Grades 7–8
Gifted 6

SCHOLASTIC

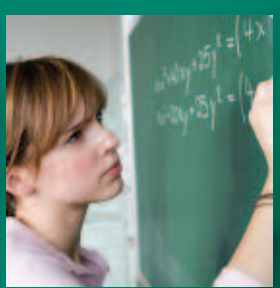
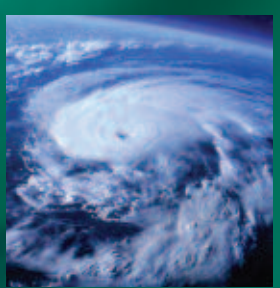
Part 1 of 2

Expect the Unexpected With Math

SHAKE, RATTLE, & ROLL

Teaching Guide & Poster




Meets NCTM Standards

Apply for a
Teacher Grant!
Details Inside

DEVELOPED WITH

THE ACTUARIAL FOUNDATION®

Lesson Overviews

Dear Teacher:

Get ready to expect the unexpected with math! **Shake, Rattle, & Roll,** a new program developed by The Actuarial Foundation with Scholastic, provides dynamic real-world math content designed to build student skills while showing students the relevance of math to understanding their world and planning for their future.

Math skills are increasingly important for students. According to the U.S. Department of Labor, computer and mathematical science occupations, are projected to add 967,000 jobs and grow fastest among the professional groups by 2014.

Inside you'll find turnkey materials to help students build skills they need. Look for easy-to-use lessons and reproducibles, an exciting wall poster, and a class set of family take-home activities.

We hope you enjoy this great new program!

Sincerely,

The Actuarial Foundation
Scholastic

Download copies of this program at:
www.scholastic.com/shakerattleroll

Lesson 1: Shake It Up with Scatterplots

OVERVIEW: Students will create and analyze scatterplots that compare the relationships between different data sets. They will analyze the information and develop an understanding of how actuaries use this type of math in the real world.

OBJECTIVES: Students will understand—

- How to use a scatterplot to compare two sets of data to determine if they are related
- The definition of *regression line* (the "line of best fit")
- How scientists and actuaries use math and data to study earthquake probability

Time Required: 30 minutes

Materials Needed: **Reproducible Activity 1**; rulers

WHAT YOU WILL DO:

1. Introduce the actuarial profession briefly and define *premium* (see Real-World Connections below). Explain that students will use tools throughout the lessons, similar to those used by actuaries, to strengthen their math, data analysis, and probability skills.
2. Tell students they will make a scatterplot, and use it to analyze the effects of an earthquake. Explain that a scatterplot compares two different sets of data. Students will use the scatterplot to determine if there is a strong relationship between the variables presented. They will analyze the relationship and discuss effects.
3. Ask students what they would like to know about earthquakes if they were to compare two variables to find out if the data are closely related. These variables would become labels on the horizontal and vertical axes of a scatterplot (e.g., intensity and distance from the epicenter).
4. Distribute copies of **Reproducible Activity 1** to students. Explain that students will be looking at information about an earthquake event near the real town of Parkfield, California, which is famous for its seismic activity. Explain that the data used here are distance from the epicenter of the earthquake (in kilometers) and intensity at that location. Magnitude is measured at the source of an earthquake, while intensity is measured wherever the earthquake is felt. Often, but not always, the closer to the epicenter, the greater the intensity.
5. Instruct students to study the data and plot it in the scatterplot. Students should draw a regression line, or "line of best fit": a straight line that lies close to most, but does not necessarily touch all, points. When students plot the points, they should see that points fall roughly in a straight line indicating that there is a strong relationship between the two sets of data. Discuss effects of the relationship between distance from the epicenter and intensity. How might living closer to the epicenter affect homeowners' decisions about insurance (e.g., they might consider earthquake policies, and their homes' building materials, etc.)?

Real-World Connections: An *actuary* is a statistical expert who determines the financial impact of randomly occurring events like earthquakes, injuries from an accident, even death. Actuaries work primarily in the insurance industry and for state and federal government agencies. Actuaries use math and statistics to determine the probability of major events in a geographic area (like an earthquake in central California). They also use additional information, like the expected magnitude of an earthquake, to help an insurance company set premium rates. A *premium* is the amount paid by a customer, usually annually, for a given amount of insurance coverage.

Background: For additional information and statistics about earthquakes and their intensity, visit www.ngdc.noaa.gov/seg/hazard/int_srch.shtml. For additional information about the Modified Mercalli Intensity Scale and the Richter Scale, visit http://earthquake.usgs.gov/learning/topics/mag_vs_int.php and http://pubs.usgs.gov/gip/earthq4/severitygip.html.

Teacher Grants Available!

Advancing Student Achievement is a grant program that brings together actuaries and educators in local classroom environments through the belief that interaction with real-world mentors will boost students' interest and achievement in math. **Apply for an ASA Grant at:**
www.actuarialfoundation.org/grant/index.html

Best Practices Guide: This guide features a compilation of research on the value of mentoring, combined with 15 case histories of programs funded by The Actuarial Foundation, each of which includes information on program design and results. **Free copies available at:**
www.actuarialfoundation.org/grant/bestpractices.html

ADVANCING STUDENT ACHIEVEMENT®
A program of THE ACTUARIAL FOUNDATION

Lesson Overviews

See back cover for NCTM standards met by this program and reproducible answers.

Lesson 2: Histograms Manage a Flood of Data

OVERVIEW: Students will learn how histograms are used and will create and analyze histograms.

OBJECTIVES: Students will understand—

- That a histogram is a type of bar graph that represents frequency distribution
- The definition of *mean* and how it applies to histograms
- How an actuary may use histograms to analyze the frequency of events to determine risk

Time Required: 30 minutes

Materials Needed: **Reproducible Activity 2**; calculator

WHAT YOU WILL DO:

1. Explain that a histogram is a kind of bar graph showing the frequency with which something happens within given intervals. While bar graphs compare fixed amounts, histograms compare a range of data.
2. Give students the example: If a histogram showed the number of books students read during several months (in intervals) on the x-axis, the y-axis would show the number of students.
3. Explain that actuaries can use histograms to compare ranges of data—e.g., about populations—and graph the mean (see the Real-World Connections below).
4. Review the definition of *mean*. The mean in this activity represents the single amount of money each person filing a claim would have to pay so that the total amount would cover the costs of all claims, regardless of individual claim amounts. For example, if 5 different people have the following claim amounts—$10, $15, $25, $30, $100—then the mean would be $36. **Note:** This is not how premiums are determined. This example is used to illustrate the concept and definition of *mean*.
5. Distribute copies of **Reproducible Activity 2**.
6. Tell students to examine information in the table and draw bars to graph the data. Remind students that there should be no gaps between the bars. The average paid claim amounts are between the ranges labeled below the horizontal axis.

Real-World Connections: Actuaries are often called upon to estimate, based on available data, the likelihood (probability) an area will flood, and to estimate the cost of the resulting damage if flooding does occur. Histograms can be used to provide a good picture of average claim costs to better estimate total costs of insuring a particular geographic area against floods. Actuaries use this information to determine what premium to charge to cover flood damage.

Background: For more about floods, visit www.floodsmart.gov and www.fema.gov/hazard/flood/index.shtm.

Lesson 3: Tune In to Insurance

OVERVIEW: Students will use cost-benefit analysis to make predictions from data.

OBJECTIVES: Students will understand—

- How to estimate costs and make inferences and predictions from data
- How to use cost-benefit analysis to make decisions

Time Required: 30 minutes (additional time for outside research)

Materials Needed: **Reproducible Activity 3**; Internet access or office-supply catalogs; calculators

WHAT YOU WILL DO:

1. Divide students into groups of 3–4. Have each group imagine they are co-owners of a small used CD and DVD store in a tornado-prone area.
2. Distribute copies of **Reproducible Activity 3**, and go through question 1 to estimate the store's total value.
3. Tell students they must choose whether to purchase an insurance policy to cover them if they were to lose their business in a tornado. Discuss insurance coverage. Explain that coverage for catastrophic events like tornadoes must be purchased separately from a basic policy, at greater cost.
4. Discuss cost-benefit analysis. Explain that it's a way of evaluating the advantages (benefits) and disadvantages (costs) of a particular purchase, investment, or course of action. Explain that actuaries use cost-benefit analyses in the real world (see the Real-World Connections below).
5. Questions in the reproducible guide students through a cost-benefit analysis for making decisions about insurance. Review students' answers. Discuss the costs and benefits of having tornado insurance.

Real-World Connections: Actuaries use cost-benefit analysis to help analyze the cost of possible events for insurance companies. They assess the risk of certain events in particular areas according to what they refer to as the "peril-type," and by the cost associated with each type of peril. Using this data, they help insurance companies adjust their business approach and set their fees in a way that helps them reduce their financial risk. (Suggestion: As an added bonus for your students, you may wish to invite a local insurance agent for a guest presentation.)

Background: For the Fujita Tornado Damage Scale, visit www.spc.noaa.gov/faq/tornado/f-scale.html.

Lesson 4: Branching Out with Tree Diagrams

OVERVIEW: Students will learn how tree diagrams can be used to understand the different possible outcomes of given events.

OBJECTIVES: Students will understand—

- How to use a tree diagram to map outcomes and determine the probability of different events occurring
- *Mutually exclusive* and *complementary* events

Time Required: 30 minutes

Material Needed: **Reproducible Activity 4**

WHAT YOU WILL DO:

1. Discuss tree diagrams. Explain that they can be used to determine the probability (or chance) of a particular scenario occurring. Explain that property and casualty actuaries think about different outcomes caused by natural events, and costs related to each outcome. They may advise insurance companies about how the costs might affect future claim payment amounts (see Real-World Connections below).
2. Distribute copies of **Reproducible Activity 4**.
3. Discuss the Saffir-Simpson Hurricane Scale used to categorize hurricanes according to strength. The scale is a 1–5 rating based on the hurricane's present intensity and can be used to estimate the potential property damage and flooding expected from a hurricane landfall. The scale is based on wind speed and storm surge.
4. Demonstrate how to calculate the probability of a possible outcome using tree diagrams. This probability can be expressed as a fraction or a percentage. The determination of probability (which would be true in ***any*** tree diagram) for any given tier is to count the number of outcomes under consideration in that tier and divide it by the total number of outcomes in that tier. The results in the second tier of this activity strongly depend on the outcome of the first tier. For example, the outcome of "Tropical Depression" in the second tier is dependent on the outcome of "Tropical Storm" in the first tier.
5. Explain that *mutually exclusive* events cannot happen at the same time. For example, a Category 1 hurricane and a Category 4 hurricane are mutually exclusive. *Complementary* events are all the other outcomes that do not occur in a given scenario. For example, if an event is 'it will rain today,' the complementary event will be 'it will not rain today.' If an event occurs, its complement cannot occur.

Real-World Connections: Actuaries must consider all of the possible outcomes for a particular event, such as a hurricane, or the likelihood that a storm will occur and spread. They can then take these possibilities a step further and consider the effects of different scenarios on different variables, such as the type of building materials used in structures and whether they can withstand hurricanes.

Background: For the Saffir-Simpson Hurricane Scale, visit www.nhc.noaa.gov/aboutsshs.shtml.

ACTIVITY 1:

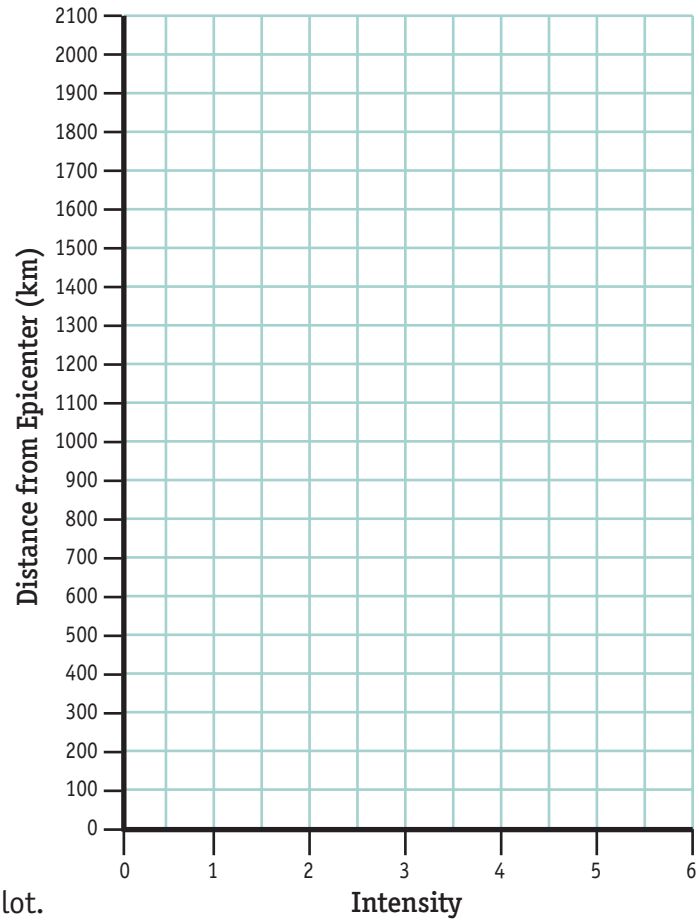
Reproducible

Shake It Up with Scatterplots

NAME: _____ DATE: _____

Actuaries use information about the magnitude and severity of earthquakes in a particular geographic area to help insurance companies determine how to serve their customers. The magnitude describes the size of the earthquake at the source. The table on the left below describes the earthquake's intensity—the effects of the earth's shaking—at different locations away from Parkfield, California, a town famous for its seismic activity. Read the table, then answer the questions below.

Date of Earthquake: Sept. 28, 2004 Epicenter: 9 Miles South of Parkfield, CA Magnitude at Source: 6.0*		
Town	**Distance from Epicenter (km)**	**Intensity****
Armona, CA	89	IV
Avenal, CA	35	V
Boise, ID	934	I
Coalinga, CA	47	V
Denver, CO	1,431	I
Fellows, CA	99	IV
Henderson, NV	497	II
Hutchinson, KS	2,019	I
Las Vegas, NV	482	III
Litchfield Park, AZ	778	III
Pahrump, NV	401	III
Rancho Palos Verdes, CA	294	IV
Salt Lake City, UT	930	II
Sevier, UT	781	II
Strathmore, CA	129	V



Work the Math:

1. Plot the information given above as a scatterplot.
2. Use a ruler and mark the "line of best fit" for the scatterplot you have created.
3. What relationship do you notice based on the information plotted here? Is the relationship weak or strong? _____
4. Do you think it would cost more or less to insure customers in the Parkfield region against earthquake damage than it would customers in places where there are no recorded earthquakes? Why?

_____

_____

* Magnitude is measured by the Richter Scale, and is determined by seismographs.
** Intensity is measured by the Modified Mercalli Intensity Scale, and is based on effects on people, structures, and the natural environment.

ACTIVITY 2:

Reproducible

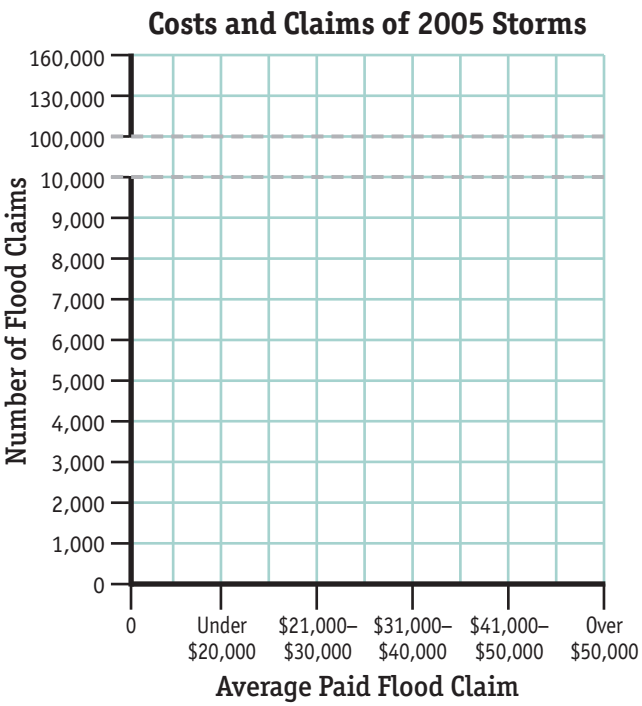
Histograms Manage a Flood of Data

NAME: _____ DATE: _____

Actuaries can use histograms to analyze the frequency of submitted insurance claims after natural events and the range of average claim amounts insurance companies paid to customers over a particular period of time. The information in the table on the left below lists the number of flood insurance claims submitted and average paid flood claim amounts as a result of storms in 2005. An *average paid claim* is the average of all the flood claims paid by the insurance companies. Read the claims in the table, then answer the questions below.

Much of New Orleans, LA, was flooded after levees broke following Hurricane Katrina in August 2005.

2005 Storm	Category at Landfall	Number of Flood Claims	Average Paid Flood Claim
Hurricane Dennis	3	3,332	$26,687
Hurricane Katrina	3	158,786	$94,750
Hurricane Rita	3	8,602	$46,089
Tropical Storm Tammy	not applicable	3,600	$10,213
Hurricane Wilma	3	8,474	$36,126



Work the Math:

1. Complete the histogram using the information provided in the table.
2. Which type of information provided is a "mean" and why is it useful? _____
3. What was the total amount paid out for Tropical Storm Tammy? _____
   Explain how you determined your answer. _____
4. Based on this information, would you expect that a tropical storm always results in fewer flood claims than a hurricane? _____ Why or why not? _____
5. You're the actuary: How would you advise an insurance company about what they should expect to pay during a Category 3 hurricane if they're expecting to have claims on 200,000 policies?
   (Hint: Using the information from the table above, come up with an average claim amount and estimate. Show your work on the back of this page.)

_____

ACTIVITY 3:

Tune In to Insurance

Reproducible

NAME: _____ DATE: _____

You are the owner of Cyclone Secondhand Music and Movies, located in an area that has experienced a number of damaging tornadoes in the last ten years. It's time to buy insurance. You rent your space but own everything in it. The expectation of a tornado will affect the choices you make about insurance. Think like an actuary: Think about the value of your property—costs of inventory, electronic equipment, and office supplies.

Work the Math:

1. What would be the cost to replace everything in your store? Work with your group to find an *estimated* total value. Keep in mind:

- You buy used CDs for about $2 to $6, and used DVDs for $4 to $8. You usually have 10,000 items in stock.
- Besides the CDs and DVDs, what else needs replacing? (Imagine walking into a music store. What do you see around you?)

_____

_____

- What is your estimate? (Visit an office supply store online or look in a catalog for ideas of prices.)

_____

2. For $400 per year, you can buy $200,000 of basic coverage for fire and theft. For an additional $400 per year, you can get $200,000 in tornado coverage. Remember that if your store is damaged, you will not automatically get $200,000 but what it will cost to replace the damaged items *up* to $200,000.

- How much would basic and tornado coverage cost for 10 years?

  _____

- How much would you save over 10 years if you had basic only? _____
- How much would you lose if you had one tornado and weren't covered? _____
  What if there were more than one tornado? _____

3. Does the benefit of having tornado insurance outweigh the cost? _____

Explain your answer.

_____

_____

ACTIVITY 4:

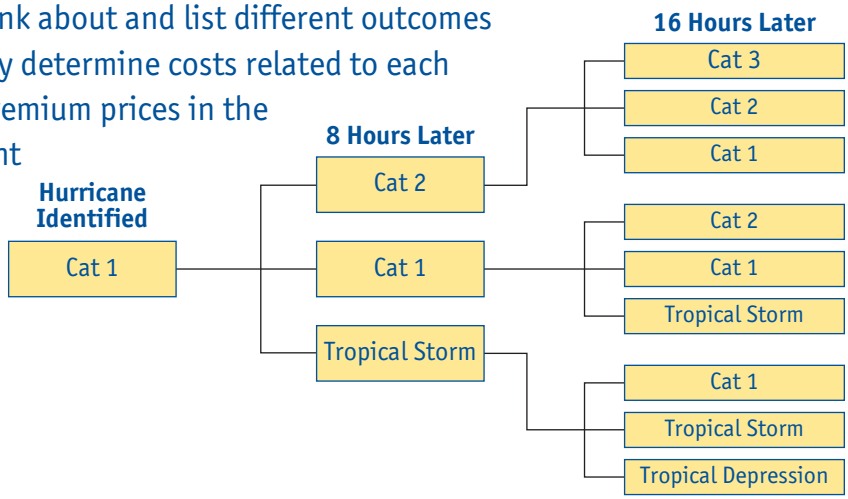
Reproducible

Branching Out with Tree Diagrams

NAME: _____ DATE: _____

Hurricanes are measured based on wind speed and storm surge. The Saffir-Simpson Hurricane Scale ranks categories of hurricanes from Category 1, weakest, to Category 5, strongest. A tropical storm is weaker than a Category 1, but stronger than a tropical depression. It takes more than eight hours for most hurricanes to change in intensity.

Property and casualty actuaries think about and list different outcomes caused by natural events. Then they determine costs related to each outcome. These costs may affect premium prices in the future. The tree diagram to the right shows some of the possible outcomes of a Category 1 hurricane over time. Study the tree diagram carefully and then answer the questions.



Work the Math:

1. List the possible events that could happen 8 hours after a hurricane has been identified.

_____

2. What is the probability that this hurricane is a Category 1 after 16 hours? Write your answer as a fraction and a percentage. _____

3. What is the probability that this hurricane remains a Category 1 for the entire time? Write your answer as a fraction and a percentage. _____

4. What is the probability that this hurricane is a Category 2 after 16 hours? Write your answer as a fraction and a percentage. _____

5. After 16 hours, is it more likely that the hurricane will be a Category 1 or a Category 3? Explain your answer using fractions and a percentages.

_____

6. If flooding is possible in any of these scenarios, would a storm and a flood be mutually exclusive events? _____

NCTM Standards Met by This Program

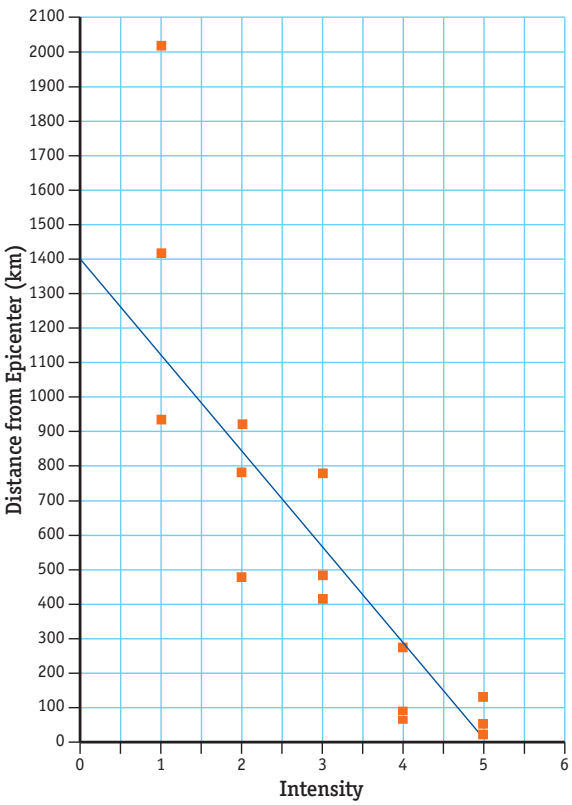
www.nctm.org/standards

	LESSON 1	LESSON 2	LESSON 3	LESSON 4
Data Analysis and Probability	✔	✔		✔
Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them	✔			
Select and use appropriate statistical methods to analyze data	✔	✔		
Develop and evaluate inferences and predictions that are based on data	✔	✔		
Understand and apply basic concepts of probability				✔
Algebra	✔	✔		
Understand patterns, relations, and functions	✔	✔		
Analyze change in various contexts	✔			
Number and Operations		✔	✔	✔
Understand numbers, ways of representing numbers, relationships among numbers, and number systems			✔	✔
Compute fluently and make reasonable estimates		✔	✔	✔
Problem Solving	✔	✔	✔	✔
Reasoning and Proof	✔	✔	✔	✔
Communication	✔	✔	✔	✔
Connections	✔	✔	✔	✔
Representation	✔	✔	✔	✔

Answer Key to Reproducible Activities:

Activity 1, Shake It Up with Scatterplots

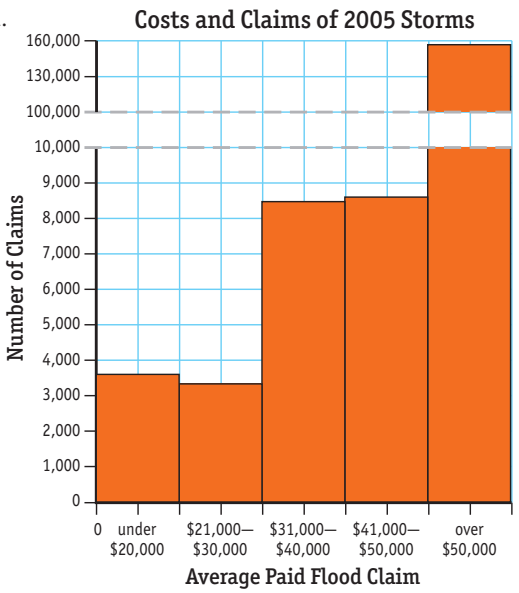
1 & 2. Answers will vary slightly. However, be sure the students draw a straight line that is as close as possible to the majority of the points.



3. Overall, there is a strong relationship between the distance from the epicenter and the intensity of the earthquake. In this particular case, the closer a town is to the epicenter, the stronger the intensity of the earthquake there. However, there are points that don't adhere to this relationship; some points are farther away from the regression line. Ask your students to identify them. 4. It would likely cost more because the high frequency of earthquakes makes it more likely that an insurance company would have to cover damages.

Activity 2, Histograms Manage a Flood of Data

1.



2. The "average paid claim." The mean, the average, is useful, because it is the most common measure for describing data. Looking at the histogram, students can see that the average amount of submitted claims range from $31,000 to over $50,000 in 2005. 3. $36,766,800. Students should multiply the average paid claim by the number of claims. 4. No. Tropical Storm Tammy resulted in more claims than Hurricane Dennis. 5. Answers will vary slightly. To find the average paid claim, use a calculator that goes to 12 places. Multiply the number of claims by the average paid claim for each hurricane [3,332 x $26,687 = $88,921,084; 158,786 x $94,750 = $15,044,973,500; 8,602 x $46,089 = $396,457,578; 8,474 x $36,126 = $306,131,724; total amount paid in dollars = $15,836,483,886]. Divide the total amount by total number of claims [$15,836,483,886 ÷ 179,194 = $88,376 average paid claim]. Multiply the average paid claim by 200,000 claims [$88,376 x 200,000 = $17,675,200,000].

Activity 3, Tune In to Insurance

1. Answers will vary. What to look for: Students should show all work and estimates. In addition to the costs of the CDs and DVDs themselves, a comprehensive list of goods to be replaced beyond inventory is important. Students should think about things like desks, chairs, computers, file cabinets, etc. 2. Basic and tornado coverage for 10 years is $8,000. You would save $4,000 over 10 years if you bought basic only. Answers will vary, but have students refer to their total estimate, which is the amount they would lose without coverage. For more than one tornado, students should multiply their estimate by 2, 3, etc. Encourage students to think about how they would pay for the damage. 3. Answers will vary.

Activity 4, Branching Out with Tree Diagrams

1. After 8 hours, a hurricane can stay the same, increase intensity, or decrease intensity. 2. 3/9 (or 1/3) or 33%. 3. 1/9, or 11%. 4. 2/9, or 22%. 5. A Category 1 is more likely. The probability of a Category 1 is 3/9, or 33%, while the probability of a Category 3 is 1/9, or 11%. 6. No, mutually exclusive events cannot happen together.