

**2013 AP<sup>®</sup> STATISTICS FREE-RESPONSE QUESTIONS**

**STATISTICS**

**SECTION II**

**Part B**

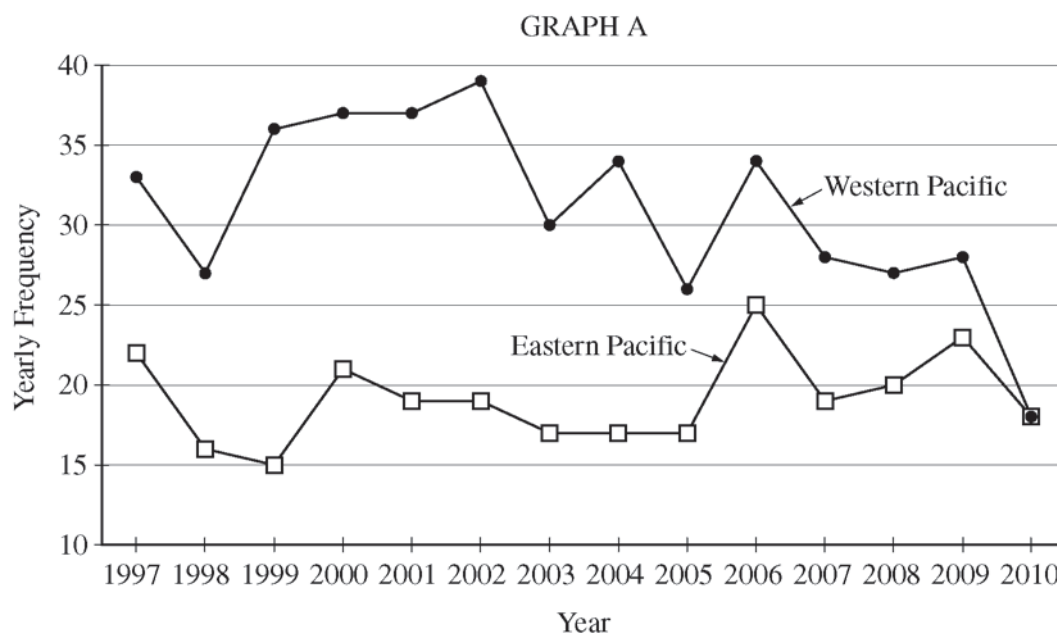
**Question 6**

**Spend about 25 minutes on this part of the exam.**

**Percent of Section II score—25**

**Directions:** Show all your work. Indicate clearly the methods you use, because you will be scored on the correctness of your methods as well as on the accuracy and completeness of your results and explanations.

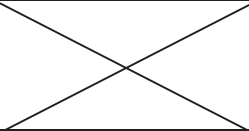
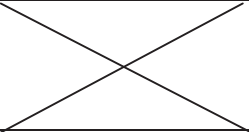
6. Tropical storms in the Pacific Ocean with sustained winds that exceed 74 miles per hour are called typhoons. Graph A below displays the number of recorded typhoons in two regions of the Pacific Ocean—the Eastern Pacific and the Western Pacific—for the years from 1997 to 2010.



- (a) Compare the distributions of yearly frequencies of typhoons for the two regions of the Pacific Ocean for the years from 1997 to 2010.
- (b) For each region, describe how the yearly frequencies changed over the time period from 1997 to 2010.

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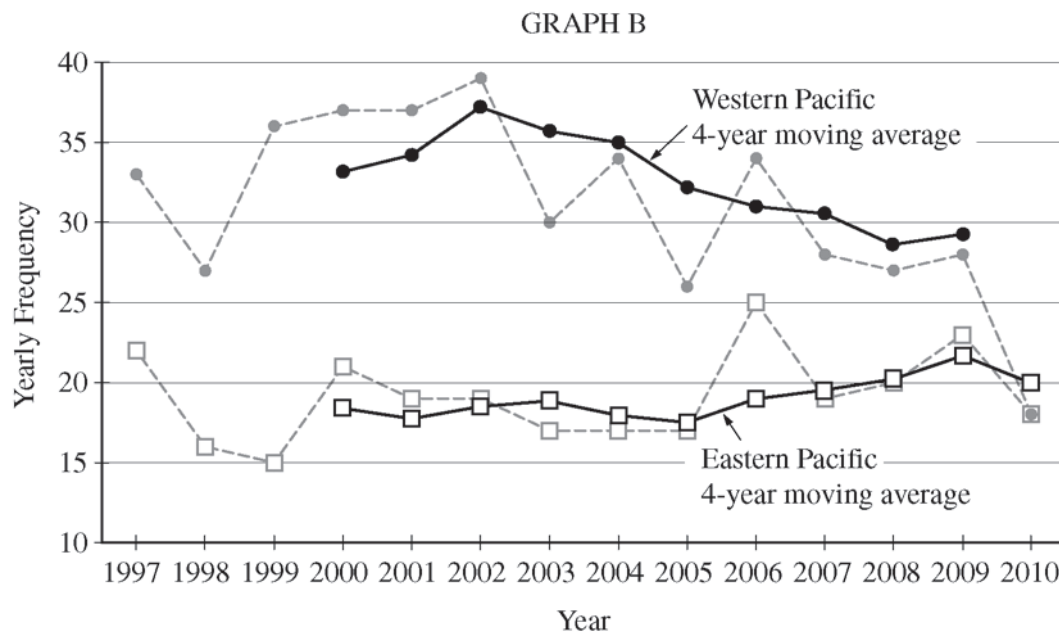
A moving average for data collected at regular time increments is the average of data values for two or more consecutive increments. The 4-year moving averages for the typhoon data are provided in the table below. For example, the Eastern Pacific 4-year moving average for 2000 is the average of 22, 16, 15, and 21, which is equal to 18.50.

Year	Number of Typhoons in the Eastern Pacific	Eastern Pacific 4-year moving average	Number of Typhoons in the Western Pacific	Western Pacific 4-year moving average
1997	22		33	
1998	16		27	
1999	15		36	
2000	21	18.50	37	33.25
2001	19	17.75	37	34.25
2002	19	18.50	39	37.25
2003	17	19.00	30	35.75
2004	17	18.00	34	35.00
2005	17	17.50	26	32.25
2006	25	19.00	34	31.00
2007	19	19.50	28	30.50
2008	20	20.25	27	28.75
2009	23	21.75	28	29.25
2010	18	20.00	18	

- (c) Show how to calculate the 4-year moving average for the year 2010 in the Western Pacific. Write your value in the appropriate place in the table.

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- (d) Graph B below shows both yearly frequencies (connected by dashed lines) and the respective 4-year moving averages (connected by solid lines). Use your answer in part (c) to complete the graph.



- (e) Consider graph B.
- What information is more apparent from the plots of the 4-year moving averages than from the plots of the yearly frequencies of typhoons?
  - What information is less apparent from the plots of the 4-year moving averages than from the plots of the yearly frequencies of typhoons?

**STOP**

**END OF EXAM**

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### Question 6

#### Intent of Question

The primary goals of this question were to assess a student's ability to (1) summarize information provided in a time plot that involves trend components; (2) perform calculations related to a summary statistic not previously studied; and (3) compare and contrast information conveyed by the summary statistics with the data.

#### Solution

##### **Part (a):**

The Western Pacific Ocean had more typhoons than the Eastern Pacific Ocean in all but one of these years. The average seems to have been about 31 typhoons per year in the Western Pacific Ocean, which is higher than the average of about 19 typhoons per year in the Eastern Pacific Ocean. The Western Pacific Ocean also saw more variability (in number of typhoons per year) than the Eastern Pacific Ocean; for example, the range of the frequencies for the Western Pacific is about 21 typhoons and only 10 typhoons for the Eastern Pacific.

##### **Part (b):**

The Western Pacific Ocean had a decreasing trend in number of typhoons per year over this time period, especially from about 2001 through 2010. In contrast, the Eastern Pacific Ocean was fairly consistent in the number of typhoons per year over this time period, with a slight increasing trend in the later years from 2005 through 2010.

##### **Part (c):**

The four-year moving average for the year 2010 in the Western Pacific Ocean is

$$\frac{28 + 27 + 28 + 18}{4} = 25.25.$$

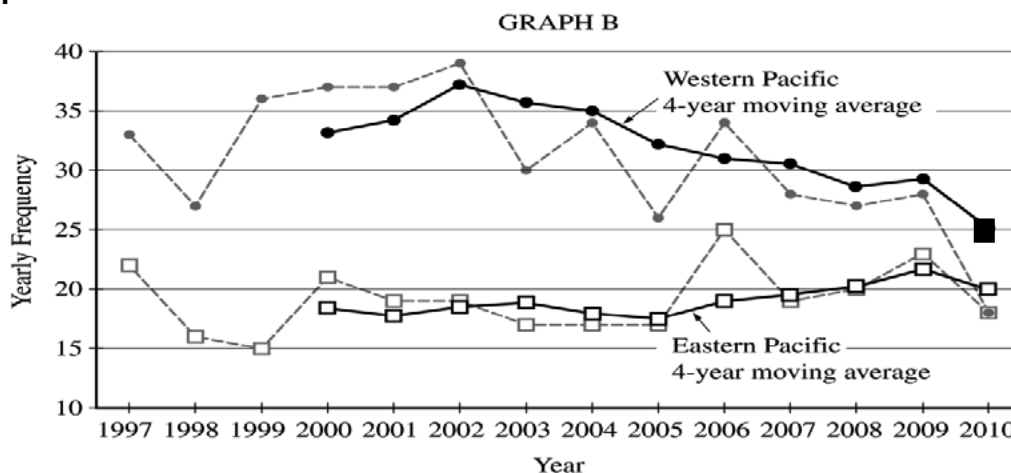
The value is written in the table as follows.

⋮	⋮	⋮	⋮	⋮
2008	20	20.25	27	28.75
2009	23	21.75	28	29.25
2010	18	20.00	18	<b>25.25</b>

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## Question 6 (continued)

Part (d):



Part (e):

- (i) The overall trends across this time period were more apparent with the moving averages than with the original frequencies. The moving averages reduce variability, making more apparent the overall decreasing trend in number of typhoons in the Western Pacific Ocean and the slight increasing trend in the number of typhoons in the Eastern Pacific Ocean.
- (ii) The year-to-year variability in number of typhoons is less apparent with the moving averages than with the original frequencies.

### Scoring

This question is scored in four sections: Section 1 consists of part (a); section 2 consists of part (b); section 3 consists of parts (c) and (d); and section 4 consists of part (e). Each of the four sections is scored as essentially correct (E), partially correct (P), or incorrect (I).

**Section 1** is scored as follows:

Essentially correct (E) if the response correctly includes the following three components:

1. A comparison of the center or location of the two distributions of frequencies.
2. A comparison of the variability of the two distributions of frequencies.
3. Comments in context.

Partially correct (P) if the response correctly includes two of the three components listed above.

Incorrect (I) if the response does not meet the criteria for E or P.

*Notes:*

- Comparison of frequencies for just a few years of the two regions is not a comparison of the distributions of the frequencies of the two regions.
- Comparisons of the two endpoints in the 1997 and 2010 for both regions were not sufficient for component 2.

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### Question 6 (continued)

*Notes:*

- In completing the graph, it is not necessary to draw the line connecting the calculated moving average in part (c) for 2010 to the moving average value for 2009.
- An incorrect value in part (c) can be used to obtain component 3 or component 4.
- An appropriately placed value on the graph for component 4 requires the placement on the graph close to 2010 and at or slightly above the 25 yearly frequency line.
- The severity of the mistakes resulting in a partially correct response can be used in holistic scoring for this question.

**Section 4** is scored as follows:

Essentially correct (E) if the response includes the following three components:

1. Correctly mentions overall trend in regards to the moving averages graph in at least one region.
2. Correctly identifies some characteristic of the data that is less apparent by not having individual frequencies of the typhoons.
3. Correctly links at least one of the previous two components to the time plot in this specific question.

Partially correct (P) if the response has exactly two of the three components.

Incorrect (I) if the response does not meet the criteria for E or P.

*Notes:*

- Stating that the frequencies were not determinable from the graph of moving averages is not sufficient for describing a less apparent characteristic of the data.
- If the response in part (e) can be applied to *any* plot of 4-year moving averages, then component 3 (linkage to the time plot in this specific question) is not achieved.
- Because moving averages decrease variability, which may make identifying trends easier, clear communication (for example identifying direction of the trend) in describing the trend or the decreased variability for these data can be used for the holistic scoring of this question.

Each essentially correct (E) section counts as 1 point, and a partially correct (P) section counts as  $\frac{1}{2}$  point.

- |          |                             |
|----------|-----------------------------|
| <b>4</b> | <b>Complete Response</b>    |
| <b>3</b> | <b>Substantial Response</b> |
| <b>2</b> | <b>Developing Response</b>  |
| <b>1</b> | <b>Minimal Response</b>     |

If a response is between two scores (for example,  $2\frac{1}{2}$  points), use a holistic approach to determine whether to score up or down, depending on the overall strength of the response and communication. See notes following sections 2, 3, and 4 for additional guidance in holistic scoring of this question.