



AP[®] Statistics (Operational) 2004 Sample Student Responses

The materials included in these files are intended for noncommercial use by AP teachers for course and exam preparation; permission for any other use must be sought from the Advanced Placement Program[®]. Teachers may reproduce them, in whole or in part, in limited quantities, for face-to-face teaching purposes but may not mass distribute the materials, electronically or otherwise. This permission does not apply to any third-party copyrights contained herein. These materials and any copies made of them may not be resold, and the copyright notices must be retained as they appear here.

The College Board is a not-for-profit membership association whose mission is to connect students to college success and opportunity. Founded in 1900, the association is composed of more than 4,500 schools, colleges, universities, and other educational organizations. Each year, the College Board serves over three million students and their parents, 23,000 high schools, and 3,500 colleges through major programs and services in college admissions, guidance, assessment, financial aid, enrollment, and teaching and learning. Among its best-known programs are the SAT[®], the PSAT/NMSQT[®], and the Advanced Placement Program[®] (AP[®]). The College Board is committed to the principles of excellence and equity, and that commitment is embodied in all of its programs, services, activities, and concerns.

For further information, visit www.collegeboard.com

Copyright © 2004 College Entrance Examination Board. All rights reserved. College Board, Advanced Placement Program, AP, AP Central, AP Vertical Teams, APCD, Pacesetter, Pre-AP, SAT, Student Search Service, and the acorn logo are registered trademarks of the College Entrance Examination Board. PSAT/NMSQT is a registered trademark of the College Entrance Examination Board and National Merit Scholarship Corporation. Educational Testing Service and ETS are registered trademarks of Educational Testing Service. Other products and services may be trademarks of their respective owners.

For the College Board's online home for AP professionals, visit AP Central at apcentral.collegeboard.com.

A,

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.

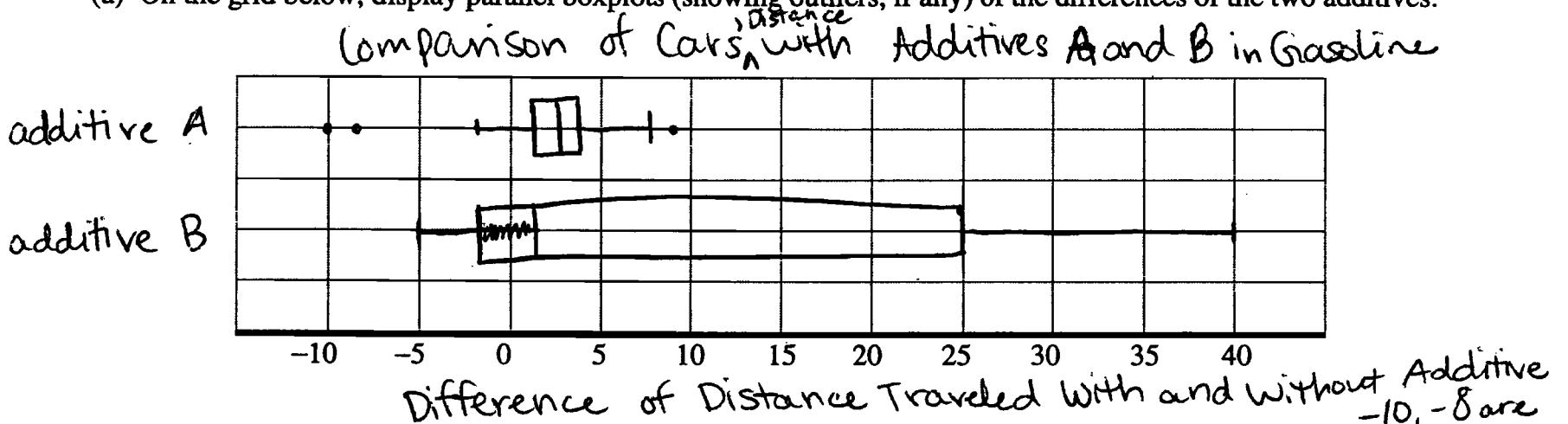
1. A consumer advocate conducted a test of two popular gasoline additives, A and B. There are claims that the use of either of these additives will increase gasoline mileage in cars. A random sample of 30 cars was selected. Each car was filled with gasoline and the cars were run under the same driving conditions until the gas tanks were empty. The distance traveled was recorded for each car.

Additive A was randomly assigned to 15 of the cars and additive B was randomly assigned to the other 15 cars. The gas tank of each car was filled with gasoline and the assigned additive. The cars were again run under the same driving conditions until the tanks were empty. The distance traveled was recorded and the difference in the distance with the additive minus the distance without the additive for each car was calculated.

The following table summarizes the calculated differences. Note that negative values indicate less distance was traveled with the additive than without the additive.

Additive	Values Below Q_1	Q_1	Median	Q_3	Values Above Q_3
A	-10, -8, -2	1	3	4	5, 7, 9
B	-5, -3, -3	-2	1	25	35, 37, 40

- (a) On the grid below, display parallel boxplots (showing outliers, if any) of the differences of the two additives.



A: $IQR = 4 - 1 = 3$ $1.5 IQR = 4.5$ $1 - 4.5 = -3.5$ $4 + 4.5 = 8.5$ *-10, -8 are outliers*
9 is an outlier

B: $IQR = 25 - (-2) = 27$ $1.5 IQR = 40.5$ $-2 - 40.5 = -42.5$ *no outliers*
 $25 + 40.5 = 65.5$ *no outliers*

Unauthorized copying or reuse of any part of this page is illegal.

GO ON TO THE NEXT PAGE.

A₂

(b) Two ways that the effectiveness of a gasoline additive can be evaluated are by looking at either

- the proportion of cars that have increased gas mileage when the additive is used in those cars
- or
- the mean increase in gas mileage when the additive is used in those cars.

i. Which additive, A or B, would you recommend if the goal is to increase gas mileage in the highest proportion of cars? Explain your choice.

I would recommend additive A. Because the value for Q_1 is greater than zero, 75% of the cars in the sample using additive A had increased gas mileage with the additive. For additive B, Q_1 is less than zero, so we only know for sure that 50% of the cars had increased gas mileage with the additive ~~but~~ ^{and definitely} less than 75%, based on our boxplots.

ii. Which additive, A or B, would you recommend if the goal is to have the highest mean increase in gas mileage? Explain your choice.

I would recommend additive B. Although the median for additive B is actually less than the median for additive A, the graph for B is strongly skewed ~~right~~ right, and so the mean would be much greater than the median. However, with the graph for A, the median and mean would be fairly close since the graph is fairly symmetrical.

Unauthorized copying or reuse of any part of this page is illegal.

GO ON TO THE NEXT PAGE.

B.

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.

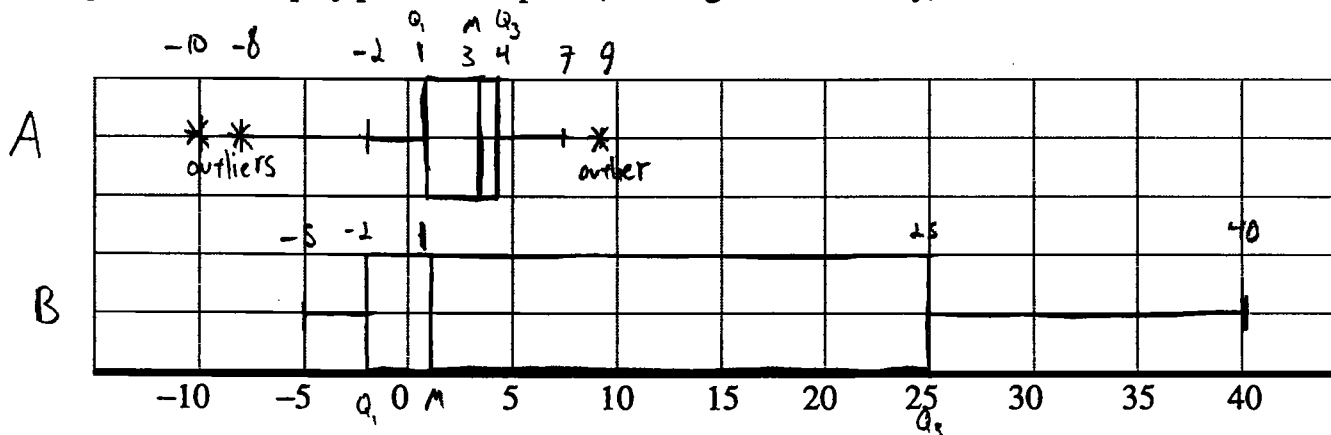
1. A consumer advocate conducted a test of two popular gasoline additives, A and B. There are claims that the use of either of these additives will increase gasoline mileage in cars. A random sample of 30 cars was selected. Each car was filled with gasoline and the cars were run under the same driving conditions until the gas tanks were empty. The distance traveled was recorded for each car.

Additive A was randomly assigned to 15 of the cars and additive B was randomly assigned to the other 15 cars. The gas tank of each car was filled with gasoline and the assigned additive. The cars were again run under the same driving conditions until the tanks were empty. The distance traveled was recorded and the difference in the distance with the additive minus the distance without the additive for each car was calculated.

The following table summarizes the calculated differences. Note that negative values indicate less distance was traveled with the additive than without the additive.

Additive	Values Below Q_1	Q_1	Median	Q_3	Values Above Q_3
A	-10, -8, -2	1	3	4	5, 7, 9
B	-5, -3, -3	-2	1	25	35, 37, 40

- (a) On the grid below, display parallel boxplots (showing outliers, if any) of the differences of the two additives.



Differences in distance traveled (additive - no additive)

$$A: 1.5(4-1) = 4.5$$

$$1 - 4.5 = -3.5 \quad (-10 \text{ \& } -8)$$

$$4.5 + 4 = 8.5 \quad (9)$$

$$B: 1.5(25 - (-2)) = 40.5$$

$$-2 - 40.5 = -42.5 \quad (\text{none})$$

$$40.5 + 25 = 65.5 \quad (\text{none})$$

Unauthorized copying or reuse of
any part of this page is illegal.

GO ON TO THE NEXT PAGE.

B₂

(b) Two ways that the effectiveness of a gasoline additive can be evaluated are by looking at either

- the proportion of cars that have increased gas mileage when the additive is used in those cars

or

- the mean increase in gas mileage when the additive is used in those cars.

i. Which additive, A or B, would you recommend if the goal is to increase gas mileage in the highest proportion of cars? Explain your choice.

Out of 15 cars, only 3 ^(those below Q_1) using additive A drove less distance than when they didn't use additive A, whereas out of 15 cars using additive B, at least 4 (those below Q_1 and $Q_1 = -2$) drove less distance using additive B than when they didn't use it. So, with A's proportion of increased gas mileage when using the additive being $\frac{12}{15}$ and that of B being no greater than $\frac{11}{15}$, additive A would be recommended.

ii. Which additive, A or B, would you recommend if the goal is to have the highest mean increase in gas mileage? Explain your choice.

Though the median of A's difference in gas mileage (additive - no additive) is greater than B's, the data set in B is strongly right skewed, meaning that its mean will be greater than its median. Meanwhile, the data set in A is slightly left skewed, and even has two outliers in the negative direction pulling down the value of the mean. Since the positive values of B's data are very large, and with the said information, I would recommend additive B if the goal is to have the highest mean increase in gas mileage.