



## “FRAPPY” {Free Response AP Problem...Yay!}

The following problem is taken from an actual Advanced Placement Statistics Examination. Your task is to generate a complete, concise statistical response in 25 minutes. You will be graded based on the AP rubric and will earn a score of 0-4. After grading, keep this problem in your binder for your AP Exam preparation.

Hurricane damage amounts, in millions of dollars per acre, were estimated from insurance records for major hurricanes for the past three decades. A stratified random sample of five locations (based on categories of distance from the coast) was selected from each of three coastal regions in the southeastern United States. The three regions were Gulf Coast (Alabama, Louisiana, Mississippi), Florida, and Lower Atlantic (Georgia, South Carolina, North Carolina). Damage amounts in million of dollars per acre, adjusted for inflation, are shown in the table below.

HURRICANE DAMAGE AMOUNTS IN MILLIONS OF  
DOLLARS PER ACRE

	Distance from Coast				
	< 1 mile	1 to 2 miles	2 to 5 miles	5 to 10 miles	10 to 20 miles
Gulf Coast	24.7	21.0	12.0	7.3	1.7
Florida	35.1	31.7	20.7	6.4	3.0
Lower Atlantic	21.8	15.7	12.6	1.2	0.3

### Scoring:

- (a) Sketch a graphical display that compares the hurricane damage amounts per acre for the three different coastal regions (Gulf Coast, Florida, and Lower Atlantic) and that also shows how the damage amounts vary with distance from the coast.

(b) Describe differences and similarities in the hurricane damage amounts among the three regions.

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Because the distributions of hurricane damage amounts are often skewed, statisticians frequently use rank values to analyze such data.

(c) In the table below, the hurricane damage amounts have been replaced by the ranks 1, 2, or 3. For each of the distance categories, the highest damage amount is assigned a rank of 1 and the lowest damage amount is assigned a rank of 3. Determine the missing ranks for the 10-to-20 miles distance category and calculate the average rank for each of the three regions. Place the values in the table below.

ASSIGNED RANKS WITHIN DISTANCE CATEGORIES

	Distance from Coast					Average Rank
	< 1 mile	1 to 2 miles	2 to 5 miles	5 to 10 miles	10 to 20 miles	
Gulf Coast	2	2	3	1		
Florida	1	1	1	2		
Lower Atlantic	3	3	2	3		

(d) Consider testing the following hypotheses.

$H_0$ : There is no difference in the distributions of hurricane damage amounts among the three regions.

$H_A$ : There is a difference in the distributions of hurricane damage amounts among the three regions.

If there is no difference in the distribution of hurricane damage amounts among the three regions (Gulf Coast, Florida, and Lower Atlantic), the expected value of the average rank for each of the three regions is 2. Therefore, the following test statistic can be used to evaluate the hypotheses above:

$$Q = 5 \left[ \left( \bar{R}_G - 2 \right)^2 + \left( \bar{R}_F - 2 \right)^2 + \left( \bar{R}_A - 2 \right)^2 \right]$$

where  $\bar{R}_G$  is the average rank over the five distance categories for the Gulf Coast (and  $\bar{R}_F$  and  $\bar{R}_A$  are similarly defined for the Florida and Lower Atlantic coastal regions).

Calculate the value of the test statistic  $Q$  using the average ranks you obtained in part (c).

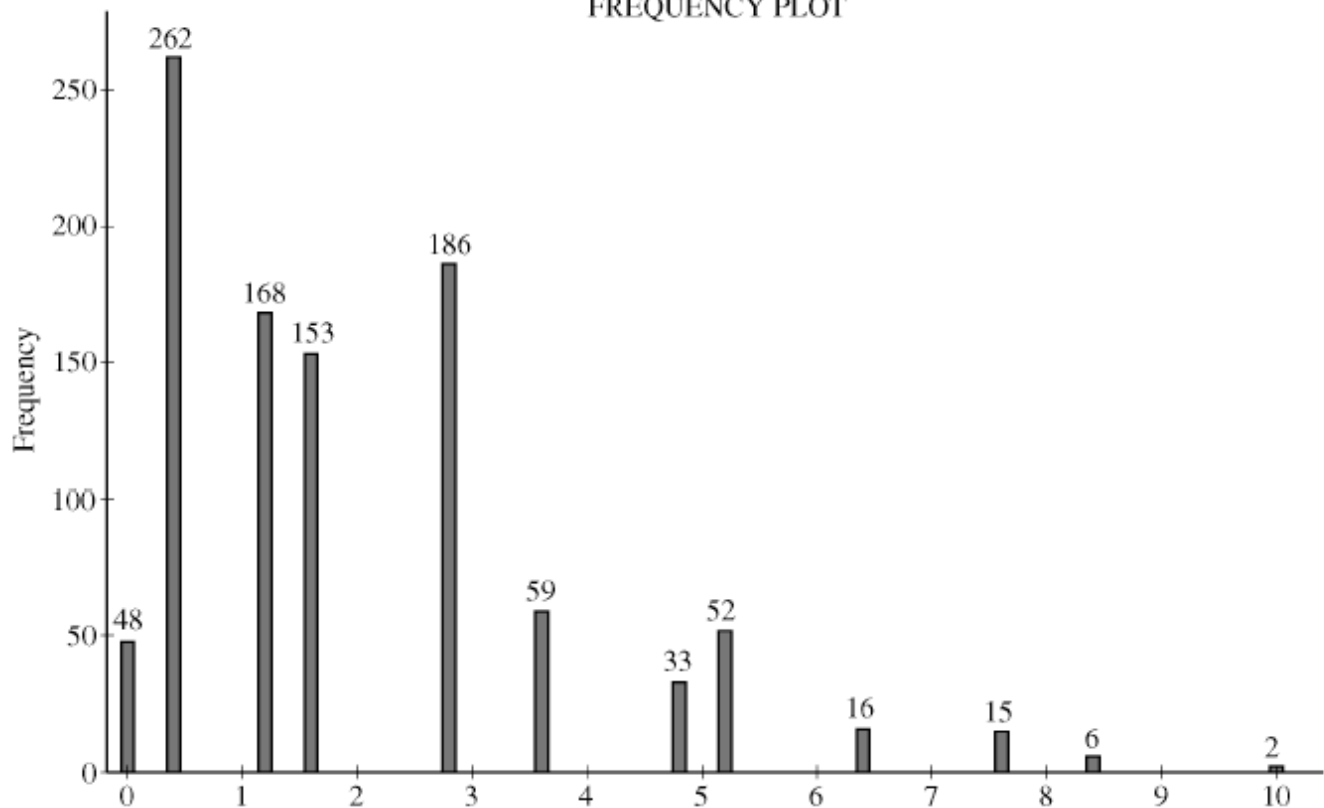
## E P I

(e) One thousand simulated values of this test statistic,  $Q$ , were calculated, assuming no difference in the distributions of hurricane damage amounts among the three coastal regions. The results are shown in the table on the following page. These data are also shown in a frequency plot where the heights of the lines represent the frequency of occurrence of simulated values of  $Q$ .

Frequency Table for Simulated Values of Q

Q	Frequency	Cumulative Frequency	Percent	Cumulative Percent
0.0	48	48	4.80	4.80
0.4	262	310	26.20	31.00
1.2	168	478	16.80	47.80
1.6	153	631	15.30	63.10
2.8	186	817	18.60	81.70
3.6	59	876	5.90	87.60
4.8	33	909	3.30	90.90
5.2	52	961	5.20	96.10
6.4	16	977	1.60	97.70
7.6	15	992	1.50	99.20
8.4	6	998	0.60	99.80
10.0	2	1000	0.20	100.00

FREQUENCY PLOT



Use these simulated values and the test statistic you calculated in part (d) to determine if the observed data provide evidence of a significant difference in the distributions of hurricane damage amounts among the three coastal regions. Explain.

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**Total: \_\_/4**