WEATHER Unit Overview

This unit is about weather phenomena — not simply describing the weather, but understanding and explaining the forces that cause the weather. The **anchor phenomenon** for the Weather unit is "What causes the weather?" Students start by brainstorming different kinds of weather events and guesses as to what might cause them. Then we look at the water cycle. While students are likely to know the basics of the water cycle and may be able to recite the steps, it is taught much more in-depth here.

In the introduction unit, students investigated phase changes by comparing water ice with dry ice. This provides a good foundation for thinking about particle motion in the water cycle, which in turn lays the groundwork for understanding what causes weather. We begin by studying the water cycle with something tangible that students can observe up close: students build a terrarium and observe it over several days, thinking about how it represents the water cycle. This small-scale closed system is then applied to the large-scale environment in which the water cycle plays out. In the meantime, students play the Water Cycle Game in which they roleplay drops of water in various states and locations. They also learn about evaporation and condensation and, if there's time, they take on an engineering design challenge — either to improve a condensation setup or to distill a few drops of water from a muddy, salty mixture.

We introduce the concept light energy from the sun being absorbed by molecules, and transforming into kinetic energy (energy of motion.) That increased kinetic motion of molecules causes them to bump into one another, which in turn increases thermal energy (commonly referred to as "heat energy," but more correctly teachers should call it "thermal energy.") The transformation of light energy to thermal energy is key to understanding weather phenomena. It is thermal energy that drives evaporation, which drives the water cycle.

Having established the role of water, we move on to other factors: uneven heating, air masses, convection, and air pressure. To study these factors, students make weather instruments as explained in the Weather Instruments lesson, or if you prefer, they set up and work with instruments that are commercially available. Alternatively, there are weather instrument cards you could use.

Much of the weather we experience can be attributed to the movement of air masses, but because air is invisible, we don't often think much about it. For this reason, the next few lessons are devoted to giving students a chance to experiment with air, become familiar with its properties, and see that it can, in fact, exert quite a bit of force. First, we introduce the notion of air masses; these might be warmer or cooler, and moister or drier, depending on the type of surface over which they form. Next, the lessons focus on density and why air masses might float up or sink down. We look at the movement of air masses, which we experience as wind, and we think about what happens when an air mass lifts up, and how that causes a drop in pressure until another air mass moves in.

It turns out that low pressure is what causes cloud formation. Students experience this first hand when they make a cloud in a plastic bottle. A small decrease in pressure can cause cloudy weather, and a large decrease can cause a storm. For this reason barometers, which measure air pressure, are one of the most important instruments for predicting the weather. Students study two different barometer designs and use the lens of structure and function to think about how they work. Finally, they use what they have learned to understand extreme weather phenomena. They make a presentation explaining an extreme weather phenomenon and what causes it.

This unit presents several project opportunities; it will be much more engaging and memorable if you have the time and inclination to take these projects on. Getting a head start and finding materials and volunteers will make it all easier. If you have never made a terrarium before, follow the instructions in Lesson 1 to make one, or recruit someone with experience to help you.

A field trip to a water resource/water treatment plant or your local watershed would be a natural extension for Lesson 2. Look into opportunities and tours or educational programs in your area.

Order weather instruments ahead of time for the Weather Instruments lesson, or recruit people who might be able to help students build these from scratch.

Lessons

Lesson 1: What Causes Different Kinds of Weather?
Lesson 2: A Terrarium
Lesson 3: 101 Uses for Water
Lesson 4: Water Cycle Game
Lesson 5: Evaporation
Lesson 6: Condensation Challenge (1-2 days)
Lesson 7: Precipitation
Lesson 8: Weather Instruments (1-2 days)
Lesson 9: Surface Heating (2 days)
Lesson 10:Full of Air
Lesson 11: Density
Lesson 12: Make a Cloud
Lesson 13: Build a Barometer (1-2 days)

Lesson 14: Wind
Lesson 15: Forecasting the Weather
Lesson 16: Extreme Weather Project (2 days)

WEATHER Unit
Next Generation Science Standards

NGSS Performance Expectations: *This lesson supports students in **progressing toward** the NGSS Performance Expectation.*	
MS-ESS2-4.	Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.
MS-ESS2-5.	Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.
MS-ETS1-1.	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Planning and Carrying Out Investigations Asking questions and defining problems	**ESS2.C:** The Roles of Water in Earth's Surface Processes **ESS2.D:** Weather and Climate **ETS1.A:** Defining and Delimiting Engineering Problems ***Supplemental*** **PS1.A:** Structure and Properties of Matter	Cause and Effect Energy and Matter ------------------------------------- ***Connections to Engineering, Technology, and Applications of Science*** Influence of Science, Engineering, and Technology on Society and the Natural World

California Common Core State Standards Connections:

ELA/Literacy –

RST.6–8.1	Cite specific textual evidence to support analysis of science and technical texts.
RST.6–8.9	Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.
WHST.6–8.7	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
WHST.6–8.8	Gather relevant information from multiple print and digital sources (primary and secondary), using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. CA

Mathematics –

MP.2	Reason abstractly and quantitatively.
6.NS.5	Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below

	zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation.
***Concepts started in this unit, but continued in Earth Systems Unit.**	

Materials **(for a breakdown of materials by lesson, see the Unit Planning Chart)**

Labware

- ★ 2 electronic balances
- ★ hot plate
- ★ fan (optional demo, Lesson 5)
- ★ measuring device for a few mL of water (small graduated cylinder or graduated pipettes)— for the teacher to use to measure each group's distilled water at the end of Condensation Challenge day 2 (Or, use an electronic balance to measure smaller quantities more accurately.)
- ★ 2 ring stands to hold a cookie sheet at an angle
- ★ plastic syringes (no needle)
- ★ small metal nuts or washers that can fit onto a dropper (for Lesson 10 Cartesian divers, optional)

<u>Per group:</u>

- ★ droppers (4 per group)
- ★ large beaker
- ★ 2 medium beakers
- ★ small beakers or cups (4 per group)
- ★ petri dishes (3 per group)
- ★ heat lamps (at least 2 or 3, ideally enough for each group)
- ★ thermometers or temperature probes
- ★ metric rulers (2 per group)

Consumable Lab Supplies

- ★ salt to make salt water (1 large beaker per class Lesson 5; more if Lesson 6 three-day version)
- ★ large balloons—2 identical balloons per class, plus several extras
- ★ food coloring (optional)
- ★ dirt and water in small plastic trays (optional: sand, salt water, sod, or sprouted grass seed) for teacher demo or for each group (Lesson 9)

<u>Per group:</u>

- ★ terrarium supplies (Lesson 2, enough for 2 teacher-made terrariums and 1 per group)
    - ○ soil—avoid "moisture control" potting soil; a peat moss mixture (ground-up sphagnum moss mixed into the soil) will help control mold
    - ○ sphagnum or sheet moss, soaked in water
    - ○ rocks or sand/gravel

    - plants: 1 or 2 small varieties, such as miniature ferns, moss, boxwood, baby tears, herbs, etc.; you only need 1 or 2 types, as students will set up more elaborate ones in 7th grade when they study ecosystems
- ice (Lessons 5, 6, 7)
- hot water (Lessons 5, 6)

Other Supplies

- 1 cookie sheet
- 1 tray to collect precipitation
- 2 closed beverage cans or 2 glasses full of ice water
- drinking glass or large beaker
- air cannon toy for teacher use (optional)
- 2 plastic bottles with narrow mouth
- plastic bottles with tightly closing lids, filled with water (Lesson 10 Cartesian divers, optional)
- clear plastic cup
- clear plastic drinking straw or piece of clear plastic tubing, about 12-inches long
- small amount of putty or modeling clay to make a good sea
- aluminum pans or plastic trays for Lesson 9

Per group:

- manila envelopes or cardstock for pasting the spinners and signs
- 14 brads
- 14 paper clips
- glue sticks
- Tape
- 30cm metric rulers; 2 per group
- wax pencil or masking tape for labeling
- rubber bands
- scissors
- envelope
- unlined paper and color pens or pencils for students to make their cartoons (recommended)
- stopwatches
- Lesson 6 Condensation Challenge (if doing 3-day version)
    - tubs of water with salt and mud mixed in
    - various possible building supplies: bowls, empty cans, jars, foil, saran wrap, plastic sheets (notebook dividers), Popsicle sticks, cardboard sheets, cardboard tubes, chopsticks, small cups, small dishes etc.
- Lesson 8 (if building weather instruments; or purchase a set of commercially available weather instruments)
    - Group 1 (Anemometer): 5 paper cups (3 oz), 2 straws, straight pin, paper hole punch, stapler, pencil with eraser, felt tip marker, stopwatch

- Group 2 (Wind Vane): broomstick or long wooden dowel (about 1 in. diameter), disposable aluminum baking dish (6 in.-by-9 in.), duct tape, wooden stick (¾ square square, 12 in. long), nail (1 in. long), metal washer (with a slightly larger hole than the nail), serrated knife, strong scissors, ruler, silicone or other glue that will stick to aluminum, leather gloves, hand drill (optional)
    - Group 3 (Screened Thermometer): large cardboard box (assuming you won't leave it outside overnight; if you will permanently post it outside, use wood or plastic), white paint, paintbrush, thermometer, strong scissors
    - Group 4 (Hygrometer): wood sheet (9 in.-by-4 in.), flat piece of plastic (thin enough to cut with scissors; about 3 in. long and 1 in. wide—an old credit card or laminated luggage tag works well), 2 small nails, 3 strands of human hair (about 8 in. long), dime, glue, hammer, scissors
    - Group 5 (Rain Gauge): straight-sided glass or plastic container with a diameter of about 2 in. or less (such as an olive jar), wire, measuring spoons (1 tsp, 1/4 tsp), hammer, nails, marker
    - Group 6 (Psychrometer): cardboard (6 in.-by-12 in.), duct tape, gauze square (about 4 in.), hole punch, string (8–10 in.), 2 thermometers (smaller and lightweight are best)
- ★ For Lesson 12 Make a Cloud (recommended: 1 per group and 1one for the teacher)
    - 2 L plastic bottle with tightly closing lid
    - matches (see Safety note in Lesson 12)
    - dark construction paper or other dark background for contrast, to see the cloud better if desks are light-colored)

Advance Preparation

- ★ Lesson 8: Parent volunteers are helpful to guide students through activities
- ★ Lesson 9:It is ideal if students can compare bare soil with vegetation. See if a landscaping business will donate a bit of sod. Or, sprout some grass seeds 2 to 3 weeks ahead of time (wheat berries will work as well): soak them for a few days, then put them in the sun in a shallow dish; keep them moist with a spray bottle. Or, do this lesson outside where there is some grass or other vegetation.
- ★ Lesson 12: Make a cloud in a bottle to see how it works before the class does it.
- ★ Lesson 13: Make a plastic tube barometer, using the directions from NOAA.

Tech Option

- ★ Lesson 14: the Explain section, students will be making a cartoon to show the sequence of events as one air mass rises and another air mass takes its place. If software is available, students can make an animation instead.
- ★ Lesson 16: access to computers for research
- ★ Lesson 14: drawing/cartooning software (optional)
- ★ Lesson 11: hot air balloon video and projection system for opening

Vocabulary

- cycle
- water cycle
- model (review)
- evaporate
- evaporation
- condense
- condensation
- transpire
- water vapor
- thermal energy (review)
- volume (review)
- temperature (review)
- precipitation
- humidity
- open/closed system
- forecast
- prediction
- hypothesis
- density
- air pressure
- matter
- molecules (review)
- barometer
- air mass

