Over 20 Reproducible Hurricane Science Worksheets

HISTORIC HURRICANES!
Storm Science Activity Book

The Science of History’s Most Catastrophic Hurricanes

Thrill Students with the Subjects They Love!

GRADES 3-6
Hurricane Andrew catches the attention of meteorologists on August 16, 1992. It begins as a tropical depression off the coast of Africa. The next day, it grows into a tropical storm. By August 22, it is a full-blown hurricane, moving quickly west and north. Andrew’s huge spiral of rotating clouds, winds and rain is studied in satellite photos.
Hurricane Andrew reaches the coast of southern Florida around 5:00 a.m. on August 24, 1992. Inside the hurricane, winds gust at speeds more than 175 miles per hour. Andrew is labeled a Category 4 hurricane in strength. It moves westward at 18 miles per hour. Wherever it passes, heavy rains, whipping winds, even tornadoes tear apart the landscape and damage buildings.

In fact, all but one percent of mobile homes are destroyed in the county where Andrew lands. Luckily, more than 2 million people have evacuated to avoid danger.
Andrew brings more than wind and rain. It also brings a wall of water—a storm surge measuring almost 17 feet. Whipping waves damage bridges and offshore structures. They crash into shore atop the storm surge, causing floods and mud slides, and smashing boats and other objects.
Within hours, Andrew moves out into the Gulf of Mexico. It hits land again in central Louisiana. At this time, it is a Category 3 hurricane. Luckily, few people live in the area. Andrew continues to move inland, dumping heavy rain but weakening quickly. By August 28, Hurricane Andrew blows itself out, becoming a depression once more as it travels northeast.

Andrew goes down as one of the most expensive hurricanes in U.S. history. It causes more than $20 billion in damages. More than 60,000 homes are destroyed or damaged. More than 60 people die due to wind action during the hurricane and dangerous conditions afterward. More than 125,000 homes are destroyed or damaged. More than 60 people die due to wind action during the hurricane and dangerous conditions afterward.

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Weather makes a great subject for study. It’s always happening just outside the window, and it’s always changing. Weather affects us all, daily and seasonally. It ties into many areas of our lives—and, as a result, many areas of the school curriculum.

Weather Wise activity books focus on weather’s dramatic, disastrous side. They teach students the science behind various weather phenomena, as well as their social impact. Activities are designed to support National Education Standards; they cover such concepts as weather patterns, measuring and quantifying data, science and technology, personal health and safety, and natural hazards and associated risks.

Each Weather Wise book kicks off with four pages of full-color photographs. Each image captures an important aspect of a severe weather event. The photographs may spark discussion about students’ personal experiences, or about a recent event that made the news. And, they can spark curiosity about why severe weather happens.

Students discover the answers to their questions as they read a story about how a severe weather event gets its start, what happens as it unfolds, and what happens when the weather clears. Each activity contains a paragraph of information that tells part of the story. This is followed by a hands-on activity to further explore concepts covered in the storyline.

In Weather Wise: Historic Hurricanes, students follow the development, descent, and destruction of a fictional hurricane. The book is organized into three units:

- Unit 1: A Hurricane is Born
- Unit 2: The Hurricane Hits
- Unit 3: After the Storm

Each unit contains teaching notes that provide tips for presenting activities, as well as ideas for science fair projects. The six activities in each unit integrate science, math, social studies, geography, and language arts. Students practice using science tools and technology, on an individual and group basis. A quiz at the end of each unit allows for assessment of student learning.

Even if you don’t live in a region threatened by hurricanes, your students will learn to appreciate these awesome weather systems. They will place themselves in the shoes of others who have faced hurricanes in real life. They will be more aware of weather and its risks. And, they will have a foundation to explore more general topics, such as clouds, rain, climate, and weather prediction.

So enjoy this handy weather resource book! We hope it allows you to learn all about hurricanes from the
### Getting Started

A good way to present the material in this book is to set up an experience station. Stock the station with materials about hurricanes, including Hurricane Andrew. You might wish to create a display from the photos at the beginning of this book. Include a copy of the Hurricane Safety Smarts handout (pages 30-31), and make copies for students to use throughout the activities.

Begin with a discussion about hurricanes. Generate a list of what students know and what they would like to know. Share the photos at the start of this book, along with the information about Hurricane Andrew. Ask students what they may have heard about this historic hurricane. Share books or videos about Hurricane Andrew with the class. Explain that students will have a chance to follow the story of a fictional hurricane, from beginning to end. They will perform experiments and other activities to better understand this awesome weather event. Introduce students to the experience station; allow them free time to explore it. Tell students they will be involved in adding to the station over time.

### Teaching the Unit

Begin each lesson by reviewing the storyline and defining vocabulary terms (which appear in boldface).

**Lesson 1:** Students should recognize that the barometer’s balloon inflates during low atmospheric pressure because the pressure inside the jar is greater. This causes the pin to point to the low pressure end of the scale. During high atmospheric pressure, the balloon deflates, as the pressure is greater outside the jar and presses down on the balloon. This causes the pin to point to the high pressure end of the scale.

**Lesson 2:** This activity should be performed with adult supervision. Photocopy the spiral pattern from the inside back cover of this book, and give one to each student. Students should cut out the shapes, and draw arrows in a counterclockwise direction on their spirals. When they hold them over the boiling water, their spirals will spin in a counterclockwise direction. The energy is supplied by warm, rising air above the pot. When the spiral is moved away, it stops spinning. Students may be curious as to why winds rotate in opposite directions on opposite sides of the equator. This is due to the Coriolis effect: because the earth rotates at different speeds near the poles vs. at the equator, it causes anything flowing over its surface to rotate, too, such as wind. In the northern hemisphere, winds rotate in a counterclockwise direction. In the southern hemisphere, they rotate in a clockwise direction.

**Lesson 3:** Students will find that the heaviest rains in a hurricane fall around the eye. If possible, provide color photos or copies of actual radar images.

**Lesson 4:** Students should recognize that, according to the Saffir-Simpson scale, hurricanes increase in intensity as barometric pressure drops and as wind speeds increase. When observing the hurricane names, students may notice the following: names are alphabetical; male and female names alternate; some letters have been omitted; names are English, Spanish, and French. Hurricane Andrew is one name that has been retired from the list.

**Lesson 5:** If necessary, help students practice reading coordinates on a map marked with lines of longitude and latitude. You might challenge them to identify the location of your city in terms of longitude and latitude. Students should identify the hurricane’s starting coordinate as 12° W, 26° N. The hurricane is traveling west and is destined to hit Florida.

**Lesson 6:** Encourage students to use the Internet for their research. All answers to the quiz can be found at the Web site maintained by the National Hurricane Center.

Once students complete all lessons and the Weather Wise Wrap-Up, discuss this stage of hurricane activity as a class. Predict what will happen next.

### Science Fair Starters

1. Make a display that outlines hurricanes that have developed so far in the most recent hurricane season.
2. Create a visual guide to damage caused by hurricanes in each category of the Saffir-Simpson scale.
3. Create a model of a hurricane, depicting clouds, wind, rain, direction of wind movement, wind speed, the eye of the hurricane, and the eyewall. Color-code clouds to indicate amount of rainfall (much like a radar image).
Hurricanes form in tropical oceans and seas, near the equator. Waters are very warm there. As a result, the air above is warm and moist, too. As warm, wet air rises, it creates wind currents and clouds. If an area of low air pressure exists, the winds and clouds spin around this area. When the pressure drops even more, the winds pick up speed. Clouds tower higher and higher. Rain starts to fall. If air pressure stays low, the storm will grow stronger. It could turn into a hurricane.

Make a tool called a barometer that measures air pressure.

You’ll Need: balloon, scissors, wide-mouthed glass jar, rubber band, straw, straight pin, masking tape, barometric pressure scale

1. Cut the neck off a balloon. Stretch the opening over the mouth of a dry, clean glass jar.
2. Wrap a rubber band around the balloon’s edge to hold it tightly in place.
3. Tape a straight pin to one end of a straw. Tape the other end of the straw to the top surface of the balloon. Make sure the taped end of the straw is in the center of the balloon.
4. On a 4” × 6” (10 cm × 15 cm) index card, make a pressure scale, like the one pictured on this page. Tape the blank edge of the card to the jar, so that the long, middle line is even with the straight pin.
5. Place the barometer indoors, away from windows. Watch the barometer each day for one week. Make notes about the weather, too. The balloon will rise and fall, causing the pin to “point” to the top or bottom of the scale.
A storm is stirring in the tropics. It began as a **tropical depression** (wind speeds = 25-39 mph/40-62 kph). It grew into a **tropical storm** (wind speeds = 40-74 mph/64-118 kph). Now, it is an official hurricane (wind speeds = 75 mph/120 kph or more). From above, the hurricane looks like a spiral of clouds. The spiral measures 400 miles (640 km) across. It contains a cloud-free center, called the **eye**. The eye is amazingly clear and calm. Just outside the eye, though, winds and rains are at their strongest. This area is called the **eyewall**. Here, wind speeds may reach more than 200 mph (320 kph). This hurricane is north of the equator. So, its winds rotate counterclockwise. South of the equator, hurricane winds rotate clockwise.

**Make a model hurricane to learn more about its shape and action.**

**You’ll Need:** hurricane spiral, scissors, straight pin, 12-inch (30.5 cm) thread, pan of boiling water

1. Cut out the spiral shape your teacher gives you. This is your hurricane model.

2. Draw arrows to show the direction winds will rotate north of the equator.

3. Poke a hole with a straight pin at the point marked “A” on the spiral. Push one end of a thread through the hole. Make a knot.

4. With your teacher’s help, hang the hurricane on its thread over a pot of boiling water.
   a. How is the boiling water similar to tropical ocean waters?
   b. What happens to your hurricane when it’s held over the boiling water?
   c. Where is the eye of your hurricane?
   d. Move your hurricane away from the boiling water. What happens?
   e. Why do you think so?
Meteorologists have watched the hurricane since it started as a tropical depression. They have recorded its size and location. They have tracked wind speeds, air pressure inside the eye, and air temperatures. It’s been a long-distance effort. The meteorologists collected photographs from satellites flying high overhead. They studied computer pictures created by radar equipment. They spoke with experts on board a ship sailing in the area. They even sent a military airplane into the eye of the hurricane for a look!

Learn how a radar image helps meteorologists study hurricanes.

You’ll need: red, green, and blue markers

Look at the drawing below. It is an image of a hurricane shown on radar equipment. Use the legend to color in the image.

- red (r) = heavy rainfall
- green (g) = moderate rainfall
- blue (b) = light rainfall

1. Radar equipment measures moisture in the air. How is this important when studying hurricanes?

2. According to the color code, which color shows the greatest rainfall?

3. Where is the most rain falling in this hurricane?

4. What is happening inside the eye of the hurricane?

5. How does rainfall change toward the outer edges of the hurricane?
Lesson 4: NAMES AND NUMBERS

The National Weather Service gives the hurricane a name. It uses a system that includes six lists of names. One list is used each year, for six years. Then, the lists repeat. The hurricane also receives a number from 1 to 5 on the Saffir-Simpson Scale. Increasing numbers stand for increasing intensity, which is linked to barometric pressure and wind speeds inside the hurricane.

Study the Saffir-Simpson Scale and hurricane names.

<table>
<thead>
<tr>
<th>category</th>
<th>barometric pressure</th>
<th>wind speed</th>
<th>potential damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&gt; 28.94</td>
<td>74-95 mph</td>
<td>trees and mobile homes slightly damaged</td>
</tr>
<tr>
<td>2</td>
<td>28.50-28.93</td>
<td>96-110 mph</td>
<td>trees blown over, roofs slightly damaged</td>
</tr>
<tr>
<td>3</td>
<td>27.91-28.49</td>
<td>111-130 mph</td>
<td>large trees uprooted, mobile homes destroyed</td>
</tr>
<tr>
<td>4</td>
<td>27.17-27.90</td>
<td>131-155 mph</td>
<td>signs blown down, structural damage to buildings</td>
</tr>
<tr>
<td>5</td>
<td>&lt; 27.17</td>
<td>&gt; 155 mph</td>
<td>small buildings destroyed, extensive flooding</td>
</tr>
</tbody>
</table>

Imagine having to name a hurricane. Pretend the most recent hurricane was named Olga.

1. What will the name of the new hurricane be? 

2. In what year will meteorologists use the name Arlene for a hurricane again? 

3. Names of extra-deadly hurricanes are ‘retired’ from the list. Research an example, and list it here. 

4. A hurricane has wind speeds of 113 mph (181 kph). Where does it rate on the Saffir-Simpson Scale?
ON THE MOVE

The hurricane is moving! It’s pushed along by global air currents, as well as the energy of its own winds. Meteorologists record the hurricane’s path on a map. They use lines of latitude and longitude. These are imaginary lines that run across a map. Lines of latitude run east-west. Lines of longitude run north-south. Points where the lines cross are called coordinates.

Learn to track a hurricane using a Tropical Tracking Map.

The picture to the right shows the path of a moving hurricane. Each dot on the path is a coordinate that shows the hurricane’s location at a point in time. Numbers across the bottom of the map match lines of longitude. Numbers along the side of the map match lines of latitude. (Example: 40° W, 30° N.) Use the map and its legend to answer questions about the hurricane’s movement.

1. What coordinate marks the origin of the hurricane? (Hint: Follow the lines outward from the coordinate to get the numbers for latitude and longitude.) 

2. What coordinate marks the hurricane’s current location?

3. Which direction is the hurricane traveling?

4. Did the hurricane’s winds increase or decrease after it passed 74° W, 26° N? 

5. If the hurricane stays on the same path, where will it hit the United States?

6. Plot these predicted coordinates for the hurricane’s path: 80° W, 30° N; 80° W, 32° N; 79° W, 33° N.
The hurricane is blowing toward the United States. If it strikes, it could threaten millions of people. It could cause billions of dollars in damage. At the National Hurricane Center, many people watch the hurricane, study its behavior, and take steps to warn the public.

As a group, hunt down these hurricane facts.

Use the Internet and printed materials to answer the questions below. Your Hurricane Safety Smarts pages also list helpful organizations and books.

Q. Where is the National Hurricane Center?
A. 

Q. When is hurricane season?
A. 

Q. What parts of the United States are the most likely to be hit by a hurricane?
A. 

Q. Where do hurricanes that strike the United States originate?
A. 

Q. What is the average number of hurricanes that develop in these waters each year?
A. 

Q. What is the average number of hurricanes that strike the United States each year?
A. 

Q. What is the name of the man who is the official United States’ “hurricane predictor”?
A. 

Q. What is the nickname for the group of pilots who fly into the eye of a hurricane to gather data?
A. 

Q. What is a hurricane watch?
A. 

Q. What is a hurricane warning?
A. 

Q. What are hurricanes called in other parts of the world?
A.
WEATHER WISE WRAP-UP

Use what you have learned in this unit to complete this page.

1. Circle the correct answer.
   a. Where do hurricanes form?
      A. over the North Pole  B. over the South Pole  C. near the Equator  D. over the U.S.
   b. What is the minimum wind speed for an official hurricane?
      A. 74 mph (118 kph)  B. 150 mph (240 kph)  C. 200 mph (320 kph)  D. 49 mph (78 kph)
   c. What does a barometer measure?
      A. wind speed  B. air pressure  C. temperature  D. none of these
   d. What equipment do meteorologists use to track hurricanes?
      A. airplanes  B. satellites  C. radar  D. all of these

2. Mark each statement true or false.
   a. The center of a hurricane is called the bull’s eye.  T  F
   b. In the U.S., hurricane season starts in December.  T  F
   c. Inside a hurricane, winds move in a circle.  T  F
   d. The lower the air pressure in a hurricane, the stronger it is.  T  F
   e. All hurricanes are given male names.  T  F

3. Fill in the blanks to complete these hurricane facts.
   A hurricane’s name is drawn from one of _____ lists. Hurricanes are also rated for their intensity, according to the _________ scale. According to this scale, the strongest hurricane rates a number ______. In the United States, hurricanes are tracked by the ________________. Most hurricanes strike the United States between the months of _________ and ___________.

4. Draw arrows to show the direction winds rotate in each hurricane.

   ![South of the Equator](arrow_south_of_equator)
   ![North of the Equator](arrow_north_of_equator)
Getting Started

Add materials that were generated in Unit 1 to the hurricane experience station. Gather information about the following topics to use for discussion and at the experience station: storm surges, flooding, hurricane preparedness.

As a class, discuss what students expect will happen next in the hurricane’s story. Share thoughts about what students would do if facing a hurricane and how they would feel. Tie the discussion into the story of Hurricane Andrew.

Teaching The Unit

Begin each lesson by reviewing the storyline and defining vocabulary terms (which appear in boldface).

Lesson 1: Before conducting this experiment, hold a class discussion about hurricane preparedness. Review terms such as hurricane watch and hurricane warning. Read through the tips contained in the Safety Smarts pages. When setting up the experiment, have students work in groups. Be sure students securely attach walls with the clay, and securely attach models to the base. Students will observe that the house without boarded windows is destroyed first. Have students imagine what the results would be in a real home with glass windows. Point out that debris may be flying through the air, too. Review the importance of staying away from windows and positioning people in safe, enclosed spaces inside the home during a hurricane.

Lesson 2: Before presenting this activity, you may wish to prepare a letter to send home with students requesting cooperation for the activity and for sending survival kit supplies. Begin the activity by getting ideas from students regarding what kinds of conditions they might face after a hurricane. What would they need to survive these conditions for three days? For the activity, you may wish to exclude certain items from those students bring in, such as a fire extinguisher, insurance papers, and car keys. You can substitute sheets of paper with item names instead. Also, you may allow students to bring in just one kind of food item and just one gallon of water. Students will need their kits for the next lesson in this unit.

Lesson 3: This activity should get students thinking about the logistics of evacuating entire cities during a hurricane. Before you begin, you will need to map out an evacuation route that takes students from the classroom to a chosen “shelter” point, perhaps outside the school. Give directions for following the route, either in words or in map format, and make enough copies for all evacuating “families.” As you explain the activity, review evacuation information in the Hurricane Safety Smarts pages. Remind everyone that each stop will take 15 seconds to complete, and families should turn in the appropriate card at each stop during evacuation. Students can complete the steps in any order they wish (obviously, evacuation route should be the last step). Students will find that they must wait in line at certain stops, causing delays. They will likely take longer to evacuate than predicted. As a class, discuss answers to the questions at the end of the activity.

Lesson 4: Students should determine that normal high tide is two feet, the storm surge is 15 feet (4.5 m), and the total storm surge is 17 (5.2 m) feet. Point out to students that waves on top of the surge often make it even higher. The house in the diagram would be flooded up to the second floor. Discuss what else might happen to property, the landscape, and living creatures during a storm surge.

Lesson 5: The sand used for this experiment should be damp enough to hold the “house” models in place when pushed into position. Have students work in groups and cover work areas with newspaper or tarps in case of spills. Remind students to be careful when tipping the baking dish. Students will find that sand washes away underwater and that houses lose their footing. Discuss the connection between increasing coastal populations and the increase over the years in hurricane damage.

 Lesson 6: During a hurricane, people may be fooled into thinking the danger has ended when the eye of the storm passes over their area. In fact, when the eye moves on, winds and rain return full-force. Cover the work area with newspaper or a tarp in case of spills. Students will see evidence of the calm conditions in the eye when they pour water into the eye (the water flows straight down and does not swirl); when they drop in the ping pong ball (the ping pong ball stays fairly stationary); and when they observe water movement throughout the tub (water swirls more quickly out near the edge).

Once students complete all the lessons and the Weather Wise Wrap-Up, discuss this stage of hurricane activity as a class. Predict what will happen next.

Science Fair Starters

1. Make a miniature model home that shows some of the effects of a hurricane, such as flooding, structural damage and damage to property. Identify home safety tips and display a hurricane survival kit.

2. Research effects of hurricanes on wildlife and on coastal ecosystems and create a display.

3. Research the connection between coastal populations and hurricane damage. Identify hurricanes that have hit heavily populated vs. lightly populated areas. Make a graphic display of results.
Lesson 1  HURRICANE HOME SAFETY

The hurricane is due to strike. A hurricane warning is in effect. People are being evacuated from areas of great danger. Others are being warned to prepare. They must make their homes safe from the high winds and possible flooding the hurricane will bring. One major step is to cover their windows with shutters or boards.

Experiment to see if boarding up windows makes a difference during a hurricane.

You’ll need: cardboard, clay, scissors, portable fan

1. Cut out 8 “walls” measuring 6” x 4” (15 cm x 10 cm), along with 2 “roofs” measuring 7” x 7” (18 cm x 18 cm) from a sheet of cardboard. Cut a 2-inch (5 cm x 5 cm) square “window” out of one of the eight walls.

2. Form clay into 24 balls measuring about one-quarter inch (6 mm) across.

3. Use four balls of clay to attach four walls to one of the roofs as shown. Use four more clay balls to attach the walls to each other.

4. Turn the “building” over, and stick it to a large sheet of cardboard using four more balls of clay. This is a model house.

5. Repeat Steps 3-5 to construct a model house with a window. Attach it to the cardboard sheet, beside the first model.

6. Place a portable fan on the floor and turn it on “high.”

7. Place the two model houses on the floor, 10 feet (3 m) in front of the fan. The window on the second model should face the fan.

8. Slowly move the model houses near the fan.
   a. What happened to the model buildings? __________________________
   b. Which home blew apart first? __________________________
   c. How did moving the models closer to the fan increase the wind force? _________
   d. Based on your results, would you board up your windows for a hurricane? _________
People who plan to stay in their homes for the hurricane check their survival kits. These kits include supplies for people’s health needs, and tools for dealing with the effects of the hurricane. Each kit must serve a person’s needs for three days.

**Put together a survival kit for one person to use during a hurricane.**

The list below includes major supplies for a hurricane survival kit. Take the list home. With an adult’s help, check off items you already have at home. Give yourself one point for each item you check off.

<table>
<thead>
<tr>
<th>Stored Water</th>
<th>Food that will not spoil</th>
<th>First Aid Supplies</th>
<th>Emergency Equipment</th>
<th>Personal Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1 point per gallon)</td>
<td>10 cans of food</td>
<td>bandages</td>
<td>flashlight</td>
<td>backpack/duffel bag</td>
</tr>
<tr>
<td></td>
<td>peanut butter/crackers</td>
<td>antiseptic</td>
<td>matches/candles</td>
<td>sleeping bag</td>
</tr>
<tr>
<td></td>
<td>dried fruit/nuts</td>
<td>pain reliever</td>
<td>batteries</td>
<td>extra car keys</td>
</tr>
<tr>
<td></td>
<td>dry cereal/cereal bars</td>
<td>cotton</td>
<td>battery-powered radio</td>
<td>copy of insurance</td>
</tr>
<tr>
<td></td>
<td><strong>Total Points</strong></td>
<td></td>
<td></td>
<td>credit card</td>
</tr>
</tbody>
</table>

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1. What surprised you the most when going through this checklist?  

2. Would you be prepared for a hurricane to strike?  

3. Team up with a partner. Between the two of you, assemble a survival kit to bring in to class.
Many people live along the coast where the hurricane is expected to strike first. These people are in great danger from powerful waves that will wash ashore with the hurricane. So, they are ordered to evacuate. Thousands, perhaps millions, of people will need to travel to safety in the next 24 hours.

As a class, stage an evacuation for a hurricane.

You’ll Need: evacuation tips (in the box below), scissors, index cards, survival kit from page 16, clock

<table>
<thead>
<tr>
<th>Take pet to animal shelter.</th>
<th>Stop at store for extra supplies.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pack survival kit. Close up house: turn off gas, electric, water; move loose items indoors; board up windows.</td>
<td>Get gas at gas station.</td>
</tr>
<tr>
<td>Contact family member/friend.</td>
<td>Leave town! Get an evacuation map from the evacuation official.</td>
</tr>
</tbody>
</table>

1. Your teacher will divide you into pairs. Each pair is an imaginary family needing to evacuate. Your teacher will also select one student to represent each “evacuation stop”: gas station, animal shelter, grocery store, family member/friend to contact, evacuation official.

2. Each family should write the six evacuation tips, shown in the box above, on separate index cards. These are the steps each “family” must complete during evacuation. Discuss the evacuation tips and evacuation rules with your teacher.

Evacuation Rules:
• Pack your survival kit first. When you finish, turn in the correct evacuation tip index card to your teacher, to show that you’ve completed that step.
• Do each step in the evacuation, in any order you choose. Visit the evacuation stop for each step. Turn in your card to the person in charge. Wait until the person tells you to move on (15 seconds).
• Get an evacuation map from the evacuation official. Follow it to the shelter.

3. Predict how long the class will take to evacuate. Start when your teacher says “go.”
   a. How did your actual time compare to your prediction? ________________
   b. What would you do differently the next time if you had to evacuate? ________________
   c. What would be the hardest part of evacuating an entire city? ________________
Lesson 4  WASHED AWAY: PART 1

During its approach, the hurricane has whipped up a giant wall of water, called a **storm surge**. The storm surge raises the water level an extra 17 feet (5.2 m). It stretches more than 50 miles (80 km) across. When the hurricane hits shore, it brings the storm surge with it. The wall of water crashes into shore, washing away beaches and homes.

**Calculate the height of a storm surge and predict the damage it will cause.**

Look at the diagram below. It shows a storm surge brought on by a hurricane during high tide.

The total height of a storm surge during high tide equals the sum of the normal high tide level plus the height the water level rises due to the hurricane.

1. What is the normal high tide? _____
2. What is the rise in water level? _____
3. What is the total storm surge? _____
4. How tall is the house? _____

5. How much of the house do you think will be flooded by the storm surge? (circle one)
   - no flooding
   - up to first floor
   - up to second floor
   - over the roof
As the storm surge hits the beach, sand washes away. Houses built near the shore are torn loose from the shifting earth. The more populated the coastline, the greater the damage from the storm surge. In fact, it’s not winds but storm surges (along with flooding) that usually cause the most deaths during a hurricane.

**Make a model of a storm surge to see its effects on shore.**

**You’ll need:** newspaper, baking dish, bucket of damp sand, bottle caps, block of wood, water, watering can

1. Spread newspaper over your work area. Pour enough sand into a baking dish to make a pile at one end. Smooth the pile to make a model of a sloping beach.

2. Push several bottle cap “houses” into the sand, about half-way up the “beach” as shown.

3. Use a wood block to raise up the sand-filled end of the baking dish. Slowly pour water into the dish at the other end. Stop when the water level just covers the edge of the sand.

4. Lift the “ocean” end of the baking dish so that water floods over the other end. Don’t spill too much water! Quickly set down the end of the baking dish again.

   a. What happened to the sand beach?

   b. What happened to the bottle cap houses?

   c. What do you think homeowners could do to keep their beach homes from washing away?
The hurricane is moving inland. Wherever it passes, it leaves a trail of ruined buildings, scattered debris, and fallen trees. Inside their homes, people listen to the roar of the wind. It is like a freight train passing overhead. Suddenly, the winds die down. A strange stillness settles. Is the danger over? No, the **eye** of the hurricane has arrived. It stretches 20 miles (32 km) across. Winds sucked into this region sink and lose moisture, creating calm conditions. Once the eye passes, though, the hurricane will whip up to full strength once again.

**Study motion around the eye of a hurricane to learn more about its behavior.**

**You’ll Need:** large, round tub or basin, plastic glass, water, ping pong ball

1. Fill a large, round basin half full of water. Push up your shirt sleeve to keep it from getting wet.

2. With your hand, begin swirling the water around in a counterclockwise direction. Keep your arm moving in a strong, steady, even circle.

3. Remove your arm when the water is turning evenly. Watch how the water circles around near the center and out toward the edge of the basin.

4. Pour a glassful of water into the “eye” of your hurricane.

5. Place a ping pong ball on the surface of the eye.
   a. How did the water move at different points of the hurricane?
   b. Where did water move the fastest? ________________
   c. What happened when you poured the water into the hurricane’s eye? ________________
   d. What happened when you placed the ping pong ball in the hurricane’s eye? __________
   e. What guesses can you make about activity in the eye of a hurricane based on your results? ____________________________________
WEATHER WISE WRAP-UP

Use what you have learned in this unit to complete this page.

1. Mark each statement true or false.
   a. Most deaths that happen during hurricanes are caused by storm surges. T F
   b. It is dangerous to place boards or shutters over windows during a hurricane. T F
   c. A hurricane survival kit must serve one person’s needs for one day. T F
   d. Families that evacuate should take their pets to the shelter with them. T F
   e. The eye of the hurricane has the highest winds and most rain. T F

2. Write three things that should be included in a hurricane survival kit.

   __________________________________________

3. Write three ways to make a house safer during a hurricane.

   __________________________________________

4. Fill in the blanks to complete these hurricane facts.

   People who live along the ____________ are in most danger from hurricanes. They are
   ordered to ____________. They must leave before the ____________ washes into land.
   If this wave of water arrives at ____________ tide, it will be even larger. To escape danger,
   families can stay in a ____________. If they remain at home, they should keep away from
   ____________ and lie on the floor inside a hallway or closet. When the ____________
   passes over, it may seem like the hurricane has ended, but winds will begin again.

   ________
**Getting Started**

Add materials that were generated in Unit 2 to the hurricane experience station. Gather information about the following topics to use for discussion and at the experience station: weather patterns, hurricane survivor stories, U.S. hurricane history, disaster relief organizations.

As a class, discuss what students expect will happen next in the hurricane’s story. Share thoughts about how a hurricane would change life at the individual and community level. Tie the discussion into the story of Hurricane Andrew.

**Teaching Tips**

*Begin each lesson by reviewing the storyline and defining vocabulary terms (which appear in boldface).*

**Lesson 1:** Help students locate books or Web sites that deal with weather or climate. Their completed diagrams should look like the diagrams shown on page 32. Students should recognize that the jet stream moves west to east. They should discover that global winds are named for the direction they blow FROM, not the direction they blow toward. Hurricanes are carried to the United States by the northeasterly trade winds. Hurricanes travel due west until they near the Atlantic coast, at which point they shift to a northeasterly direction. You can expand discussion of wind patterns to include other weather events that take place in the United States and worldwide.

**Lesson 2:** Help students locate printed materials and web sites that carry photos related to hurricane damage. Students may need to make photocopies for the activity. Encourage them to collect at least three, and to use the back of their handout if more space is needed. Direct students to use the classic “5 W and 1 H” formula for writing captions in a newspaper style: details should include Who, What, Where, When, Why and How.

**Lesson 3:** For this activity, you may wish to read a fictional story about a hurricane as a class. Select a book from the reading list or, find survivor stories on the Internet. If you live in an area where hurricanes occur, you might locate newspaper articles or even residents who have lived through a hurricane to share stories with you. Be sure to allow time for students to share their stories and photos (Lesson 2). You may wish to make a classroom display.

**Lesson 4:** Students will be able to find the information they need by visiting Web sites maintained by organizations listed on page 31. If they need guidance, have them research the following hurricanes: Galveston Hurricane (1900), Carla (1961), Betsy (1965), Camille (1969), Hugo (1989), Bob (1991), Andrew (1992), Marilyn (1995), Opal (1995), Fran (1996), Georges (1998). You may wish to tell students about the first example, as it was the deadliest in U.S. history, killing more than 8,000 people.

**Lesson 5:** The American Red Cross has statistical information on its Web site regarding disaster relief that you can use for further discussion about the cost of hurricanes.

**Lesson 6:** Before conducting this activity, you will need to research area organizations that may be suitable for a fundraising event or drive for donations. Contact local offices of organizations listed or, find information and guidelines regarding disaster relief organizations online at www.charityguide.org. Even organizations that are not directly involved in disaster relief are still worthy causes. Ask for guidelines on what the organization collects and how it prefers to receive donations. The organization may have published materials it can send to assist you. Work with the class to decide what kind of event is best and how each step listed in the activity must be carried out. Create a letter to send to parents, school faculty, local businesses, local newspapers, and others that can get involved. Check school policy regarding use of school property or resources for the purposes of a fund-raiser. Also consider inviting someone from the local newspaper or television station to cover the event. Once the event is complete, help students to get the donated goods or money to the chosen organization. As a culminating activity for this guide, have students mock up a hurricane-themed magazine that includes not only a story about the volunteer event, but safety tips, survivor stories, statistical information, and photographs.

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**Science Fair Starters**

1. Research areas around the world that are most threatened by hurricanes and identify them using a world map or globe. Also identify where hurricanes are born that threaten each area.

2. Research how the cost of hurricanes is estimated. Create a graphic display of results.

3. Research the survivor quilt created by hurricane survivors and create a similar artistic expression of surviving a hurricane.
Trade winds have moved the hurricane along in a mostly westward direction. When the hurricane hits the coast, it shifts direction. It begins to travel northeast. The hurricane meets up with the jet stream. It loses energy once it leaves the ocean. Within a few days, it “blows itself out” and is reduced to a thunderstorm.

Identify winds that control a hurricane’s movement.

You’ll need: Internet site, newspaper, or books showing location of the trade winds and the jet stream

Complete the diagram below. Identify Earth’s major wind patterns: northeasterlies, prevailing westerlies, horse latitudes, doldrums, northeast trades, southeast trades, prevailing westerlies, southeasterlies.

10. Complete the diagram below. Show the location and direction of movement of the jet stream across North America.

11. Research the definition of the jet stream.

12. Which trade winds do you think move hurricanes toward the United States?
A SURVIVOR’S STORY: PART 1

The hurricane may be over, but its effects will be long-lasting. People find their homes have been damaged or even destroyed. So have businesses, churches, schools, and other buildings in their community. Some people have lost more than property. They (or their loved ones) have lost their lives. The hurricane’s cost—both financial and emotional—is very high.

Collect pictures that tell the story of a hurricane’s deadly power.

Find pictures taken after a hurricane and place a few on this page. Look through magazines, books, and Internet sites. Cut out photos, make copies, or print out pictures to use. Write a caption below each picture that gives information about what happened.
People who have evacuated return to their homes. Those that stayed share stories of survival with each other. They describe what they heard, what they saw, and what they felt. Some talk about floods. Others talk about the eye of the storm. Yet others talk about losing precious family keepsakes. All hurricane survivors will remember this day for the rest of their lives.

Imagine living through a hurricane. Write your story here.

Read stories about people who lived through hurricanes. Find survival stories in magazines, books, or on the Internet. The reading list included in your Hurricane Safety Smarts pages lists several books to choose from. As you write your story, think about what you might experience before, during, and after the hurricane. How is your life changed?
Unit 3: After The Storm

Lesson 4  HISTORIC HURRICANES

It is time to calculate the hurricane’s damage. Officials gather information about people who have died or been injured. They add up the cost of damaged property. They decide how much money will be needed to rebuild. Luckily, the media warned citizens well ahead of the hurricane’s strike. This helped cut down on the hurricane’s deadly effect.

Research some U.S. hurricanes that have struck in the last century.

Gather information to complete the chart below.

<table>
<thead>
<tr>
<th>Name of Hurricane</th>
<th>Date</th>
<th>Location</th>
<th>Intensity</th>
<th>Number of Deaths</th>
<th>Cost of Damage</th>
</tr>
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</tbody>
</table>

1. Which hurricane caused the most deaths? ________________________
2. Which hurricane caused the most damage? ________________________
3. Do you have different answers for questions 1 and 2? ____________
4. If yes, why do you think so? __________________________________
Lesson 5  HURRICANE MATH

When calculating the cost of the hurricane, numbers quickly add up. People must rebuild and repair their homes. Shelters must serve the homeless. Businesses that cannot operate lose money every day they are closed. Most of the costs are covered by insurance. Money also comes in from government agencies. Donations also pour into relief organizations to help hurricane victims.

Calculate some of the costs and challenges associated with a hurricane.

1. The hurricane caused damage over a three-state area measuring 600 miles (960 km) across and 200 miles (320 km) long. What was the total land area affected by the hurricane? ______

2. Three towns were evacuated before the hurricane:
   Town 1: population 12,543
   Town 2: population 17,890
   Town 3: population 22,132
   How many people were evacuated? ______

3. Forty-eight shelters were set up to serve hurricane evacuees and victims. If each shelter has beds for 800, how many people could they serve altogether? ______

4. Each shelter provides meals to people it serves. It costs an average of $3.00 to feed one meal to one person.
   a. What does it cost to feed one person three meals per day? ______
   b. What does it cost to feed one person for three days? ______
   c. What does it cost to feed a family of four per day? ______
   d. What does it cost to feed 800 people per day? ______

5. People who stayed in their homes were advised to store 12 gallons of water for emergency use. If one town’s population is 1,246, how many gallons of water were stored by its residents? ______

6. One hurricane victim owned a hardware store. Due to flooding, the owner could not operate his business for two weeks. He estimates that he will lose $91,000.00 in sales. What is the amount he estimates he will lose each day? ______

7. One homeowner’s various insurance policies added up to $250,000 in coverage. She suffered the property losses listed below. How much will she have to pay to replace herself? ______
   Car: 12,000
   House: 155,000
   Personal property: 90,000
Lesson 6  HISTORIC HURRICANES

Not everyone is prepared for the hurricane’s impact. Many find themselves homeless, unable to meet basic needs. Luckily, private and government organizations are ready to help. They supply medicine, clothing, food, funds, and other items. These organizations depend a lot on the donations from citizens wanting to help. Donations may arrive after traveling thousands of miles. Thanks to the caring of strangers, hurricane victims can begin to rebuild their lives.

As a class, organize an event to collect donations for a disaster relief organization.

1. With your teacher’s help, choose an organization that helps victims of hurricanes and other disasters.
   Write the name of the organization here: ____________________________________________

2. Find out which kinds of items the organization collects for donation. As a class, plan an event that gives people a chance to make donations. Or, you might raise money to donate. Some ideas include bake sales, car washes, and craft fairs.
   Write your idea here: ____________________________________________________________

3. Work with your teacher to do the following tasks. Check them off as they’re completed.
   _____ Pick a day and get permission to use rooms or other space needed.
   _____ Make flyers to advertise the event, and send them out.
   _____ Contact a local newspaper to advertise your event.
   _____ If you are offering something to sell, collect all the goods and price them.
   _____ If you are offering a service, decide who will work and gather supplies.
   _____ Arrange for your chosen organization to collect or receive your donation.

4. Write about how your event turned out! ___________________________________________
   __________________________________________
   __________________________________________
   __________________________________________
   __________________________________________
WEATHER WISE WRAP-UP

Use what you have learned in this unit to complete this page.

1. Name one hurricane that has struck the United States in the last century. ________________

2. Name one organization that works to help hurricane victims. ________________

3. Fill in the blanks to complete these hurricane facts.
   Hurricanes are blown into the United States by _____ winds. Once a hurricane leaves the ocean, it ________ energy. It may continue to dump heavy rains until carried away by the _________. After the hurricane, high water from _________ can continue to be a problem. As people return home, they should avoid streets that have _________. Once home, they should be careful of _________.

4. Use what you have learned throughout your experiments to write the following statements.
   a. Describe how a hurricane forms. ____________________________________________

   b. Describe the weather associated with a hurricane. ________________________________

   c. Describe how hurricanes can be dangerous to people. ____________________________

   d. Describe ways to reduce the impact of a hurricane. ______________________________
Before a Hurricane...

Develop a Family Disaster Plan.
- Learn about your town’s warning signals and evacuation plans. Learn locations of official shelters, as well as safe routes inland. Call your local American Red Cross chapter or the local National Weather Service office for information.
- Place emergency numbers by all phones.
- Decide what to do if you are not all together during a hurricane or other disaster. Choose a place in your neighborhood to meet. Also choose a family member or friend to call.
- From time to time, review the evacuation plan.

Put together a hurricane survival kit.
- Each person must pack supplies to last three days. Supplies should be stored in a backpack or gym bag and should include:
  - three-day supply of water (one gallon per person, per day)
  - food that will not spoil
  - one change of clothing and footwear per person
  - one blanket or sleeping bag per person
  - a first aid kit
  - emergency tools, including a battery powered radio, flashlight, extra batteries
  - extra set of car keys
  - special items needed for babies, older people, or people with health problems
  - hygiene supplies, such as toothbrush, washcloth, soap, toothpaste
  - a waterproof container to hold important family papers
- Keep a smaller kit in the trunk of your car.
- Replace stored food and water every six months.

HURRICANE-SAFETY CHECKLIST

HURRICANE-RELATED READING

Winthrop, Elizabeth. Belinda’s Hurricane. New York:
Stay Tuned to Weather Reports

- Listen to the radio or watch television for reports put out by the National Weather Service or by the National Hurricane Center.
- During a hurricane watch, hurricane conditions are possible in the area, usually within 36 hours. During a hurricane warning, a hurricane is expected in the area, usually within 24 hours. At that time, get ready to evacuate, and finish storm preparations.

During a Hurricane...

Stay tuned to weather reports.

“Hurricane proof” your home.

- Prepare to cover all window and doors with shutters or plywood.
- Remove the antennas from roof.
- Store loose household items. Bring inside lawn furniture and other light objects such as garbage cans.

Evacuate if ordered to do so.

- You should evacuate if you live on the coastline or offshore islands, in a mobile home, or near a river.
- Review what to do in case you get separated.
- Contact someone to tell them of your plans.
- Make arrangements for your pet. Public shelters and hotels/motels do not usually allow pets.
- Bring your survival kit with you. Also carry emergency road supplies, medicines you might need, and something to entertain you while you are away from home.
- Leave early, once your home is hurricane-proofed.
- Stay with relatives or friends, at a low rise motel, or go to a shelter.

Make yourself safe if you are staying.

- Plan to stay in your home only if you have NOT been ordered to evacuate.
- Stay inside a sturdy building.
- Turn the refrigerator to cold. Open it only when needed.
- Turn off gas and electricity if officials order you to do so.
- Unplug small appliances.
- Fill the bathtub and large containers with water. Clean water may not be available after the hurricane.
- Close all doors inside the house. Cover and strengthen entrance doors.
- Stay away from windows and doors.
- Stay on the first floor. Go to a small, windowless room, or a closet, hallway, or bathroom.
- Lie on the floor under a table or another sturdy object.
- Do not leave during the calm eye of the storm. After the eye passes, the winds will change direction and quickly return to hurricane force.

After a Hurricane...

Stay tuned to weather reports.

- Do not leave your home or return home until your town is officially safe.

Travel with care.

- Roads may be closed. Do not cross roadblocks.
- Avoid bridges and washed out roads.
- Do not move around in water more than six inches deep.
- If you find someone who is hurt or trapped, give first aid or help if you can. Don’t try to move injured people.

Check for home damage.

- Check gas, water, electrical lines, and appliances.
- Watch for snakes, insects, and animals seeking shelter from flood waters.
- Open windows and doors to dry out your home.
- Take pictures of damage to the house and property inside for insurance purposes.
- Don’t use tap water until you know it is safe.
- Don’t use the telephone unless you have a life-threatening emergency.

HURRICANE-RELATED ORGANIZATIONS

Relief
American National Red Cross
www.redcross.org
Doctors Without Borders
www.dwb.org
Humane Society of the United States
http://www.hsus.org/
Federal Emergency Management Agency
http://www.fema.gov
National Voluntary Organization Active in Disasters
http://www.vita.org/nvoad
Salvation Army
www.salvationarmy.org/

Research
National Oceanic Atmospheric Administration
http://www.noaa.gov
National Weather Service
http://www.nws.noaa.gov/
Storm Prediction Center
www.nssl.noaa.gov/~spc
Tropical Prediction Center
http://www.nhc.noaa.gov/
United States Army Corps of Engineers
www.usace.army.mil/inet/functions/cw
Selected Answers

Unit 1

Lesson 3
1. Moisture is important because it is a measure of rainfall, and can help ID the eye of the hurricane as well as hurricane size.
2. Red
3. Around the eye of the hurricane (the center).
4. No rain is falling.
5. Rainfall decreases in intensity.

Lesson 4
1. Pablo
2. 2005
3. answers will vary (see p. 22)
4. 3

Lesson 5
1. 72°W, 26°N
2. 79°W, 26°N
3. West
4. increase
5. Florida
6. Teachers: check graph for points plotted.

Lesson 6
Q&A Answers:
Miami, Florida; June 1 through November 30; Atlantic and Gulf coasts from Texas to Maine; North Atlantic Ocean, Caribbean Sea, Gulf of Mexico; 6; 2; Professor William Gray at Colorado State University; storm trackers; An alert that hurricane conditions are possible in the area, usually within 36 hours; A warning that hurricane-force winds and water are expected in the area within 24 hours or less; cyclones, typhoons, willy-willies.

Unit 1 Weather Wise Wrap-Up (p. 13)
1a. C 2a. F
1b. A 2b. F
1c. B 2c. T
1d. D 2d. T
2e. F
3. six, Saffir-Simpson, five, National Hurricane Center, June, November
4. see diagrams below

Unit 2

Lesson 4
1. 2 feet (0.6 km)
2. 15 feet (4.5 km)
3. 17 feet (5.2 km)
4. 22 feet (6.6 km)
5. up to second floor

Unit 2 Weather Wise Wrap-Up (p. 21)
1. T, F, F, F, F
2. answers will vary
3. answers will vary (board-up windows, turn off utilities, move loose items indoors, clear gutters, trim tree branches)
4. coast, evacuate, storm surge, high, shelter, windows, eye

Unit 3

Lesson 1
1. horse latitudes
2. northeast trades
3. horse latitudes
4. prevailing westerlies
5. northeasterlies
6. prevailing westerlies
7. doldrums
8. southeast trades
9. southeasterlies
10.
11. A jet stream can be defined as a narrow belt of high-altitude winds moving east at high speeds.
12. northeast trades

Lesson 5
1. 120,000 square miles (307,200 square km)
2. 52,565 people
3. 38,400 people
4a. $9.00
4b. $27.00
4c. $36.00
4d. $7,200.00
5. 14,952 gallons of water
6. $6,500.00
7. $7,000.00

Unit 3 Weather Wise Wrap-Up (p. 29)
1. answers will vary
2. answers will vary
3. trade(winds); loses; jet stream; flooding; roadblocks; gas leaks or animals avoiding high water.
4a-4d. answers will vary