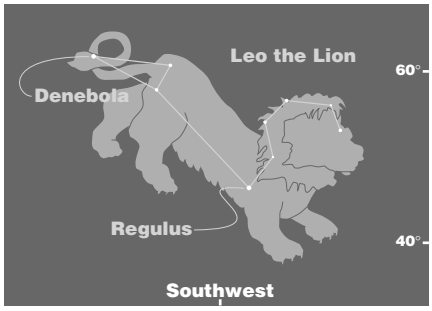
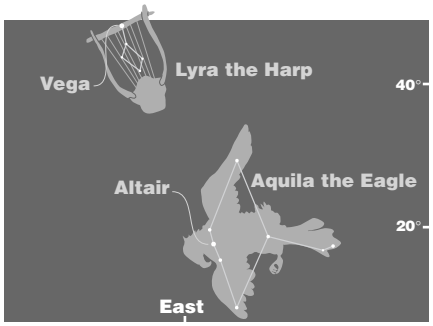
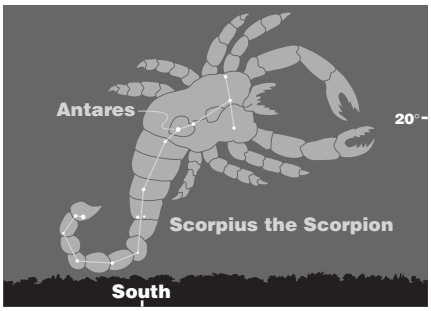


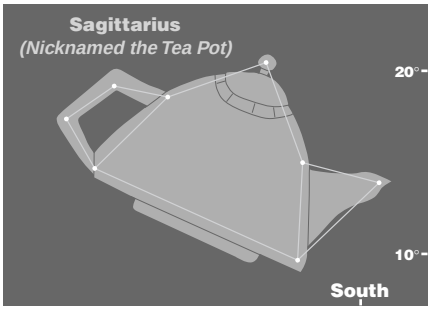

May 15, 2002 at 10:00 pm CDT



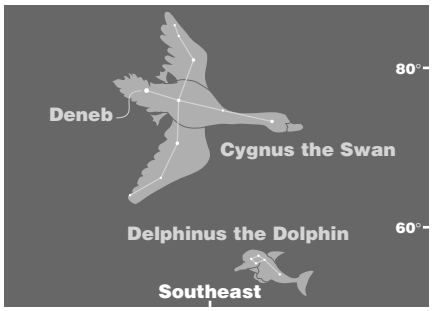

June 15, 2002 at 10:30 pm CDT



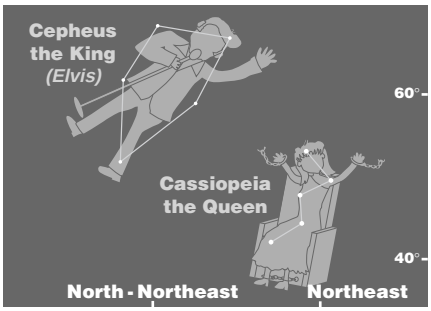

July 15, 2002 at 10:30 pm CDT



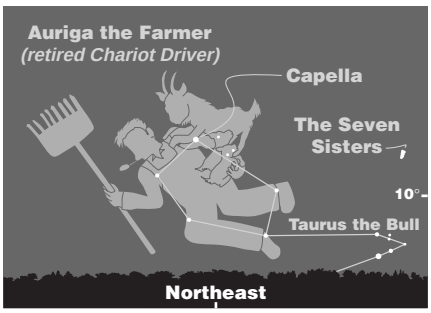

August 15, 2002 at 9:45 pm CDT



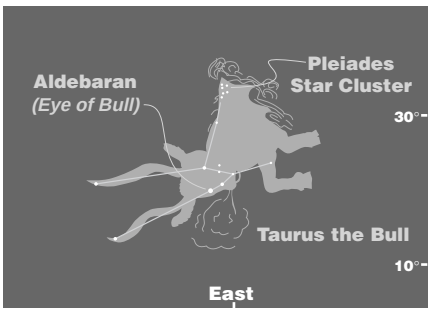

September 15, 2002 at 9:00 pm CDT




October 15, 2002 at 8:00 pm CDT




November 15, 2002 at 6:15 pm CDT




December 15, 2002 at 6:00 pm CST

# Weather Station Creation

**Subjects**
Art
Science

**Time**

| | |
|---|---|
| Day 1 | 30-40 minutes |
| Other days | Varies according to project |

**Objective**
After discussing the needed elements, students will design and create a weather station.

After building a weather station, students will be able to read the weather gauges, observe the clouds, and forecast the weather.

**Concept**
By combining equipment and good observation skills, weather forecasting becomes possible.

**Skills**
Observing
Designing
Building
Critical Thinking
Drawing conclusions
Forecasting

**Materials**
Drawing paper and utensils
Temperature gauge
Yardstick
Metal can
Wooden dowels (2)
Clear glass canning jar
Several medium-size balloons
Several large rubber bands
Small flag or pennant
Hammer and nails
Indelible marker

**Key Word**
Barometer, thermometer, observation, forecast, wind vane.
(See Vocabulary in Appendix.)

**Directions**

*Prior to starting this lesson, obtain permission for setting up a small weather station outside the building.*

1. Tell the class that they are going to create and build a weather forecasting station. Discuss what should be measured and why. Include such things as temperature (rising or falling), wind (speed and direction), rain (amount), snow (amount), and air pressure (rising, falling, or steady). Continue the discussion on what devices can be used for this kind of measuring. Include devices such as an outdoor thermometer, a wind gauge, a rain gauge, a snow-measuring device, and a barometer.

2. Brainstorm on how these various measuring devices can be constructed and what materials are needed to make each of them. Write the ideas and materials list for each idea on the whiteboard. See the table on the following page for a list of possibilities.

3. End the brainstorming session with a list of the devices the class is going to make and the construction plan for each one. Complete the needed materials list for each device.

4. Have the class develop a plan for executing the design and creation of the devices. Include ideas for buying or gleaning the materials from recycling, home or purchased at a store; ways construction can be completed; and tools that are needed. Have students volunteer to be builders of the various devices. Ask the class to appoint a leader to oversee project completion.

5. Have the class set a project completion date.

| **Measuring device** | **Materials needed** |
|---|---|
| Outdoor thermometer | purchase |
| Wind gauge | pennant, flag, dowel, scissors, needle, thread |
| Rain gauge | metal can, dowel, ruler, marker |
| Snow gauge | yardstick |
| Barometer | clear glass jar, balloon, rubber band |

**Possible ways to make these devices:**

*Temperature gauge*
Purchase

*Wind gauge*
Have students borrow a small pennant or flag or make one out of approximately one yard of rainproof material cut into the shape of a flag. Once it is made, have them attach it to a 36-inch wooden dowel, a broom handle, or a metal pole. If the weather station is missing one or more data-collection devices, students can fill in the blanks by either estimating wind speed using the Beaufort Wind Scale (provided in the *Minnesota Weatherguide Environment Calendar*), or finding the missing information in a local daily newspaper, or on a weather-related website.

*Barometer*
Have students obtain a clear glass jar, such as a canning jar that has been recycled or bought at a store. Have them cut a balloon larger than the jar opening and stretch it over this opening. Have them secure the balloon with a large rubber band.

*Rain gauge*
Ask students to find a one-or two-pound coffee can or another metal can. Have them secure the top of the can to a wooden dowel or broom handle with a hook or nail.

*Snow gauge*
Buy or borrow a yardstick.

6. After the devices are made, purchased, or borrowed, place the outdoor instruments (thermometer, wind gauge, and rain gauge) in a previously selected location, preferably on the north side of the building on a level surface away from any overhanging eaves or trees. The thermometer needs to be at least six feet above the surface of the ground and in the shade. Ask students to select a stable shelf in the classroom for the barometer. Keep the snow gauge available for a snow measurement when needed.

7. Appoint a student team to be responsible for reading the gauges each day and forecasting the weather. Try to take the measurements at about the same time each day. Record the readings on your observation chart.

**Observation Chart**

| | Date | Date | Date | Date | Date | Date | Date |
|---|---|---|---|---|---|---|---|
| Temperature | | | | | | | |
| Precipitation | | | | | | | |
| Wind Direction | | | | | | | |
| Wind Speed | | | | | | | |
| Pressure R, F, S | | | | | | | |
| Cloud Type* | | | | | | | |

8. Every day you take readings, look up the actual and predicted weather data reported by official sources. Record the relevant data on your table. You can find the data in the newspaper or on the Internet. (See Appendix for a list of weather sites).

* Use the cloud chart provided in the *Minnesota Weatherguide Environment Calendar* to identify the cloud types.

**Questions For Discussion**

**What does the glass jar barometer tell me?** The information you want to know from the barometer is whether it is rising, falling, or remaining steady. A level balloon indicates a steady pressure. A bulging balloon or a balloon drawn inward indicates a change in atmospheric pressure. Placing a toothpick or a plastic drinking straw across the lip of the jar will make it easier to see.

**How can a flag, pennant, or windsock tell us about the wind speed?** By using a simple scale *The Beaufort Scale,* it is possible to estimate wind strengths without the use of instruments, based on the effects wind has on the physical environment.

**Taking It Further**

Plan a class trip to the Science Museum of Minnesota to visit the Experiment Gallery where they may view a monitor showing data collected by the automated weather station on the Museum's rooftop.

Invite a meteorologist to talk to the class about weather forecasting, models, forecasting tools and products.

Visit the National Weather Service office in your area.

Invite an individual to speak to the class that has survived a significant weather event such as a tornado, blizzard, or flood.

Appoint a student volunteer to be the daily weather forecaster for a week. Have the student be responsible for collecting the necessary daily weather information, resource materials, and consult the team that is responsible for reading the outside and inside gauges. Have the student predict local weather based on clouds seen, barometric pressure, as well as wind direction.

Use the data collected to create graphs and find averages of each measurement. **Hint:** numerical data can be entered into a simple spreadsheet-type computer program and manipulated to create impressive charts and graphs. Students can also create a wall chart to display the data.

Have students access the Internet to obtain a variety of weather forecasts to compare and contrast them. Have student teams compare all forecasts and make note of which was more accurate. To access some of the familiar cites students should visit:

The Science Museum's Weather Station:
http://intranet.smm.org/public/post/weather/egweather.jpg

www.weather.com

www.kare11.com

www.kstp.com

www.wcco.com

www.accuwx.com

www.cnn.com/WEATHER/

Have students record the temperature in both Fahrenheit and Celsius.
Have students write essays or articles about their predictions, how they made the weather station, and the events they observed.

## Vocabulary

**Abiotic factor**
nonliving physical influences, e.g. a thunderstorm, water, air.

**Annual**
completing the life cycle in one growing season (when referring to a plant.)

**Astronomy**
the scientific study of the universe beyond the Earth.

**Barometer**
an instrument for determining the air pressure of the atmosphere.

**Biology**
the scientific study of life.

**Biotic factor**
Living influences, e.g. shade from plants, competition for food.

**Cirrus clouds**
Curly, wispy clouds found at least three miles above the ground and often much higher. Because of their height, they are made of ice crystals rather than water droplets. These are the clouds that sometimes cause a halo around the moon by refraction of moonlight through the ice crystals.

**Cloud**
A collection of water droplets (sometimes ice crystals) suspended in the air. Clouds are classified by both their shape and height above the ground.

**Compass**
A device for determining the direction north.

**Condensation**
The process by which a vapor (gas) becomes a liquid, such as $H_2O$, by cooling.

**Conifer**
Plants that have seeds in cones, such as pines and firs. Leaves are usually needle-like.

**Constellation**
Any of the 88 configurations of stars that encompass the entire night sky seen from earth. Most represent some object or mythological being.

**Cumulonimbus clouds**
Vertically rising and growing cumulus clouds whose appearance usually means the imminent arrival of rain, thunder, and lightning. Theses clouds can reach heights of 40,000 feet or greater and those rising greater than 45,000 feet often become severe.

**Cumulus clouds**
Puffy, white clouds that form less than a mile above the ground and are known to be fair-weather clouds unless they rise vertically. Cumulus become congestus when the upward currents of warm air continue to rise.

**Deciduous**
A plant that sheds its leaves at a certain season.

**Equinox**
The day on which the sun's apparent path crosses the Earth's equator, and day and night are about equal in length. These days occur around March 21 - the beginning of spring, and September 21 - the beginning of fall.

**Evaporation**
The process by which a liquid, $H_2O$, becomes a vapor (gas) by adding heat energy.

**Evergreen**
A plant that retains its green leaves through all seasons.

**Fog**
A cloud that touches, or nearly touches, the ground.

**Hibernation**
Passing winter in a dormant or resting state.

**Jet stream**
Swiftly flowing air current several miles above the Earth's surface that moves from west to east in the Northern Hemisphere and divides cold air and warm air.

**Meteorology**
The study of the Earth's atmosphere, including weather and weather forecasting.

**Migration**
Seasonal movement from one place to another for feeding or breeding purposes and to survive climactic changes.

**Perennials**
Plants that last for several growing seasons without replanting.

**Phenologist**
A person who studies phenology.

**Phenology**
The science of tracking natural biological and physical events in relationship to climactic condition (e.g. bird migration, plant flowering).

**Precipitation**
A process by which some form of water falls as rain, snow, sleet, or hail.

**Shelterbelt**
A barrier of trees or shrubs that protects from the winds and storms and reduces erosion.

**Solstice**
The point of the sun's apparent path at which it is either the farthest north of Earth's equator or the farthest south of Earth's equator. The date of the summer solstice is on or about June 21. This is usually the longest day of the year in the Northern Hemisphere. The date of the winter solstice is on or about December 21. This is usually the shortest day of the year in the Northern Hemisphere.

**Stratus clouds**
Dull and gloomy layered clouds, flat on the bottom and top, that form from one to one-and-one-half miles above the earth. Their gloominess may be linked to the fact that they usually block the sun.

**Transpiration**
The loss of water vapor from a plant to the atmosphere.

**Ursa Major**
The constellation that is the most obvious of the northern sky constellations. Its seven brightest stars are commonly known as the "Big Dipper."

**Ursa Minor**
The constellation that is known as the Little Bear and includes the stars known as the Little Dipper. The North Star lies at the tip of the dipper's handle.

**Waning moon**
The time interval when the moon appears to shrink from full to new.

**Water Cycle**
The movement of water from the oceans to the atmosphere (through evaporation and transpiration), from the atmosphere to the earth (in the form of precipitation such as rain or snow), and from the land to the ocean (by way of runoff from rivers and streams).

**Waxing moon**
The time interval when the moon appears to grow and new to full.

## Bibliography

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http://www.npwrc.usgs.gov/resource/tools/ndblinds/ndblinds.htm

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Lehr, Paul, R. Will Burnett, and Herbert Zim. *The Golden Guide to Weather*. New York, NY. Golden Press. 1987.

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Rubin, Louis D. Sr., Duncan, Jim. *The Weather Wizard's Cloud Book*. Chapel Hill, NC. Algonquin Books of Chapel Hill. 1989.

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Tekiela, Stan. *Birds of Minnesota Field Guide*. Adventure Publications, Cambridge, MN. 1998.

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# Internet Links

### Weather and Climate

Climate Prediction Center: www.cpc.noaa.gov
Climate Summaries for Cities and States: www.cdc.noaa.gov/USclimate/
Environmental News Network: www.enn.com/specialreports/climate/
National Climatic Data Center, NOAA: www.ncdc.noaa.gov
National Weather Service www.nws.noaa.gov
Space Weather: www.sel.noaa.gov/today.html
Storm Prediction Center: www.spc.noaa.gov
The Tornado Project: www.tornadoproject.com
U.S. Environmental Protection Agency: www.epa.gov/globalwarming/
Worldwide Weather Events of 1991-2000: www.ncdc.noaa.gov/ol/reports/weather-events.html

### Current US Weather

AccuWeather: www.accuwx.com
CNN Weather: www.cnn.com/WEATHER/
KARE11 – TV: www.kare11.com
NCAR-RAP: www.rap.ucar.edu/weather/
NWS Interactive Weather Information Network: www.nws.noaa.gov/iwin/iwdspg1.html
The Weather Channel: www.weather.com
University of Michigan Weather Links: http://cirrus.sprl.umich.edu/wxnet/servers.html
University of Wisconsin Space, Science & Engineering: www.ssec.wisc.edu/data/
USA Today Weather Page: www.usatoday.com/weather/
WGN-TV, Chicago: www.wgntv.com

### Federal Agencies

Federal Emergency Management Agency (FEMA): www.fema.gov
Marshall Space Flight Center: www.msfc.nasa.gov
NASA – Kids Earth: http://kids.earth.nasa.gov
NASA – NASA for Kids: www.nasa.gov/kids.html
NASA Education: www.education.nasa.gov
National Center for Atmospheric Research (NCAR): www.ncar.ucar.edu
Spaceflight Meteorology Group: www.spaceflight.nasa.gov/realdata/weather/
Time: www.time.gov
U.S. EPA – Water Cycle: www.epa.gov/region07/kids.wtrcycle.htm
University Corporation for Atmospheric Research (UCAR): www.ucar.edu
USGS Real-time Streamflow and Lake Level Data: http://water.usgs.gov/realtime.html
Water Science for Schools - USGS: http://ga.water.usgs.gov/edu/
Weather Information for Kids: www.fema.gov/kids/

## Educational Resources

Institute on Climate and Planets: Atmospheric Pressure/Layers of the Atmosphere
http://icp.giss.nasa.gov/education/cloudintro/pressure.html

Space Academy: Earth's Atmosphere
http://liftoff.msfc.nasa.gov/academy/space/atmosphere.html

NOVA Online Adventure: The Atmosphere
http://www.pbs.org/wgbh/nova/balloon/science/atmosphere.html

Miami Museum of Science: What Happens When a Storm Comes?
http://www.miamisci.org/hurricane/airpressure.html

NASA: More Fun – "For Kids Only" Activities
http://kids.earth.nasa.gov/archive/air_pressure/index.html

Athena Curriculum: Earth and Space Science – K-12
http://www.athena.ivv.nasa.gov/cirric/weather/

Athena Curriculum: Weather
http://athena.ivv.nasa.gov/curric/weather/index.html

Little Cloud Album with SYNOP Codes
http://www.met.hu/cloudalbum/cloud.htm

Miami Museum of Science: Hurricane Storm Science
http://www.miamisci.org/hurricane/

Dan's Wild, Wild Weather Page: Tornadoes
http://www.wildwildweather.com/twisters.htm

The Why Files: Tornadoes—Going Around in Circles
http://whyfiles.news.wisc.edu/013tornado/index.html

Monarch Watch: In the Classroom
www.monarchwatch.org/class/curric/index.htm

Journey North
www.learner.org/resources/resource.html

Operation Ruby Throat
www.rubythroat.org

Franklin Institute Online: Earth Science Resource
http://sln.fi.edu/tfi/hotlists.geology.html
Science Museum of Minnesota – Explore Science
www.smm.org/explorescience/research/top.html

Minnesota Science Teacher's Association
www.mnsta.org

National Science Teacher's Association
www.nsta.org

**Plants**

Minnesota Native Plant Society
http://www.stolaf.edu/depts/biology/mnps

University of Minnesota Landscape Arboretum
http://www.arboretum.umn.edu

Botanical Society of America
www.botany.org

Virtual Foliage Home Page
www.wisc.edu/botany/virtual.html

Minnesota Natural Heritage and Nongame Research Program
www.dnr.state.mn.us/ecological_services/nhnrp/index.html

Bell Museum of Natural History – University of Minnesota Herbarium
www.cbs.umn.edu/herbarium

Links to Botanical References
www.keil.ukans.edu/cgi_bin/botany

Northern Prairie Wildlife Center
www.npsc.nbs.gov:80/

Orchids of Wisconsin
www.wisc.edu/botany/orchids/orchids_of_Wisconsin.html

**Birding**

National Bird Feeding Society – For Kids
www.birdfeeding.org/kids.html

National Audubon Society
http://www.audubon.org

Minnesota Pine to Prairie Birding Trail
www.mnbirdtrail.com

Peterson Online Birds
www.petersononline.com/birds

National Hummingbird Organization
www.hummingbird.org

**Astronomy**

STARDATE
http://stardate.org

Minneapolis Planetarium
www.mplanetarium.org/planet_home.html

Minnesota Astronomical Society
www.mnastro.org

University of Minnesota Astronomy Department
www.astro.umn.edu

NASA Spacelink
http://spacelink.nasa.gov/educator.focus

Starchild
http://starchild.gsfc.nasa.gov.docs.starChild/StarChild/html

Space Telescope Science Institute
www.stsci.edu

Amazing Space: Web-based activities for classroom and other educational uses.
http://amazing-space.stsci.edu/

Astronomical Society of the Pacific: Wide assortment of astronomical formation.
http://www.astrosociety.org/

Astronomy Café: On-line astronomical questions & answers with Dr. Sten Odenwald.
http://www.theastronomycafe.net/

The Nine Planets: Multimedia Tour of the Solar System.
http://www.nineplanets.org/

Star Child: Web learning center for young astronomers.
http://starchild.gsfc.nasa.gov/docs/StarChild/StarChild.html

The Space Place: Educational activities for students and teachers.
http://spaceplace.jpl.nasa.gov/spacepl.html

Hands On Universe: Educational resources for students and teachers.
http://hou.lbl.gov/

NASA Space Link: Aeronautics and space resources.
http://spacelink.nasa.gov/.index.html

Planetary Photojournal: Net access to the best solar system photos available.
http://photojournal.jpl.nasa.gov/

Odyssey Magazine: Monthly science/astronomy magazine for kids.
http://www.odysseymagazine.com

Observing ISS, Shuttle & Earth Satellites: Best site for on-line satellite observing.
http://www.heavens-above.com/

Spaceweather.com: Finest northern lights, meteors, comets and asteroid website.
http:spaceweather.com/
Thursday's Classroom: NASA prepared lesson plans and activities.
http://www.thursdaysclassroom.com

KidsAstronomy.com: Astronomy website by and for kids.
http://kidsastronomy.com

Space Calendar: List of space activities/anniversaries for the next twelve months.
http://www.jpl.nasa.gov/calendar/

Space.com: Current daily space news.
http://space.com/

NASA Kids: Astronomical website written for and by kids.
http://kids.msfc.nasa.gov/

Eclipse Home Page: Everything you wanted to know about lunar and solar eclipses.
http://sunearth.gsfc.nasa.gov/eclipse/eclipse.html

Encyclopedia Astronautica: Info about every rocket, spacecraft, etc. since Sputnik 1.
http://www.astronautix.com/

U. S. Naval Observatory Astronomical Applications: Sky events computed on-line.
http://aa.usno.navy.mil/

## Resource List

**Minneapolis Planetarium**
300 Nicollet Mall
Minneapolis Minnesota 55401-1904
Showtime Line: 612.630.6150
www.mplanetarium.org/planet_home.html

Operated by the Friends of the Minneapolis Public Library, the planetarium offers shows to the public and school groups on a regular basis. Call for time availability and group pricing.

**Minnesota Landscape Arboretum**
3675 Arboretum Drive
Chanhassen, Minnesota 55317
952.443.2460
www.arboretum.umn.edu

The arboretum has 905 acres where you can view hills, woods, prairies, formal gardens, and plant collections via hiking trails, paved paths, or a three-mile drive. Educational opportunities are available for school groups. Check with the staff to see what is available and what fits your class needs.

**Minnesota Zoo**
13000 Zoo Blvd.
Apple Valley, Minnesota 55124
952.432.9000
www.mnzoo.org

This naturally landscaped area provides habitat for both native Minnesota animals and those whose natural habitat is in another place and climate. Have students walk the Minnesota Trail to see beavers and wolverines. Call for information and group rates.

**Science Museum of Minnesota**
120 W. Kellogg St.
St. Paul, Minnesota 55102
651.221.9444 General Information
www.smm.org

The museum offers a wide variety of exhibits, some permanent and others for limited periods of time. Call for information on what is currently available as well as group rates.

## Phenology Checklist

## Spring: March 21 - June 21

Record the dates as you observe the following events of spring:

| Event | Date Observed |
|---|---|
| 1. Ice melts off the lakes. | |
| 2. Maple trees are tapped for syrup. | |
| 3. The sun feels warmer. | |
| 4. Daylight lengthens. | |
| 5. Buds on the trees start to open. | |
| 6. Rhubarb is ready to harvest. | |
| 7. Robins and other returning birds build nests. | |
| 8. Dandelions become profuse. | |
| 9 Field corn planting begins. | |
| 10 Honeysuckle and lilac bushes bloom. | |
| 11. Tulips, grape hyacinth, and crocus bloom. | |
| 12. Squirrels become more active. | |
| 13. Mallards and their ducklings appear. | |
| 14. Daylight savings time begins. | |
| 15. Small leaves appear on the maples, oaks, and lindens. | |
| 16. Soil is plowed. | |
| 17. Toads appear on land. | |
| 18. Grass goes from brown to green. | |
| 19. Snow melts and disappears. | |
| 20. Spring rain refreshes. | |
| 21. Lawn mowing season begins. | |
| 22. Maple tree flowers are profuse. | |
| 23. Apple blossoms appear on the apple tree. | |
| 24. New growth appears on the raspberry canes. | |
| 25. Robins return. | |

## Phenology Checklist Summer: June 22 - September 21

Record the dates as you observe the following events of spring:

| Event | Date Observed |
|---|---|
| 1. The summer solstice occurs. | |
| 2. Common loons can be heard singing on northern lakes. | |
| 3. Strawberry and blueberry patches ripen for picking. | |
| 4. Raspberry bushes produce profusely. | |
| 5. Basswood and catalpa trees bear and shed their flowers. | |
| 6. Corn ripens and is for sale at field stands and in the marketplace. | |
| 7. Butternuts and bur oak acorns begin to fall. | |
| 8. Apples ripen and fresh apple juice becomes available. | |
| 9. Fresh squash and cucumbers abound. | |
| 10. Daylight lengthens then shortens. | |
| 11. Alfalfa fields are cut. | |
| 12. Garden-ripened tomatoes are ready. | |
| 13. Turtles begin to lay their eggs. | |
| 14. Prairies abound with wildflowers. | |
| 15. Katydids sing loudly on hot summer nights. | |
| 16. American robins gather for migration. | |
| 17. Squirrels enjoy their fruit and nut feast. | |
| 18. Black bears ready themselves to enter their winter dens. | |
| 19. Lake water temperatures reach 70-80 F degrees. | |
| 20. Crabgrass abounds in city lawns. | |
| 21. Thunderstorms appear and move on. | |
| 22. Sirens occasionally sound severe weather warnings. | |
| 23. Leaves on some maples and basswoods turn yellow and brown. | |
| 24. Beekeepers extract honey. | |
| 25. Mosquitoes are busy biting. | |

## Phenology Checklist Autumn: September 22 - December 21

Record the dates as you observe the following events of spring:

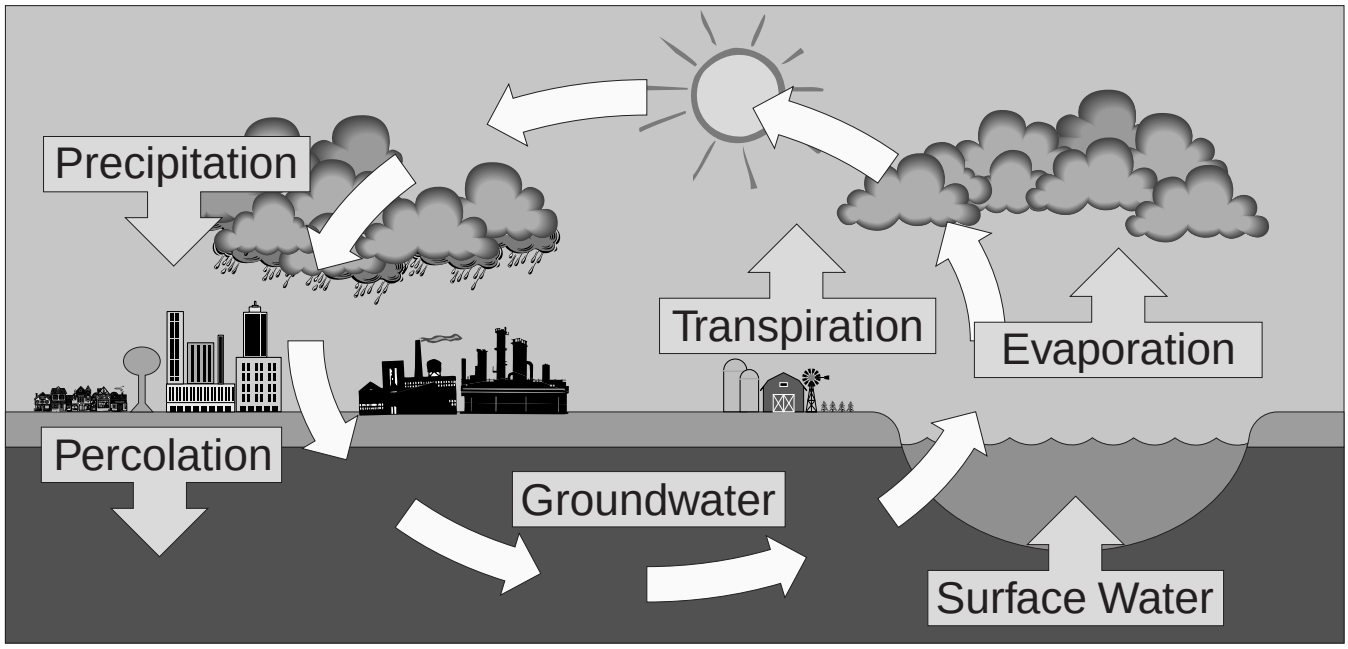
| Event | Date Observed |
|---|---|
| 1. Milkweed pods become empty. | |
| 2. Daylight savings time ends. | |
| 3. Winter solstice occurs. | |
| 4. Squirrels and deer mice gather winter food. | |
| 5. Autumn colors are at their peak. | |
| 6. Leaves turn glorious colors and fall from the trees. | |
| 7. Daylight shortens. | |
| 8. Pheasants feed in the cornfield. | |
| 9. Deer, pheasants, and grouse become the hunted. | |
| 10. Leaves are raked or mulched. | |
| 11. Pumpkins appear in markets, yards, and on porches. | |
| 12. Winter birds appear at the feeders. | |
| 13. American toads cover their bodies with soil for the winter and burrow into the mud. | |
| 14. Most lakes cool and freeze over. | |
| 15. The first snowfall occurs. | |
| 16. The first frost makes the final harvest occur. | |
| 17. Fall mums appear in summer gardens. | |
| 18. Roses bloom their last and are left to harden off. | |
| 19. The coats of the farm and domestic animals change. | |
| 20. White-tailed deer perform their rutting routine. | |
| 21. Cattails shed their seeds. | |
| 22. Some geese, ducks, and birds migrate. | |
| 23. Deciduous trees become bare. | |
| 24. Summer gardens are cleaned of debris and spaded. | |
| 25. Black bears begin to hibernate. | |

## Phenology Checklist Winter: December 22 - March 21

Record the dates as you observe the following events of spring:

| Event | Date Observed |
|---|---|
| 1. Animal tracks are visible in the snow. | |
| 2. Lakes are covered with ice and snow. | |
| 3. Ice-fishing season begins. | |
| 4. Gray squirrels look for food on warmer days. | |
| 5. Winter birds flock to feeders. | |
| 6. Evergreen boughs droop from the heavy snowfalls. | |
| 7. Wind chill reports accompany weather reports. | |
| 8. Daylight lengthens. | |
| 9. Stars in the winter sky appear brighter. | |
| 10. New snow squeaks on extremely cold days. | |
| 11. Steam fog appears on open water patches. | |
| 12. Warm breath is visible on cold days. | |
| 13. Winter animals hunt for food. | |
| 14. Deer gather at sunrise and sunset near food and water sources. | |
| 15. Baby bears are born while their mothers hibernate. | |
| 16. Blizzards block roads and create hazardous driving conditions. | |
| 17. The smell of burning firewood hangs in the air. | |
| 18. Cities track snowfall depths to prepare for spring runoff. | |
| 19. Large rivers, such as the Mississippi, continually freeze and thaw. | |
| 20. Ground hog day comes and goes. | |
| 21. Large snowfalls produce crowds of winter skiing enthusiasts. | |
| 22. Shelterbelts catch the flowing snow in their branches. | |
| 23. Downy and hairy woodpeckers drum their tunes on trees. | |
| 24. The spring equinox ends the winter season. | |
| 25. Ice dams appear on the roofs of houses. | |

# The Water Cycle



# Milk Carton Bird Feeder

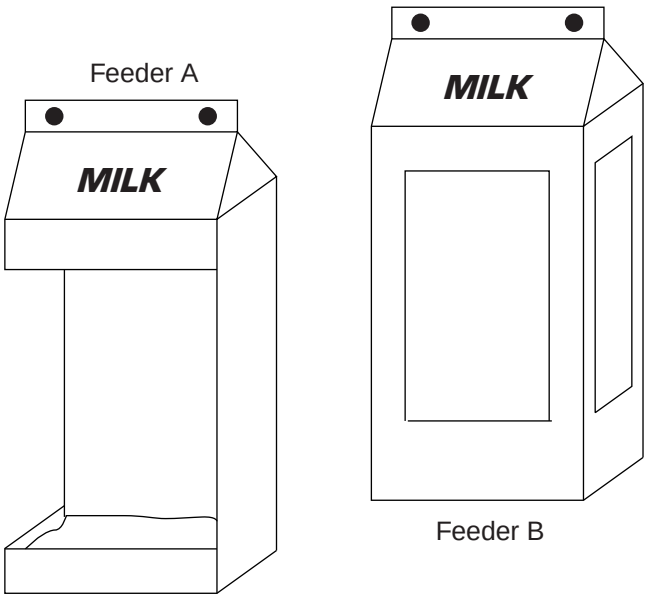
Feeding birds can provide entertainment and enjoyment for people of all ages. You can attract birds to your backyard throughout the year but the most important time to help the birds is during the winter. Cold temperatures and snow limit the food available and put extra demands on birds to keep warm. Once you begin feeding during the winter, don't stop. Birds become dependent on a food source and may not locate an alternative once you stop feeding. There are a variety of seeds and foods that attract birds. Black oil sunflower seeds are the single favorite and most nutritious food for birds. Adding specialty foods to feeders will attract even a wider variety of birds.

In the summer, for example, sugar water attracts hummingbirds. Fruit brings northern orioles, waxwings, blue jays, and thrashers. Mealworms can lure in bluebirds. In the spring and fall, thistle seed will attract the Harris' sparrow and red-breasted nuthatch. A mixture of black sunflower and thistle attracts evening grosbeaks, red polls, and pine siskens during the winter. Niger thistle attracts purple, house, and goldfinches all year long. Woodpeckers, nuthatches, and chickadees enjoy suet.

**Instructions**

Empty one-half gallon milk cartons can be turned into a variety of bird-related items. To make a bird feeder, you can cut away two adjoining sides of a carton, leaving two inches at the top and bottom. You will have two solid sides (see Feeder A). Another plan is to cut windows in all four sides of the carton, again leaving about two inches at the bottom (see Feeder B).

Next, punch two holes in the top of the carton. Thread some strong string through the holes and tie it, making a loop for hanging. Now you can put the feeder wherever you want. Both of these designs can also be used as bird baths.




Source: U.S. Geological Survey, Northern Prairie Wildlife Research Center