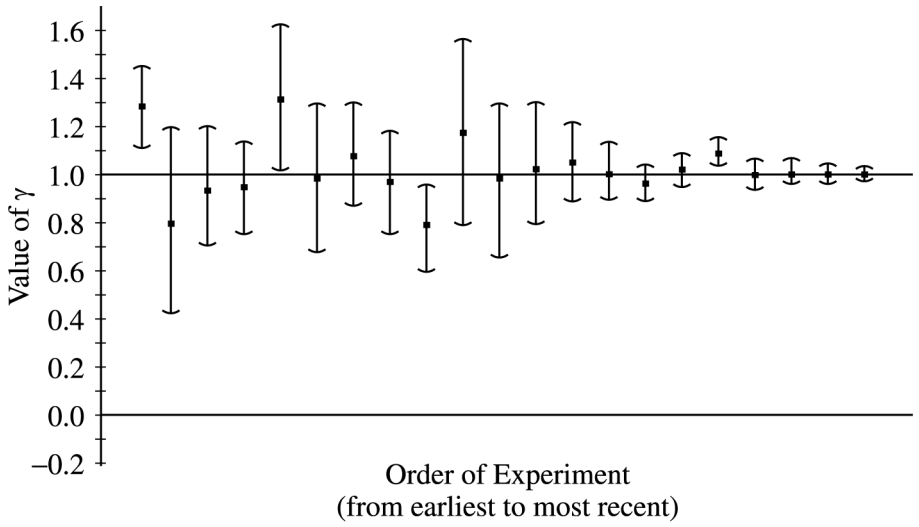
STATISTICS
SECTION II
Part A
Questions 1-5
Spend about 65 minutes on this part of the exam.
Percent of Section II grade—75

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

1. In 1915 Einstein's theory predicted that the curvature of space, denoted by γ, was 1, while Newtonian theory predicted it was 0. Since 1915 scientists have repeatedly found estimates of γ using various methods and procedures. Each estimate has a margin of error. The figure below displays

   (estimate $\pm$ margin of error)

   from each of 21 experiments.



   (a) Based on the display on page 6, describe how the precision of the estimates of γ has changed over time.

   (b) Write a few sentences describing the strength of evidence the experiments provide for the claim from Newtonian theory that $\gamma = 0$. Your response must include justification based on the display.

   (c) Write a few sentences describing the strength of evidence the experiments provide for the claim from Einstein's theory that $\gamma = 1$. Your response must include justification based on the display.

GO ON TO THE NEXT PAGE.

2. A manufacturer of boots plans to conduct an experiment to compare a new method of waterproofing to the current method. The appearance of the boots is not changed by either method. The company recruits 100 volunteers in Seattle, where it rains frequently, to wear the boots as they normally would for 6 months. At the end of the 6 months, the boots will be returned to the company to be evaluated for water damage.

   (a) Describe a design for this experiment that uses the 100 volunteers. Include a few sentences on how it would be implemented.

   (b) Could your design be double blind? Explain.

3. There are 4 runners on the New High School team. The team is planning to participate in a race in which each runner runs a mile. The team time is the sum of the individual times for the 4 runners. Assume that the individual times of the 4 runners are all independent of each other. The individual times, in minutes, of the runners in similar races are approximately normally distributed with the following means and standard deviations.

	Mean	Standard Deviation
Runner 1	4.9	0.15
Runner 2	4.7	0.16
Runner 3	4.5	0.14
Runner 4	4.8	0.15

   (a) Runner 3 thinks that he can run a mile in less than 4.2 minutes in the next race. Is this likely to happen? Explain.

   (b) The distribution of possible team times is approximately normal. What are the mean and standard deviation of this distribution?

   (c) Suppose the team's best time to date is 18.4 minutes. What is the probability that the team will beat its own best time in the next race?

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Question 1

Solution

Part (a):

The precision of the estimates of γ has gotten better over time. This is indicated by the fact that the intervals

$$\text{value} \pm (\text{margin of error})$$

shown in the figure become narrower over time, indicating that the margin of error is getting smaller.

Part (b):

The value of $\gamma = 0$ is not included in any of the 21 intervals. This indicates that 0 is not a plausible value for γ. There is no support for Newton's theory.

Part (c):

The support for Einstein's theory that $\gamma = 1$ is quite strong. Most of the intervals contain the value 1, and the more recent intervals, where the precision is greater, suggest that the value of γ is at least very close to 1.

Scoring

Part (a) is scored as incorrect (I), partially correct (P), or essentially correct (E). The response is essentially correct if the student indicates that precision is increasing. (If the student also explains how he or she can tell this from the figure, this is a plus.)

If the student incorrectly says that precision is decreasing, but gives a good explanation that is tied to the figure, the response is scored as partially correct.

Part (b) is scored as incorrect (I), partially correct (P), or essentially correct (E). To be scored as essentially correct, the response must say that there is no (or very weak) support *and* give a valid reason for this conclusion based on the intervals in the figure.

If the student states only that there is no (or weak) support, but does not say how this follows from the intervals in the figure, the response is scored as partially correct.

Part (c) is scored as incorrect (I), partially correct (P), or essentially correct (E). To be scored as essentially correct, the response must say that there is strong support *and* give a valid reason for this conclusion based on the intervals in the figure.

If the student states only that there is strong support, but does not say how this follows from the intervals in the figure, the response is scored as partially correct.