Math101

Group Work on The Coordinate System and Equations of Lines: Hurricane Season.

Hurricanes are powerful storms blowing across oceans, and from oceans to shores, and leaving wreckage and devastation in their wake. The National Hurricane Center (NHC) in Miami, Florida is involved in tracking the path of each hurricane, assessing its intensity, issuing warning advisories, keeping archives of past and present hurricane-related data, and conducting research in an attempt to minimize damages. They have a fascinating web site: http://www.nhc.noaa.gov , which is the source of all the hurricane data provided in this group work. If you visit the NHC web site you will notice that mathematics plays a crucial role in all NHC reports of past and present hurricanes. We will explore some of these mathematical aspects in the following exercises.

1. Tracking Andrew. You are a meteorologist working at NHC, and are involved in tracking the path and determining the intensity of hurricane Andrew. Hurricane position information is issued every 6 hours. The table below lists Andrew's positions and wind intensity (in knots) for four days. The positions are given in latitude (vertical scale on the hurricane tracking chart), and longitude (horizontal scale on the hurricane tracking chart).

Date	Time	Latitude (○N)	Longitude (○W)	Wind Speed (kt per hr)
8/23	6:00 am	25.6	72.5	105
	12:00 pm	25.4	74.2	120
	6:00 pm	25.4	75.8	135
8/24	12:00 am	25.4	77.5	125
	6:00 am	25.4	79.3	120
	12:00 pm	25.6	81.2	110
	6:00 pm	25.8	83.1	115
8/25	12:00 am	26.2	85	115
	6:00 am	26.6	86.7	115
	12:00 pm	27.2	88.2	115
	6:00 pm	27.8	89.6	120
8/26	12:00 am	28.5	90.5	120
	6:00 am	29.2	91.3	115

a. Plot the positions of hurricane Andrew on the attached tracking chart. Which parts of the United States are affected, or are likely to be affected in the next few days, by Andrew?

b. On a separate sheet of graph paper construct a coordinate system. The x axis represents the hours in the four tracking days, 8/23- 8/26. You may place measuring ticks on the x axis only every six hours. The y axis represents the wind speed in knots. You may place measuring ticks on the y axis only every 5 units. Plot the ordered pairs (hour in the tracking date, wind speed at that time). Connect the plotted dots with line segments. The resulting curve is called the **Wind Speed Curve** of the hurricane.

c. Which wind speed corresponds to the highest peek in the Wind Speed Curve of Andrew? At what hour of which date is this speed obtained? The highest wind speed value of a hurricane is one of the decisive factors in determining the hurricane's category. What is the most likely category of hurricane Andrew ? (Consult the attached Saffir-Simpson Hurricane Scale.)

d. Observe the wind pattern of Andrew as seen in its Wind Speed Curve. What will be the likely category of Andrew when it blows on land for the second time on 8/26 or 8/27?

Hurricane Andrew struck Eastern US in 1992. Visit the NHC website (archives) to learn more about this unusually ferocious storm, and to verify if your answers and predictions are correct.

2. Assessing Damages. Hurricanes are responsible for floods, torrential rains, and wind inflicted damages on a gigantic scale. You work in the research division of NHC, and are exploring the relation between the wind speed of a hurricane and the financial damages inflicted by it. As a first step you are trying to determine if this relation is linear. That is, you are trying to find a line equation connecting the wind speed and the approximate damages. The following table provides (inflation adjusted) data on two past hurricanes:

Hurricane	Wind speed (in knots per hour)	Approximate Damages (in billions $)
Georges (1998)	89	2.49
Opal (1995)	113	3.52

a. Use ordered pairs of the form (Wind Speed, Approximate Damages) to find a line equation that fits the data in the table above. Write your answer in slope-intercept form.

y = ______________________________

b. Graph the line on a separate sheet of graph paper. Label the axes. Discuss the meaning of the slope and y-intercept in the context of this problem.

The slope of the line is _______, which means that......

The y intercept of the line is _____.
What would you have expected the value for the y-intercept to be? _____. Why?

What is, in your opinion, the reason for the unexpected value of y-intercept of this line?

c. Use the line equation you found in **a** to calculate the approximate damages done by a hurricane whose wind intensity reaches 135 knots per hour.

d. Compare your answer in **c** with the known fact that the damages inflicted by hurricane Andrew , the most expensive hurricane in US history, are estimated to be approximately 35 billion dollars. Does this, in your opinion, imply that the relation between the wind speed and the approximate damages of a hurricane is not linear? Explain your answer.

SAFFIR-SIMPSON HURRICANE SCALE

Tropical Storm
Winds 39-73 mph
Category 1 Hurricane — winds 74-95 mph (64-82 kt)
No real damage to buildings. Damage to unanchored mobile homes. Some damage to poorly constructed signs. Also, some coastal flooding and minor pier damage.
- Examples: Irene 1999 and Allison 1995

Category 2 Hurricane — winds 96-110 mph (83-95 kt)
Some damage to building roofs, doors and windows. Considerable damage to mobile homes. Flooding damages piers and small craft in unprotected moorings may break their moorings. Some trees blown down.
- Examples: Bonnie 1998, Georges(FL & LA) 1998 and Gloria 1985

Category 3 Hurricane — winds 111-130 mph (96-113 kt)
Some structural damage to small residences and utility buildings. Large trees blown down. Mobile homes and poorly built signs destroyed. Flooding near the coast destroys smaller structures with larger structures damaged by floating debris. Terrain may be flooded well inland.
- Examples: Keith 2000, Fran 1996, Opal 1995, Alicia 1983 and Betsy 1965

Category 4 Hurricane — winds 131-155 mph (114-135 kt)
More extensive curtainwall failures with some complete roof structure failure on small residences. Major erosion of beach areas. Terrain may be flooded well inland.
- Examples: Hugo 1989 and Donna 1960

Category 5 Hurricane — winds 156 mph and up (135+ kt)
Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. Flooding causes major damage to lower floors of all structures near the shoreline. Massive evacuation of residential areas may be required.
- Examples: Andrew(FL) 1992, Camille 1969 and Labor Day 1935