NATIONAL GEOGRAPHIC

RESOURCE LIBRARY
LESSON

Extreme Weather on Earth and Other Planets

Students investigate extreme weather on Earth and other planets, learn about instruments used to measure weather, and design a space probe that will gather weather information on another planet.

GRADES

2 - 5

SUBJECTS

Earth Science, Astronomy, Meteorology, Engineering, Mathematics

CONTENTS

5 Activities

Program

WILDEST WEATHER IN THE SOLAR SYSTEM

ACTIVITY 1: EXTREME WEATHER ON OUR PLANET | 30 MINS

DIRECTIONS

1. Activate students' prior knowledge about extreme weather on Earth.
Ask: *What do you know about extreme weather on Earth?* Encourage students to think about weather they have experienced, read about, or seen on TV or in the movies. Have students brainstorm a list of weather-related words and phrases as they "pass the marker." Start the process by writing one weather-related word on the board. Distribute three dry-erase markers to volunteers with ideas. Have each student holding a marker approach the board and write one extreme weather word, then pass it to another student raising his or her hand. Continue

until no one has ideas to add to the list. Encourage students to include words such as lightning, hail, sleet, rain, wind, gust, flood, snow, blizzard, storm, hurricane, tornado, cyclone, thunder, dust storm, and temperature.

2. View a photo gallery and video of extreme weather.
Show students images from the photo gallery Extreme Weather. Read aloud the captions as you scroll through the images. Then, show the National Geographic video "Weather 101." Pass out the three dry-erase markers again. Have students add words related to the photos or video to the list on the board. Assist them, as needed. Then explain to students that some words from the list are weather events, and some words are part of those weather events; call the latter "ingredients." For example, a lightning storm is a weather event. Ask: *What words from our list can be part of a lightning storm?* Elicit responses such as lightning, clouds, rain, wind, and thunder.

3. Have students complete the worksheet Weather Investigation.
Distribute a copy of the worksheet Weather Investigation to each student. Read aloud the directions and go over the provided answer. Allow students to gather and organize the information they have learned about weather and conditions present for each type of weather. Have students work in pairs or as a whole class to identify other weather events and the ingredients for each from their list. Help students to find answers to any questions they have, including definitions of words that are new to them. Their answers should include the following:

- Thunderstorm: rain, clouds, lightning, thunder, wind
- Tornado: clouds, strong wind, rain, hail
- Hurricane or cyclone: strong wind, heavy rain
- Blizzard: heavy snow, ice, cold temperatures
- Dust storm: strong winds, arid conditions
- Flood: heavy rainfall
- Hail storm: cold or warm temperatures, rain, ice
- Ice storm: freezing rain

4. Discuss the ingredients of extreme weather events.
Ask: *How are the ingredients for each weather event the same? How are they different?* Help students to identify that many weather events have certain ingredients in common, including wind, clouds, and high or low temperatures.

Modification

In Step 1, have students create a visual glossary of weather-related terms using pictures cut out of magazines or their own drawings.

Informal Assessment

Have students orally describe examples of extreme weather on Earth and the ingredients present for each.

Extending the Learning

Have students play NASA's Weather Word Cross game.

OBJECTIVES

Subjects & Disciplines

Earth Science

- Meteorology

Learning Objectives

Students will:

- list the criteria and conditions required for weather events to occur
- describe climate, or weather patterns

Teaching Approach

- Learning-for-use

Teaching Methods

- Brainstorming
- Discussions
- Multimedia instruction
- Visual instruction

Skills Summary

This activity targets the following skills:

- Critical Thinking Skills
  - Analyzing
  - Understanding

National Standards, Principles, and Practices

NATIONAL SCIENCE EDUCATION STANDARDS

• **(K-4) Standard D-3:**
Changes in earth and sky

Preparation

BACKGROUND & VOCABULARY

Background Information

The term *weather* describes conditions in the atmosphere over a short period of time. *Climate* describes weather patterns of a particular region over a longer period, usually 30 years or more. Climate is an average pattern of weather for a particular region. Identifying patterns in the atmospheric conditions of extreme weather events can help you understand Earth's weather system.

Prior Knowledge

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Recommended Prior Activities

- Design Your Own Space Probe
- Discover Space Probes
- Extreme Weather on Other Planets

- Jupiter's Great Red Spot
- Measuring Weather with Tools

Vocabulary

Term	Part of Speech	Definition
atmosphere	*noun*	layers of gases surrounding a planet or other celestial body.
blizzard	*noun*	storm with high winds, intense cold, heavy snow, and little rain.
dust storm	*noun*	weather pattern of wind blowing dust over large regions of land.
extreme weather	*noun*	rare and severe events in the Earth's atmosphere, such as heat waves or powerful cyclones.
flood	*noun*	overflow of a body of water onto land.
hail	*noun*	precipitation that falls as ice.
hurricane	*noun*	tropical storm with wind speeds of at least 119 kilometers (74 miles) per hour. Hurricanes are the same thing as typhoons, but usually located in the Atlantic Ocean region.
temperature	*noun*	degree of hotness or coldness measured by a thermometer with a numerical scale.
thunderstorm	*noun*	cloud that produces thunder and lightning, often accompanied by heavy rains.
tornado	*noun*	a violently rotating column of air that forms at the bottom of a cloud and touches the ground.
weather	*noun*	state of the atmosphere, including temperature, atmospheric pressure, wind, humidity, precipitation, and cloudiness.

FUNDER

LOCKHEED MARTIN

ACTIVITY 2: EXTREME WEATHER ON OTHER PLANETS | 45 MINS

DIRECTIONS

1. Compare ways of investigating weather on Earth and on other planets in our solar system.

Explain to students that scientists and meteorologists investigate weather on Earth in several ways:

- They measure weather with thermometers and other tools.
- They view the weather from satellites above Earth's atmosphere.
- They use photography and video to capture images of major weather events.

Ask: *What is weather like on other planets? How do you think scientists investigate weather on other planets?* Have students draw their ideas about what weather is like on other planets and how scientists investigate it. Then tell students that they will explore the answers to these questions in this activity.

2. View and discuss the video "Solar System 101."
Show students the National Geographic video "Solar System 101." Ask students what types of information about the planets might help us understand what the environments are like on each planet. Write students' ideas on the board. Elicit responses such as temperature, winds, presence of water or ice, or whether a planet is made of gas or rock/soil. For each characteristic, ask: *What might this tell us about the weather on that planet?*

3. Have students complete a worksheet to analyze weather conditions in our solar system.
Distribute copies of the handout Solar System Environments to each student. Read aloud the directions and answer any questions students may have. Review any vocabulary that is new to students, such as math terms *minimum, maximum*, and *mean* and science terms *wind speed, moons, gaseous,* and *rocky*. Help students practice using the information in the chart by looking for the hottest planet or the planet with the highest wind speed. Then distribute copies of the worksheet Planet Investigation. Have students work in pairs or small groups to complete the worksheet. Emphasize that in worksheet questions six and seven, there are no right answers. Help students use information from the handout to inspire their ideas. Make sure students understand that scientists still ask questions and seek more information about the planets in our solar system—even if that planet has been explored already.

Modification

If students have difficulty understanding temperatures that are below zero, draw a thermometer on the board and mark where the mercury falls with different temperatures in both Celsius and Fahrenheit. Talk about temperatures on Earth. For example, if you are using Fahrenheit (F), mention 100 degrees F being very warm, 32 degrees F being freezing, 212 degrees F being the boiling point for water, and temperatures below zero being very cold for

humans. Then talk about temperatures on another planet, drawing and numbering another thermometer. Students will have trouble imagining such temperature extremes, but they will understand that they are extreme.

Informal Assessment

Ask students to explain which planets they think may be good for weather study and why. Then have them imagine they are scientists studying solar system weather, and have students each write a question they would want to answer about wild weather on another planet or dwarf planet.

Extending the Learning

You can use this series of activities to prepare students to design their own space probe. If so, let students know that each of these activities is leading to that goal. Encourage them to think of ideas for their probe as they move through the activities.

OBJECTIVES

Subjects & Disciplines

Earth Science

- Astronomy
- Meteorology

Learning Objectives

Students will:

- describe weather conditions on other planets in our solar system

Teaching Approach

- Learning-for-use

Teaching Methods

- Brainstorming

- Discussions
- Multimedia instruction
- Visual instruction

Skills Summary

This activity targets the following skills:

- Critical Thinking Skills
  - Analyzing
  - Understanding

National Standards, Principles, and Practices

NATIONAL SCIENCE EDUCATION STANDARDS

• **(K-4) Standard D-3:**
Changes in earth and sky

Preparation

BACKGROUND & VOCABULARY

Background Information

Scientists and astronomers are interested in learning more about our solar system. Before exploration takes place, even via remote sensing by probes or satellites, scientists and engineers must consider environmental conditions such as weather. They must design equipment that can handle extremes of temperature, wind, and other factors.

Prior Knowledge

["planets in our solar system"]

Recommended Prior Activities

- Design Your Own Space Probe

- Discover Space Probes
- Extreme Weather on Our Planet
- Measuring Weather with Tools

Vocabulary

Term	Part of Speech	Definition
mean	*noun*	mathematical value between the two extremes of a set of numbers. Also called the average.
meteorologist	*noun*	person who studies patterns and changes in Earth's atmosphere.
moon	*noun*	natural satellite of a planet.
planet	*noun*	large, spherical celestial body that regularly rotates around a star.
satellite	*noun*	object that orbits around something else. Satellites can be natural, like moons, or artificial.
solar system	*noun*	the sun and the planets, asteroids, comets, and other bodies that orbit around it.
space probe	*noun*	set of scientific instruments and tools launched from Earth to study the atmosphere and composition of space and other planets, moons, or celestial bodies.
temperature	*noun*	degree of hotness or coldness measured by a thermometer with a numerical scale.
thermometer	*noun*	device that measures temperature.
weather	*noun*	state of the atmosphere, including temperature, atmospheric pressure, wind, humidity, precipitation, and cloudiness.
wind speed	*noun*	force and velocity of wind.

FUNDER

LOCKHEED MARTIN

ACTIVITY 3: MEASURING WEATHER WITH TOOLS | 30 MINS

DIRECTIONS

1. Activate prior knowledge about instruments used to measure weather.
Ask: *What instruments do you or your family members use to measure weather? What instruments do scientists use to measure weather?* Students will likely be able to name a thermometer, but they may not be able to name any other instruments that measure weather. Explain to students that there are many more tools scientists use to measure weather. They even use their eyes as important instruments for measuring visibility and making observations.

2. Discuss the photo gallery of instruments that measure weather.
Display the photo gallery Instruments That Measure Weather. Cover the names of the instruments and the captions with a piece of blank paper. Describe what each instrument is and how it works, without stating what it measures. Have students raise their hands to tell what "weather ingredient" the instrument measures. For example:

- Display the photo of an anemometer. Point out that it is a stick with a rotating x on the top. At the tips of the x are little cups that catch moving air. When the air moves a lot, the cups spin the x around quickly. Elicit from students that the instrument measures wind.
- Display the photo of a snow/rain gauge. Point out that the tall cylinder is left out in the weather and fills with snow or water. Elicit from students that the instrument measures rain or snow.
- Display the photo of a thermometer. Point out that the long, thin tube is filled with mercury. Heat makes the mercury expand and it rises up the tube. Elicit from students that the instrument measures hot and cold temperatures.
- Display the photo of a barometer. Point out that it looks like a thermometer, but it moves up when the air is lighter and down when it is heavier. Elicit from students that the instrument measures air pressure.
- Continue with the remaining photos.

3. Have small groups create decks of cards.
Divide students into small groups. Distribute one copy of the worksheet Instruments That Measure Weather to each group. Have the group cut apart the cards to create a deck for their group.

4. Have small groups match illustrations and descriptions.
Make sure each group has a full set of 9 description cards and a full set of 9 illustration cards. Have each group mix or shuffle each set of cards and then arrange the cards so they can see all of both sets. Ask students to look at all of the illustrations of instruments that measure weather. Have each group choose one student to start the activity. The starting student will

read the clues on the back of a card. The student who thinks they see the matching illustration will give it to the starting student and explain why they think it is a match. The matched pair is set aside. Then the student to the left reads the clues on the back of another card, and play continues around the circle until all illustrated cards have a matching description. After all groups are done, have a whole-class discussion to check groups' answers. (Instrument 1: thermometer; Instrument 2: barometer; Instrument 3: anemometer; Instrument 4: rain/snow gauge; Instrument 5: sling psychrometer; Instrument 6: wind vane; Instrument 7: weather satellite; Instrument 8: observations; Instrument 9: visibility)

5. Have students make connections to weather on other planets.
After a couple of rounds of play, refocus students. Have a whole-class discussion about the questions below. In between each, allow students time to discuss the question in their small groups and then report back to the whole class. Ask:

- *What weather ingredient(s) do you think would be important to measure on another planet?*
- *Which instrument would give you the best measurement of your chosen weather ingredient?*

Modification

To make this activity more hands-on, and to help your kinesthetic learners, obtain examples of the actual instruments from the school science lab or other teachers. Allow students to touch and examine them.

Informal Assessment

Have students play the card game a second time as an assessment activity after teaching about weather instruments.

OBJECTIVES

Subjects & Disciplines

Earth Science

- Meteorology

Learning Objectives

Students will:

- determine which instruments would be helpful on other planets

Teaching Approach

- Learning-for-use

Teaching Methods

- Discussions
- Simulations and games

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Learning and Innovation Skills
    - Communication and Collaboration
- Critical Thinking Skills
  - Analyzing
  - Understanding

National Standards, Principles, and Practices

NATIONAL SCIENCE EDUCATION STANDARDS

• **(K-4) Standard A-1:**
Abilities necessary to do scientific inquiry
• **(K-4) Standard E-2:**
Understanding about science and technology

Preparation

BACKGROUND & VOCABULARY

Background Information

Weather is measured using a variety of instruments. Before we can collect data on other planets, we must understand what data is collected on our own planet and how.

Prior Knowledge

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Recommended Prior Activities

- Design Your Own Space Probe
- Discover Space Probes
- Extreme Weather on Other Planets
- Extreme Weather on Our Planet

Vocabulary

Term	Part of Speech	Definition
air pressure	*noun*	force pressed on an object by air or atmosphere.
anemometer	*noun*	a device that measures wind speed.
barometer	*noun*	an instrument that measures atmospheric pressure.
observation	*noun*	something that is learned from watching and measuring an object or pattern.
rain gauge	*noun*	device for measuring rain or other forms of liquid precipitation, usually in millimeters. Also called a precipitation gauge, udometer, pluviometer, or ombrometer.
sling psychrometer	*noun*	device for measuring humidity that uses two thermometers: one measures the air temperature while the bulb of the other is kept cool and moist. The sling psychrometer is whirled around until moisture from the wet bulb evaporates.
thermometer	*noun*	device that measures temperature.

Term	Part of Speech	Definition
visibility	*noun*	the ability to see or be seen with the unaided eye. Also called visual range.
weather satellite	*noun*	instrument that orbits the Earth to track weather and patterns in the atmosphere.
wind vane	*noun*	device that rotates to show the direction the wind is blowing. Also called a weather vane.

FUNDER

ACTIVITY 4: DISCOVER SPACE PROBES | 30 MINS

DIRECTIONS

1. Build background about space probes.
Show students the National Geographic video "Space Probes." Then explain to students that a space probe is an unpiloted, unmanned device sent to explore space. A probe may operate far out in space, or it may orbit or land on a planet or a moon. It may make a one-way journey, or it may bring samples and data back to Earth. Most probes transmit data from space by radio. Ask: *Why don't we just send people to these places in our solar system?* Students may respond that it would be more expensive or dangerous to send a person. Provide students with examples. Explain that it would cost over $100 billion for a six-person crew to land on Mars, while the space probe *Mars Science Laboratory*, scheduled to launch in 2011, will cost about $2.3 billion. A manned space device would need to be larger to carry the people, equipment, and supplies needed for the trip, and it would also need to return home. In addition, manned space transport would involve unknown conditions with many risks to the crew.

2. View and discuss a variety of space probe images.
Display the photo gallery Space Probes. Read aloud each caption as you scroll through. Then, as a class, discuss and list on the board how structures of probes are different. Ask: *What different types of equipment do you see on different probes? How do you think equipment would be protected from different weather conditions?*

3. Explore space probe measurement on the Cassini probe.
Explain to students that a space probe records observations of temperature, radiation, and objects in space. Different probes have different mission objectives. There are lunar (moon) probes, solar (sun) probes that measure solar radiation, and probes that investigate the terrain on rocky planets or the gases on gaseous planets. Introduce the *Cassini* space probe. Display the web page NASA: Cassini Solstice Mission—Inside the Spacecraft and explore the diagram together. Ask:

- *What types of instruments does this probe have?*
- *Why do you think information collected by this probe may be important to scientists?*
- *Which instruments would you include on a probe of your own design to observe weather on other planets?*

Informal Assessment

Have students write their ideas about instruments they would want to include on a probe of their own design.

Extending the Learning

Use National Geographic *Explorer* Magazine's poster Saturn's Wildest Weather to give students more information about the *Cassini* space probe and weather conditions on Saturn.

OBJECTIVES

Subjects & Disciplines

Earth Science
- Astronomy

- Engineering

Teaching Approach

- Learning-for-use

Teaching Methods

- Discussions
- Multimedia instruction
- Visual instruction

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Learning and Innovation Skills
    - Critical Thinking and Problem Solving
- Critical Thinking Skills
  - Analyzing
  - Understanding

National Standards, Principles, and Practices

NATIONAL SCIENCE EDUCATION STANDARDS

• **(K-4) Standard E-1:**
Abilities of technological design
• **(K-4) Standard E-2:**
Understanding about science and technology

Preparation

BACKGROUND & VOCABULARY

Background Information

Scientists and astronomers are interested in learning more about our solar system. A space probe is an unpiloted, unmanned device sent to explore space. Most probes transmit data from space by radio.

Prior Knowledge

["extreme weather conditions","tools used to measure weather"]

Recommended Prior Activities

- Design Your Own Space Probe
- Extreme Weather on Other Planets
- Extreme Weather on Our Planet
- Measuring Weather with Tools

Vocabulary

Term	Part of Speech	Definition
lander	*noun*	space probe designed to land on a moon, planet, asteroid, or other celestial body.
orbit	*noun*	path of one object around a more massive object.
orbit	*verb*	to move in a circular pattern around a more massive object.
solar radiation	*noun*	light and heat from the sun.
solar system	*noun*	the sun and the planets, asteroids, comets, and other bodies that orbit around it.
space probe	*noun*	set of scientific instruments and tools launched from Earth to study the atmosphere and composition of space and other planets, moons, or celestial bodies.
temperature	*noun*	degree of hotness or coldness measured by a thermometer with a numerical scale.
terrain	*noun*	topographic features of an area.
transmit	*verb*	to pass along information or communicate.
unmanned	*adjective*	lacking the physical presence of a person.
weather	*noun*	state of the atmosphere, including temperature, atmospheric pressure, wind, humidity, precipitation, and cloudiness.

FUNDER

LOCKHEED MARTIN

ACTIVITY 5: DESIGN YOUR OWN SPACE PROBE | 45 MINS

DIRECTIONS

1. Introduce the mission.
Ask students to imagine they are scientists or engineers designing a new space probe to explore our solar system. Have each student choose a planet as a destination for the probe from this list: Mercury, Venus, Mars, Jupiter, Uranus, or Neptune. Have them use worksheet content from previous Wildest Weather activities to review the weather factors on that planet, including possible extreme weather. Have students list any considerations they can imagine related to the environment and weather on the planet, including what their probe will look like, what size it will be, and how their probe will travel the distance to reach that destination.

2. Review instruments that measure weather.
Have students review and take notes on the different types of weather instruments they might want to include on their space probes. Ask students to consider how they might need to modify instruments to collect information far from Earth and to withstand the weather on their selected planet. Have students add to their notes.

3. Have students create the design.
Provide each student with multiple sheets of blank drawing paper. Have each student sketch a space probe that lands on or hovers above the chosen planet. Require students to include the following:

- at least two instruments that will measure at least two different weather conditions
- labels of the parts of the probe

4. Conduct peer evaluation.
Explain to students that the engineering and design process involves a great deal of review. Many people give input into the design of a space probe that costs millions of dollars. Display the Space Probe Design Rubric. Tell students that you will use the rubric to evaluate their finished projects. Allow them to ask questions about it. Then explain that first, students will seek feedback on the initial design from their peers in class. Distribute copies of the worksheet Space Probe Design Feedback to each student. Then divide students into small

groups of up to four. Have each student partner with the others in their group to give and get feedback on their design for about five to seven minutes. The student whose space probe design is being evaluated should complete the worksheet for their probe. They can fill in ideas from their three reviewers as well as their own ideas based on the feedback.

5. Have students finalize their drawings or build models at home.
Have students use the design feedback from peer evaluation to finalize their drawings. Give students the option of working on their designs at home, if they would like to create a three-dimensional model of their probe.

6. Have students name their space probes and write brief descriptions of their designs.
Have each student create a unique name for their space probe. Then ask students to write a brief paragraph describing their space probe and what it does, including any special features. Help students with their writing, as needed.

7. Have students publish or present their space probes.
Hang students' space probe designs in a central place in the classroom. Ask each student to present their design—using their writing and the drawing or model.

Rubric

Use the Space Probe Design Rubric to grade each student's final product, the drawing or model, plus the design review form.

OBJECTIVES

Subjects & Disciplines

Earth Science
- Astronomy
- Meteorology
- Engineering
- Mathematics

Learning Objectives

Students will:

- use peer review to strengthen the design

Teaching Approach

- Learning-for-use

Teaching Methods

- Brainstorming
- Cooperative learning
- Hands-on learning
- Research

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Learning and Innovation Skills
    - Communication and Collaboration
    - Creativity and Innovation
    - Critical Thinking and Problem Solving
- Critical Thinking Skills
  - Analyzing
  - Creating
  - Evaluating

National Standards, Principles, and Practices

NCTM PRINCIPLES AND STANDARDS FOR SCHOOL MATHEMATICS

• **Geometry (3-5) Standard 4:**
Use visualization, spatial reasoning, and geometric modeling to solve problems

NATIONAL SCIENCE EDUCATION STANDARDS

• **(K-4) Standard E-1:**
Abilities of technological design
• **(K-4) Standard E-2:**
Understanding about science and technology
• **(K-4) Standard G-1:**
Science as a human endeavor

Preparation

BACKGROUND & VOCABULARY

Background Information

Designing or developing any type of scientific instrument is a complex process. Scientists and engineers make many modifications and changes, even during the drawing stages.

Prior Knowledge

["extreme weather conditions","tools used to measure weather","the function of space probes"]

Recommended Prior Activities

- Discover Space Probes
- Extreme Weather on Other Planets
- Extreme Weather on Our Planet
- Measuring Weather with Tools

Vocabulary

Term	Part of Speech	Definition
engineer	*noun*	person who plans the building of things, such as structures (construction engineer) or substances (chemical engineer).
extreme weather	*noun*	rare and severe events in the Earth's atmosphere, such as heat waves or powerful cyclones.
model	*noun*	image or impression of an object used to represent the object or system.
planet	*noun*	large, spherical celestial body that regularly rotates around a star.

Term	Part of Speech	Definition
solar system	*noun*	the sun and the planets, asteroids, comets, and other bodies that orbit around it.
space probe	*noun*	set of scientific instruments and tools launched from Earth to study the atmosphere and composition of space and other planets, moons, or celestial bodies.
weather	*noun*	state of the atmosphere, including temperature, atmospheric pressure, wind, humidity, precipitation, and cloudiness.

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