WeatherREADY plan for it. Hurricanes

Age Range: *This unit has been designed specifically for students in grades 5-8. It can easily be adapted for younger or older students.*
Teaching Note: *Depending on your time frame and student abilities and interests, have student groups complete each of the activities below or assign groups to work on specific activities and share their information.*

Vocabulary

Hurricane	rain bands	land fall	satellites
condensation	anemometer	tropical storm	eye
Saffir-Simpson scale	National Hurricane Center	U.S. Weather Bureau	trade winds
storm surge	satellite pictures/images	eyewall	TIROS
dropsonde	Doppler radar	low pressure	

Check The Weather Channel Education online glossary (http://www.weatherclassroom.com) for the meanings of these weather terms.

Resources

For information on the science and safety of hurricanes, check out The Weather Classroom program on The Weather Channel. Check online at http://www.weatherclassroom.com for program schedules and accompanying lesson plans and hands-on activities. www

Weather Note:
A hurricane is a vast engine fueled by warm, moist air. As warm moist air rises and condenses into clouds and rain, condensation releases a tremendous amount of heat into the atmosphere. This lowers the air pressure, drawing more air toward the center, increasing winds. The cycle repeats.

Science

Purpose: To have students investigate and demonstrate the science behind the development of hurricanes

1. Distribute "The Science of Hurricanes" Student Handout to small groups of students. Have them follow the steps to demonstrate the science behind hurricanes. Encourage them to consider:
   a. How do hurricanes develop?
   b. What are the characteristics of a hurricane?
   c. Why are hurricanes dangerous?

2. Have groups research to find and develop other ways to demonstrate the science behind, and the power of, hurricanes. Have them turn these demonstrations into lesson plans, complete with handouts for others in the class. www

Language Arts Extension:
Have students research the history of naming hurricanes. Are there drawbacks to this system? Explain. In small groups, have students develop a new naming system based on animals, number combinations, plants, adjectives, etc. Have groups explain the rationale for their systems and describe why the new system would be an improvement over the current system. www

Research

Purpose: To guide students to understand and demonstrate the forecasting and tracking of hurricanes in the U.S.

Weather Note:
North of the equator, hurricanes, cyclones and typhoons spin counterclockwise. South of the equator, they spin clockwise.

1. Have student teams follow the steps on the "Mapping and Graphing Hurricanes" Student Handout to begin to develop an understanding of ways meteorologists use tracking information to predict landfall and force of hurricanes, and use the Saffir-Simpson Scale to categorize hurricane force. www
2. Have teams analyze their data and develop the best plans for illustrating and presenting the information.

Language Arts Extension:
Have students develop radio or television reports based on "before, during and after" scenarios from a hurricane that affected their area. Reports should include continuous hurricane plotting information and predictions of landfall and intensity, as well as actual intensity and damage.

Safety

Purpose: To guide students to research, devise, and distribute guidelines for staying safe before, during, and after a hurricane

Weather Note:
Almost half the 256 people killed during Hurricane Camille died in floods far off the Gulf Coast where the hurricane originally struck.

1. Have student teams use the "Safety...Hurricanes" Student Handout and other resources to find and illustrate the best way to stay safe during a hurricane. www
2. Teams should review the guidelines they discover in their research and create customized hurricane safety guidelines for school and home. Obtain local maps and illustrate evacuation routes and pinpoint emergency shelters. Have students consider safety preparations for the community before, during, and after the storm.
3. Have students share their guidelines with others in the school community in various forms: skits, brochures, posters, interviews, or presentations to a younger grade.

Hurricane Mitigation:

The greatest threat from hurricanes comes from the storm surge, high winds, and flooding caused by extensive rains.

1. Based on these hazards, have students brainstorm ways they could mitigate the danger of hurricanes. Examples include:
   - Raising air conditioner units onto platforms
   - Bracing roofs onto foundations
   - Putting wooden shutters on windows
   - Bolting down outdoor grills

   For each suggestion, have students explain how the step would lessen the danger and/or damage caused by hurricanes.

2. Have students use the "Safety...Hurricane Mitigation" Student Handout to discover and discuss other possible ways to mitigate the dangers of hurricanes. What problems can be fixed easily? What might take more time and money? Check online. 

3. Finally, have students use this information to go on a "Hazard Hunt" around their homes with their parents. Which mitigation projects can they complete?

Geography Extension:

Have students create a map to illustrate hurricane occurrences that have affected their area. They should include names, dates and categories. Around the map, have them place facts concerning the effects of specific storms on people and property.

the Science of...

Hurricanes

Activity #1

When a hurricane forms, it follows these steps:

1. Warm, humid air rises from the warm ocean water of the tropics.
2. Latent heat is released as rising warm air condenses into water droplets when it reaches cooler air above.
3. The released heat warms the cooler air around it.
4. The warmed air becomes lighter and rises.
5. The rising warmer air is replaced by more warm, humid air that flows up from the warm ocean water.
6. This continuous exchange of heat in the atmosphere creates wind.

Based on this description, why might this be called a "hurricane engine"?

Challenge: On a separate sheet of paper, illustrate and label these steps to explain the hurricane engine.

Activity #2

Below is a "recipe" for a hurricane. Based on the steps above and your own research, explain why each "ingredient" is necessary for a hurricane to form.

Ingredient:	Why You Need It:
1. Warm waters must go a depth of about 200 feet.	
2. Ocean waters must be about 80° F.	
3. Winds at the surface must converge.	
4. At the surface there must be a low-pressure area.	
5. Pre-existing winds must come from the same direction at similar speeds at all altitudes.	
6. Air in the lower atmosphere must be warm and humid.	
7. In the upper atmosphere, there must be an area of high pressure.	

Challenge: On another sheet of paper, create an illustration of water, clouds, and atmosphere. Use the information above to label your illustration. Use arrows to show air flow.

Going Further: Based on this information, why do you think hurricanes are seasonal?

Mapping & Graphing

Hurricanes

Atlantic Coast Hurricane Problem

You and Jane Eye are working in the Norfolk Hurricane Center when an alert comes over the fax. A storm moving NW at 17mph has the following data:

Buoy#	Buoy Location	Wind Speed
35	29.0 N 70.0 W	45 mph
36	30.0 N 70.0 W	68 mph
37	31.0 N 70.0 W	82 mph
38	32.0 N 70.0 W	15 mph
39	33.0 N 70.0 W	93 mph
40	34.0 N 70.0 W	67 mph
41	35.0 N 70.0 W	44 mph

Challenge: Turn this storm information into a Pacific Coast Hurricane Problem. What tracking information would change? What questions/ answers would change?

From the chart, answer the following:

1. Locate the buoys on a map of the Atlantic. Draw a light sketch of the storm over the buoys. Remember, the storm is round.
2. Why is the wind speed at buoy 38 so different from the others?
3 What stage is this storm in now?
4 Where is the eyewall located?
5 What is the location of the storm in coordinates?
6. Where do you think this storm started?
7. Does a watch or warning need to be issued? Which? Where? When?

Going Further: Use a map to track and compare this abbreviated list of tracking data for Hurricane Opal and Hurricane Hugo:

Hurricane Opal: Sep. 27 - Oct. 6, 1995

LAT	LON	DATE	WIND	PR	STATUS
19.10	-87.30	09/27	25	1004	TD
19.30	-88.40	09/28	25	1003	TD
19.80	-88.20	09/29	30	1003	TD
21.40	-89.10	09/30	40	1000	TD
20.80	-91.60	10/01	50	985	TD
21.20	-92.30	10/02	65	972	H-1
23.50	-91.00	10/03	85	965	H-2
27.30	-88.50	10/04	130	919	H-4
29.00	-87.70	10/04	110	938	H-3
33.20	-86.20	10/05	50	974	TS
35.40	-85.70	10/05	30	982	TD
44.30	-78.40	10/06	35	997	ETS

Hurricane Hugo: Sep. 10 - 25, 1989

LAT	LON	DATE	WIND	PR	STATUS
19.10	-87.30	09/27	25	1004	TD
19.30	-88.40	09/28	25	1003	TD
19.80	-88.20	09/29	30	1003	TD
21.40	-89.10	09/30	40	1000	TD
20.80	-91.60	10/01	50	985	TD
21.20	-92.30	10/02	65	972	H-1
23.50	-91.00	10/03	85	965	H-2
27.30	-88.50	10/04	130	919	H-4
29.00	-87.70	10/04	110	938	H-3
33.20	-86.20	10/05	50	974	TS
35.40	-85.70	10/05	30	982	TD
44.30	-78.40	10/06	35	997	ETS

From the data and your tracking chart, how do these two storms compare?

Safety
Hurricanes

To be prepared for any kind of weather hazard, you should gather a Family Safety Supplies Kit, set up emergency contact information, and plan for the special needs of people and pets.

Since today's forecasters can track the movement and measure the strength of hurricanes so closely, announced evacuations are often the best way to save lives during major storms.

If Evacuation Seems Possible

- Call your out-of-town contact to make arrangements for a possible stay with them.
- Make sure your Family Safety Supplies Kit is ready.
- Be sure to have road maps with well-marked evacuation routes on hand.
- Stay tuned to NOAA Weather Radio or local radio and television stations to listen for updates on evacuation and traffic.

If Evacuation is Announced

- Get ready to leave immediately.
- Call your out-of-town contact person to tell them you're on your way to them or to say where you're going.
- If time permits, and you live in a "surge zone," elevate furniture or move it to a higher floor if possible.
- Turn off electricity and the main water valve.
- Follow your plans for emergency pet care.
- Pack your Family Safety Supplies Kit in the car.
- Lock and secure your home.
- Listen to local radio and television stations and follow advised evacuation routes to avoid flooded roads and washed-out bridges.

Returning Home after a Hurricane

- Return home only after authorities advise that the area is safe.
- Stay tuned to local radio stations to avoid flooded roads and washed-out bridges and to find out where to get help.
- Be careful of downed power lines. Report them to the power company, police, or fire department.
- Enter your home with extreme caution.
- Wear sturdy shoes and protective clothing; use a flashlight to check for damage around your home.
- Beware of snakes, insects, and animals driven to higher ground by floodwater.
- Check refrigerated foods for spoilage.
- Have a professional check your water, gas, electric, and sewage lines if you suspect there is damage.
- Be sure not to drink water from the faucet until officials indicate that it is safe to drink.
- Be patient - it takes time for a community to recover from a hurricane.

Safety

Hurricane Mitigation

Mitigation is the ongoing effort to lessen the impact of disasters on people and property. Mitigation measures can be low-cost and simple, such as clearing debris from around your home. Or, they can be more costly and difficult to accomplish, such as elevating your home onto stilts. If your property is at risk from hurricanes, then you might want to consider one or more of the following actions to reduce or eliminate the potential for damage.

Wind Damage

- **Make a list of items to bring inside in the event of a hurricane.** Lawn furniture, bikes, and tools. Objects that cannot be brought in, such as gas grills, should be bolted to the ground.
- **Keep trees and shrubbery trimmed.** Removing diseased or damaged limbs from trees makes them more resistant to the wind. Cutting branches can help the wind blow through trees.
- **Remove any debris or loose items in your yard.** Debris blown by hurricane-force winds can cause a great deal of damage.
- **Clear loose and clogged rain gutters and downspouts.** Provide clear drainage for hurricane rains to help prevent flooding.
- **Shutter your windows.** Install permanent hurricane shutters for windows and glass doors to protect against wind and to prevent damage from flying debris. If you cannot install permanent shutters, install anchors for precut plywood window covers.
- **Strengthen garage doors.** You can reinforce garage doors by adding girts across the back of the door and strengthening the glider wheel tracks. If your existing door is old or damaged, you might want to replace it with a stronger door and tracks.
- **Install hurricane straps.** Hurricane straps secure the roof to the walls and foundation of your home to reduce the risk of losing your roof during high winds.

Flooding and Storm Surge Damage

- **Elevate coastal homes.** Raising houses can make them more resistant to hurricane-driven water and rising floodwaters.
- **Move valuables and appliances out of the basement.** Keeping costly items out of the basement increases the chance that your belongings will be safe and will not have to be replaced after the storm.
- **Elevate the main breaker or fuse box and the utility meters.** Floodwaters won't damage your utilities if these are installed above anticipated flood levels.

the Science of...
Hurricanes

Activity #1

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4. The warmed air becomes lighter and rises.
5. The rising warmer air is replaced by more warm, humid air that flows up from the warm ocean water.
6. This continuous exchange of heat in the atmosphere creates wind.

Based on this description, why might this be called a "hurricane engine"?

Webster's dictionary defines an engine as a device to affect a certain purpose. Just as a car engine provides the power for a car to travel, the "hurricane engine" is the device that makes a hurricane go. The warm, humid air rising from the ocean is like the gasoline being pumped into the car engine. In a car engine, a spark plug ignites the gasoline in a controlled explosion that releases energy in the form of heat. In a hurricane, the condensation of water releases energy in the form of heat. In both the car engine and the hurricane engine, the released heat is the source of energy that drives the process of a car moving or air moving at high speeds.

Challenge: On a separate sheet of paper, illustrate and label these steps to explain the hurricane engine.

Activity #2

Below is a "recipe" for a hurricane. Based on the steps above and your own research, explain why each "ingredient" is necessary for a hurricane to form.

Ingredient:	Why You Need It:
1. Warm waters must go a depth of about 200 feet.	*You need lots of warm water to keep supplying warm air to the hurricane forming above the water.*
2. Ocean waters must be about 80° F.	*Warm water is needed to warm the air so it rises. Below 80 ºF water temperature, the very stable atmosphere in the tropics and sub-tropics makes it difficult for thunderstorms to form.*
3. Winds at the surface must converge.	*Converge means to come together. Winds coming together will collide and under the right conditions will start to rotate to form a hurricane.*

the Science of...
Hurricanes

Activity #2 (continued)

Ingredient:	Why You Need It:
4. At the surface there must be a low-pressure area.	*Winds travel from areas of high pressure to areas of low pressure. A low pressure area allows winds to converge. The low pressure area also attracts warm moist air near the surface of the water.*
5. Pre-existing winds must come from the same direction at similar speeds at all altitudes.	*Winds blowing in different directions and altitudes at different speeds create what meteorologists call wind shear. If there is high wind shear, meaning winds are coming from different directions at different speeds, then rising warm air is spread over a larger area and it's unlikely a hurricane will develop. If winds are the same speed and from the same direction, then warm air will rise vertically, producing optimal conditions for hurricanes.*
6. Air in the lower atmosphere must be warm and humid.	*Tropical storms form best when there is plenty of warm, humid air over warm water. The warm air meets cooler air as it rises, then condenses and releases latent heat, which is a key energy source in the hurricane engine.*
7. In the upper atmosphere, there must be an area of high pressure.	*The high pressure area will act to push the rising air outward, making room for more air to rise up from the surface. This movement of air contributes to the characteristic rotation pattern of the hurricane.*

Challenge: On another sheet of paper, create an illustration of water, clouds, and atmosphere. Use the information above to label your illustration. Use arrows to show air flow.

Going Further: Based on this information, why do you think hurricanes are seasonal?

For hurricanes to form certain conditions related to the atmosphere and water temperatures must be present. For example, if the water temperature is less than 80° F, then an insufficient amount of warm air will be generated to fuel a hurricane. Winds must also be traveling in certain directions to assist in creating a hurricane. Because the Earth's axis is tilted toward the sun at an approximately 23 degree angle, the Earth experiences seasonal weather depending on how much sunlight reaches the Earth at any one time. The heating of the Earth's atmosphere, plus the rotation of the Earth, produces the winds that carry energy from one location to another. Only during certain times of the year are the conditions right for hurricanes to form.

Mapping & Graphing

Hurricanes

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1. Locate the buoys on a map of the Atlantic. Draw a light sketch of the storm over the buoys. Remember, the storm is round.
2. Why is the wind speed at buoy 38 so different from the others?

   The low speed indicates that the eye of the storm is located close to buoy 38. Remember, the lowest wind speeds will be near the center of the hurricane.

3 What stage is this storm in now?

   By stage, we mean tropical depression (maximum sustained surface winds less that 39 mph), tropical storm (maximum sustained surface winds greater than 39 mph but less than 73 mph), or hurricane (maximum sustained surface winds greater then 74 mph). The data indicate that this tropical cyclone is not yet a hurricane, but it is a rather strong tropical storm.

4 Where is the eyewall located?

   The eyewall can be found by looking for the areas where the winds have the highest speeds. For this tropical storm the eyewalls are located at buoys 37 and 39.

5 What is the location of the storm in coordinates?

   Reading the coordinates from the data table, buoy 38 is located at 32.0 N latitude, 70.0 W longitude.

6. Where do you think this storm started?

   Since it is moving northwest, it must have started somewhere to the southeast of its present location. Looking on the globe, the storm likely started developing somewhere southeast of Bermuda Island.

7. Does a watch or warning need to be issued? Which? Where? When?

   A hurricane watch is when hurricane conditions are possible in the specified area of the watch, usually with 36 hours. A hurricane warning is when hurricane conditions are expected in the specified area, usually within 24 hours. This storm is not yet a hurricane, but will be one soon if the maximum sustained surface winds increase to 74 mph. Since this is a likely event, a hurricane warning should be issued. Assuming the storm continues to track to the northwest at 17 mph, the warning should be issued for areas along the projected track of the storm over the next 24 hours.

Mapping & Graphing

Hurricanes

Going Further: Use a map to track and compare this abbreviated list of tracking data for Hurricane Opal and Hurricane Hugo:

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From the data and your tracking chart, how do these two storms compare?

Students may plot the coordinates of each hurricane on an appropriate chart, or do a quick search of the Internet to locate plots of each hurricane.

Examining the paths, Hurricane Opal began in the Gulf of Mexico and traveled northeast to impact the United States Gulf Coast and then made its way to the New England area. Hurricane Hugo began near the coast of Africa in the eastern Atlantic Ocean, traveled northwest toward the United States and made landfall in South Carolina, then turned northeast in Ohio to follow a similar path as Hurricane Opal.

Looking at wind speeds, Hugo reached Category 5 status and overall had higher sustained winds for a longer period of time than Hurricane Opal. Hurricane Hugo also had a longer life than Hurricane Opal, mostly as it traveled a much longer distance.

Archived information on both hurricanes can be found at: http://www.nhc.noaa.gov/pastall.shtml