"HURRICANE...derived from 'hurican', the Carib god of evil...
alternative spellings: foracan, foracane, furacana, furacane, furicane, furicano, haracana, harauncana, haraucane, haroucana, harrycain, hauracane, haurachana, herican, hericane, hericano, herocane, herricao, herycano, heuricane, hiracano, hirecano, hurac[s]n, huracano, hurican, hurleblast, hurlecan, hurlecano, hurlicano, hurrican, hurricano, hyrracano, urycan, hyrricano, jimmycane, oraucan, uracan, uracano"
From the "Glossary of Meteorology": thanks to Chris Landsea, NOAA/OAR/AOML

Activity 4.2 Hurricane Houses
Thanks to Florida teachers Cathy McQuone (LFSTORM development team member) and Ernie Tindell for the detailed procedure and original inspiration for this Activity. Cathy demonstrates "Hurricane Houses" with her Leon High School students in the Teacher Resource Video: as you'll see, despite the unusual noise associated with operating a leaf-blower in a classroom, her principal is convinced that when students are paying attention and having fun, sound (sic) education is also underway.

Teacher Background
Many people believe their home will survive most kinds of severe weather. However, recent disasters (F-5 and F-4 tornadoes in Oklahoma, a large twister in downtown Salt Lake City or Hurricanes Andrew, Hugo, and Floyd) demonstrate just how devastating major storms can be. Teachers can play a vital role in making students more aware of storm disasters and how to prepare for them. One NOAA researcher attributes the fact that there were no fatalities in young people aged 5 to 25 in the 1999 OKC tornadoes *specifically* to the good job teachers in the region have been doing in making students aware of tornado safety precautions. (See WHO/BIOs/Harold Brooks at the LIVE FROM THE STORM site.)

This Activity introduces students to some basic design techniques that can prevent or reduce damage to structures caused by high or hurricane force winds. (And—after some of the houses are ripped to shreds or blown away—it also provides for some teachable moments for emergency preparedness procedures.) New materials are constantly being developed and used in the construction of new homes. New materials are constantly being developed and used in the construction of new homes, but there are some simple but effective ways to reinforce existing homes:

- Cover windows and doors
- Reinforce garage doors
- Secure the roof gables to each other
- Secure the roof to the walls
- Secure the walls to foundation

(source: FEMA, Red Cross, NOAA.)

Objectives
Students will build a house that will be tested against "hurricane force winds."
Students will learn what design features make a house more or less resistant to strong winds.
Students will practice math skills in calculating surface area and a targeted volume.
Students will use problem-solving techniques.

Materials (for teacher)
leaf blower
wind gauge (if possible)
"Against the Wind" document (available in English or Spanish) or video (available from American Red Cross) and online at http://www.redcross.org/disaster/safety/agnstwd.pdf
LFSTORM Standards Correlation sheet for teacher reference
Hurricane Houses Scoring Rubric (supplied)

Building Materials (per team of 3-4 students)
one or two pairs of safety goggles (for the students holding the house when being tested)
2 standard size sheets of construction paper
4 straws (with or without flexible bend: all students should have the same type)
glue stick
60 cm Scotch tape (or equivalent)
styrofoam tray, to be used turned upside down. (The produce department of a grocery store might donate fruit/vegetable trays. Minimum size is 7" x 9") The tray is only to be used for the base. It cannot be cut apart and used for the house.
scissors
metric scale
markers (to decorate the house): optional
WEATHERlogs
Student Worksheets 4.2.1 Construction checklist (per student)
Student Worksheets 4.2.2 Area and Volume formulas reminder sheet (per student)
Student Worksheets 4.2.3 Activity self-evaluation form (per student)

Note: The size or kind of materials may vary. But it is critical for *all* teams to have exactly the same since the challenge is to compare more and less effective house designs. If every team has the same materials then design is the *only* variable. Remind students that the upside down styrofoam tray is to be used only as a foundation, not for walls or bracing for their houses.

Engage (Choose one scenario based on your geographic location)
For students in non-hurricane areas: "Your family has decided to move to the eastern coast of North Carolina. You'll have a good chance of experiencing a hurricane. What are some features of a 'hurricane proof' house that your family should look for?" (Impact resistant windows or shutters that close over the windows; door frames that are securely anchored to the frame of the house; center supports on garage doors; roof shingles that are securely attached to the house as well as the roof; pitch of the roof should be low, or the gables—the top, pointed part of the side walls—should be reinforced; "hurricane clips" can be added to connect the roof to the walls; the walls should be securely fastened to the foundation, and—if it's a house with more than one level—they should be securely connected together.)

For students in hurricane-prone regions: “Students, we have recently seen the destructive forces of hurricanes like Andrew, Hugo, Mitch, and Floyd. A significant number of homes were damaged by the winds. Designing homes that can better withstand the force of hurricanes is a consideration in all future housing starts. And remember the cost of storm-proofing an existing house is much less than the cost of repairing damage. Possibly, you’ll live in a home along a coastline. Knowing how to design and construct a home that will withstand hurricane force winds could save your investment if and when a hurricane comes.”

Challenge for both scenarios: What are the most significant characteristics of hurricanes? (Sustained high winds of over 74 mph, shifting wind directions, storm surge; only the first 2 are simulated in this Activity.) What are the most important design features that make a house able to withstand hurricane force winds. (Attaching the roof securely to the house, and securing the house to the foundation.) “Your task is to design and build the most wind resistant building you can, using only the materials provided and meeting the design specifications. The local ‘building code’ specifies that your house must be at least 1,500 cubic centimeters in volume and be enclosed (no missing walls). But it can be any shape. Good luck!”

Explain/Explore
Day 1: Distribute Student Worksheets 4.2.1, 4.2.2, and 4.2.3. Review the procedures and timetable. Explain that student teams will have the remainder of the first day’s class and one additional class period to discuss, plan and design their house using the materials provided. Day 1 can be a practice run for the “apprentice builders.” If at the end of the class, they feel their house is “vulnerable” they will have day 2 (as “experienced builders”) to redesign and build a new design.

Ask students how the size or surface area of their house will affect its ability to withstand strong winds. Explain that they must calculate the volume of their houses to meet the 1,500 cubic cm target, which must be the same for all teams. Review the formulas for calculating the volume and surface area of different shapes, if necessary. See Student Worksheet 4.2.2 for reminders of the relevant formulas. ?” If the volume of the house is not shown to be very close to 1,500 cubic centimeters through appropriately labeled explanatory diagrams as on Worksheet 4.2.1 they must rebuild their house on day 2. Surface area will vary according to each team’s design: remind them that for the purposes of this Activity, the house’s surface area is the sum of the area of each side and the roof, but excludes the base. If necessary, give students samples of each shape and have them calculate surface area and volume. Explain that the surface area will be considered after the houses are tested by the “hurricane force” winds to answer the question, “Did the surface area affect the success of house to withstand the winds.

Day 2: Provide new materials for those who need it. They will have one class period to complete their house and have it ready for testing by leaf-blower. To compare designs all houses should be tested on the same day.

Before "blowing away the houses": if you have a wind gauge, stand a distance away from where the houses will be held. Starting at the edge of the classroom indicate with masking tape on the floor where the wind is "tropical depression" (< 39 mph ), "tropical storm" (39-73 mph), "hurricane strength" (>74 mph) and the strongest. (Some leaf blowers can blow as fast as 94 mph. On new leaf-blowers you may even find "miles per hour" indicated on the box.) The final tape mark will be just inches away from where the house will be held. If you do not have a wind gauge, simply mark a place for 'light', 'mild' and 'strong' winds.

SAFETY NOTE TO TEACHERS

The student holding the house should wear safety goggles. When blowing the houses, make sure that any small items are removed from the area so that no stray "debris" can hurt a student. This would be a great time to recruit a parent volunteer to handle the leaf-blower, freeing you up to work with the students and ensure safety procedures are followed.

Day 3: Testing the Houses

Using the leaf blower, you or the parent-volunteer should stand at the "light", then "mild", then "strong" wind marks. Aim the leaf blower at the house while one of the student team members turns the house with extended arms to simulate the swirling winds of a hurricane as it makes landfall. Have each team record the results (damage sustained within X minutes at Y wind condition, or survival for X minutes at the strongest wind position) on the Worksheet, or in WEATHERlogs.

Grade each team according to the Scoring rubric provided.

Please note that this Activity merely simulates hurricane force winds and construction techniques. "Construction paper", despite its named, does not scale to sheetrock and 2x 10's and roof shingles. But just as the manufacturers of leaf-blowers think it's a good sales gimmick to rate their product by its hurricane force, we think students will be excited and impressed by this Activity, even without precise correspondence to real wind velocities and building materials.

Expand/Adapt/Connect

"What do you get when you cross a styrofoam tray, straws, construction paper and a leaf blower in a classroom? You get a localized hurricane trying to topple model houses." This is how a local TV meteorologist described the "Hurricane Houses" Activity when it was first implemented in a Florida high school classroom. You might also invite your local weatherperson to your school: we think they'll be interested to see how their professional interests have been incorporated into the curriculum! And you and your school might get some welcome local exposure.)

As a class activity, have students note the strongest winds each house could withstand, and plot these results against volume and the surface area of each design. Is there a correlation between specific designs and the strength of the winds the house could withstand? If you can videotape the results, students from each class can view the designs and results from your other classes. What design features seem to prove more effective than others? How might those "construction paper" principles apply to real world building techniques?

Have students do the same assignment but vary the materials. Students can bring in materials from home. Who can build the most hurricane proof home if there is a free choice of materials? Consider having students re-test some of the surviving houses during a school Open House event or at a science fair Expo. This is a great way to involve parents and other faculty in the excitement of this "real science" activity.

Suggested URLs
http://www.nhc.noaa.gov/
National Hurricane Center. Latest official warnings, and general information about hurricanes.

http://www.redcross.org/services/disaster/beprepared/Agnstwd.pdf
"Against the Wind": From the Red Cross chapters. Spanish ("Contra el viento") and other languages are also available.

http://www.ibhs.org/
"Is your Home Protected from Hurricane Disaster: A Homeowner's Guide to Hurricane Retrofit" Prepared by the Institute for Business and Home Safety

http://www.fema.gov/library/lib07.htm
Federal Emergency Management Agency Online Library: links to all FEMA publications (including "Against the Wind") and preparedness guides.

University of Wisconsin, Madison: Tropical storm website with latest warnings, information and for every part of the world.
http://cimss.ssec.wisc.edu/tropic/tropic.html