## Using Functions in Models and Decision Making: Step and Piecewise Functions
V.C Student Activity Sheet 8: Introducing Step and Piecewise Functions

Texas experiences a wide variety of weather, including hurricanes. Coastal residents often feel the direct effects of hurricanes when they make landfall along the coast. Cities and towns that are directly hit by a hurricane can sometimes take years to rebuild. Galveston is one such city.
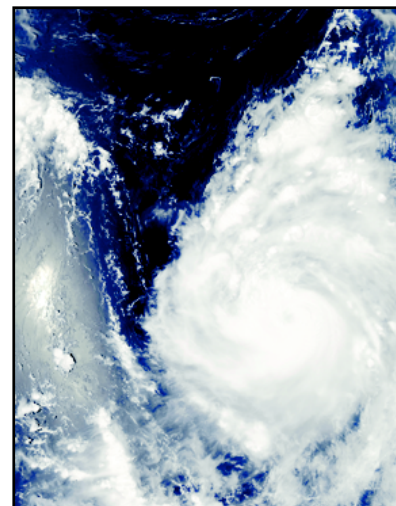
Galveston was almost completely destroyed by the storm that hit in 1900, the deadliest hurricane in U.S. history. Rebuilding after the storm took several years, partly because residents raised the elevation of the entire city and built the Galveston Seawall to protect the city. Other towns were not so resilient. In 1886, residents of Indianola completely abandoned the ruins of their town on the shores of Matagorda Bay after it was wiped away by a strong hurricane.

Meteorologists use the Saffir-Simpson scale to describe the strength of a hurricane. This scale is based on a combination of wind speed and barometric pressure. The faster the wind speed and the lower the barometric pressure, the higher the rating of the hurricane on the Saffir-Simpson scale.

Saffir-Simpson Scale

Category	Wind Speed (miles per hour)
1	74-95
2	96-110
3	111-130
4	131-155
5	156 and above

Many hurricanes have struck the Texas coast, but there have been no recorded Category 5 hurricanes, which are the strongest, most destructive storms. Although many Caribbean and Central American nations have been pounded by Category 5 hurricanes, the United States has been hit by only three: the 1935 Labor Day Hurricane, which struck the Florida keys; Hurricane Camille, which struck Pass Christian, Mississippi, in 1969; and Hurricane Andrew, which struck near Homestead, Florida, in 1992.

Charles A. Dana Center at The University of Texas at Austin   Advanced Mathematical Decision Making (2010)
Activity Sheet 8, 6 pages

32

Using Functions in Models and Decision Making: Step and Piecewise Functions

V.C Student Activity Sheet 8: Introducing Step and Piecewise Functions

The following table shows the year, wind speed, and Saffir-Simpson category for some hurricanes that have made landfall on the Texas coast. This table also includes the Category 5 storms that have hit the United States.

Texas Hurricanes

Hurricane	Year	Wind Speed (miles per hour)	Category
Indianola Storm	1886	155	4
Galveston Storm	1900	125	3
Brownsville Storm	1933	100	2
Labor Day Storm*	1935	161	5
Audrey	1957	100	2
Debra	1959	105	2
Carla	1961	150	4
Beulah	1967	140	4
Camille*	1969	190	5
Celia	1970	130	3
Allen	1980	115	3
Alicia	1983	115	3
Bonnie	1986	86	1
Andrew*	1992	167	5
Bret	1999	115	3
Claudette	2003	90	1
Rita	2005	115	3
Dolly	2008	86	1
Ike	2008	110	2

*Storm did not make landfall in Texas.
Source: National Hurricane Center

Charles A. Dana Center at The University of Texas at Austin   Advanced Mathematical Decision Making (2010)
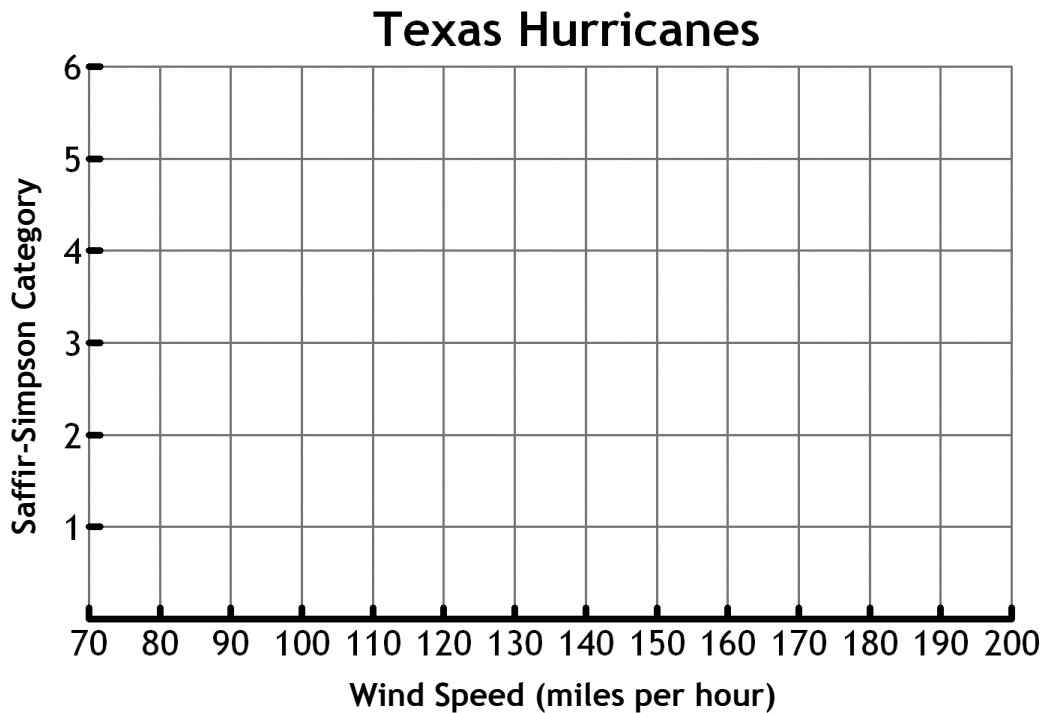   Activity Sheet 8, 6 pages

33

Using Functions in Models and Decision Making: Step and Piecewise Functions

V.C Student Activity Sheet 8: Introducing Step and Piecewise Functions

1. Write a dependency statement that describes the relationship between the two variables, wind speed and Saffir-Simpson category.

2. Make a scatterplot of the Saffir-Simpson category versus wind speed for the hurricanes listed in the table.

Texas Hurricanes

Saffir-Simpson Category (y-axis, 1 to 6)
Wind Speed (miles per hour) (x-axis, 70 to 200)

3. Now mark the wind speed endpoints for each Saffir-Simpson category on the scatterplot. Connect those endpoints with a line segment. For example, along the line for Category 1, mark the wind speeds 74 and 95 [that is, the points (74, 1) and (95, 1)] and then connect them with a line segment.

4. Is it possible for a hurricane to be rated between Category 1 and Category 2? Why or why not?

Using Functions in Models and Decision Making: Step and Piecewise Functions

V.C Student Activity Sheet 8: Introducing Step and Piecewise Functions

---

Hurricane wind speeds are difficult to measure precisely. Thus, most hurricane wind speeds are estimated to the nearest 5 miles per hour. Suppose a new technology were invented that allowed meteorologists to measure hurricane wind speeds very precisely.

5. If a hurricane had a wind speed of 95.1 miles per hour, what category would it be rated? How do you know?

6. Revise the Saffir-Simpson scale so that you can rate hurricanes with wind speeds that lie between the existing categories.

Revised Saffir-Simpson Scale

Category	Wind Speed (miles per hour)
1	
2	
3	
4	
5	

7. When graphing inequalities, how do you represent an endpoint that does not include *or equal to*?

8. Use a closed or open endpoint to revise your scatterplot for the new hurricane rating scale.

9. What kind of function does your new scatterplot represent?

Charles A. Dana Center at The University of Texas at Austin   Advanced Mathematical Decision Making (2010)
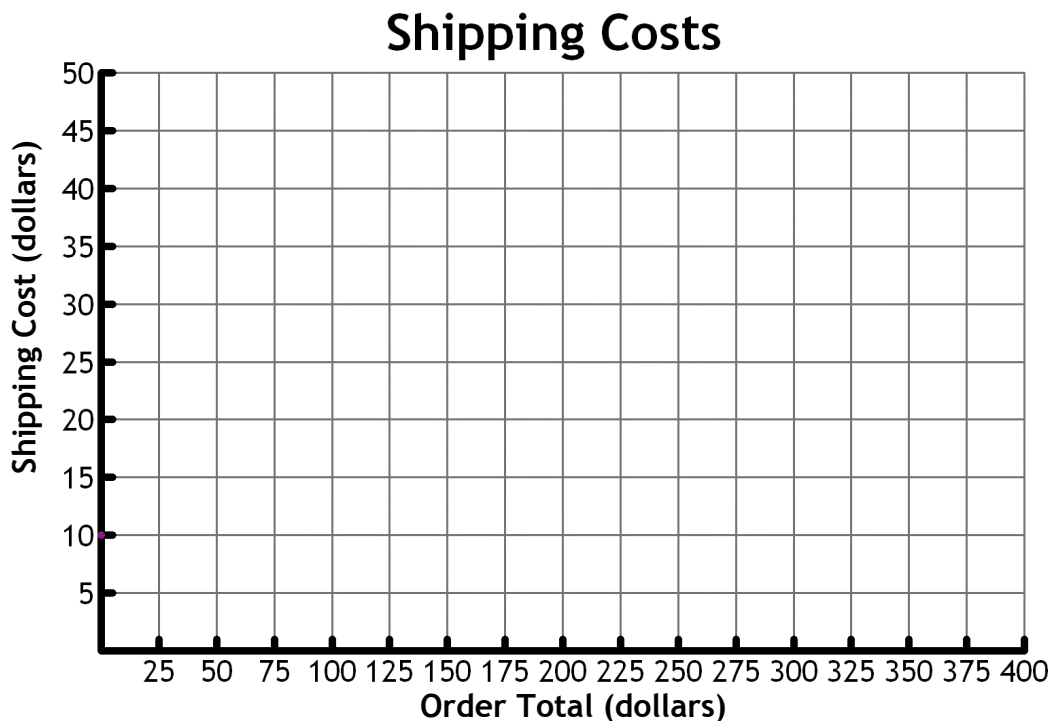Activity Sheet 8, 6 pages

35

Using Functions in Models and Decision Making: Step and Piecewise Functions
V.C Student Activity Sheet 8: Introducing Step and Piecewise Functions

An online store uses a step function to determine shipping costs.

Order Total	Shipping Costs	
	Continental United States	Europe
Less than $25.00	$5.00	
$25.00-$74.99	$10.00	
$75.00-$124.99	$15.00	
$125.00-$349.99	$20.00	
$350.00 and greater	$25.00	

10. Use a colored pencil to make a graph of shipping costs versus the order total.

Shipping Costs

Using Functions in Models and Decision Making: Step and Piecewise Functions
V.C Student Activity Sheet 8: Introducing Step and Piecewise Functions

11. For orders shipped to Europe, the shipping cost for the United States is doubled. Fill in the table to show the shipping costs to Europe. Then use a different colored pencil to make a graph of the shipping costs to Europe versus the order total.

12. How do the two graphs compare?

13. **REFLECTION:** How do step functions compare to linear functions?

14. **REFLECTION:** How is multiplying a step function by a constant multiplier similar to multiplying the slope of a linear function by a constant multiplier?

15. **EXTENSION:** What other situations can be modeled using a step function? Use the Internet to collect data and generate a graph of a situation. How does your graph compare to those in this activity?