# AP® STATISTICS
2009 SCORING GUIDELINES (Form B)

Question 1

Intent of Question

The primary goals of this question were to assess students' ability to (1) approximate the median and the IQR of a distribution from the boxplot and (2) recalibrate the values of the median and the IQR of the distribution if the same constant value is added to each observation in the distribution.

Solution

Part (a):

Median

Q1   Q3

0   5   10   15   20   25   30   35
State Gasoline Taxes (in cents per gallon)
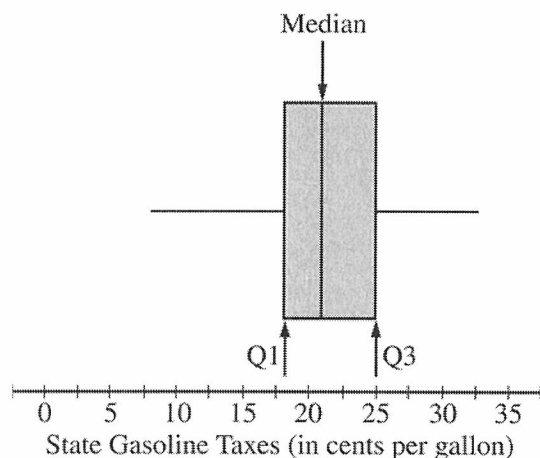
The median and quartiles are marked and labeled on the boxplot above. The median is approximately 21 cents per gallon.

The first and third quartiles are approximately 18 cents per gallon and 25 cents per gallon, respectively. The IQR is Q3 − Q1, which is approximately $25 - 18 = 7$ cents per gallon.

Part (b):

After adding 18.4 cents per gallon to each of the state taxes, the median of the combined gasoline taxes would be the median of the state tax plus the federal tax, which is approximately $21 + 18.4 = 39.4$ cents per gallon.

Although the quartiles of the combined gasoline taxes will change (Q1 = 18 + 18.4 = 36.4 cents per gallon and Q3 = 25 + 18.4 = 43.4 cents per gallon), the IQR will remain the same as it was for the state taxes at 7 cents per gallon ($43.4 - 36.4 = 7$).

Scoring

Parts (a) and (b) are each scored as essentially correct (E), partially correct (P), or incorrect (I).

Part (a) is scored as follows:

Essentially correct (E) if the student identifies reasonable values for the median and IQR and justifies them by marking and labeling the boxplot.

Partially correct (P) if the student identifies reasonable values for the median and IQR but does not mark or label the boxplot *OR* identifies, marks, and labels only one value (median or IQR).

Incorrect (I) if the student identifies neither value *OR* identifies only one value but fails to mark and label the boxplot.

Part (b) is scored as follows:

Essentially correct (E) if the student gives a median that is 18.4 cents per gallon larger than the median identified in part (a), gives an IQR that is the same single number found in part (a), *AND* provides a reasonable justification for at least one of these values.

Partially correct (P) if the student provides only one correct value (either the median or the IQR) *AND* provides a justification.

Incorrect (I) if the student gives incorrect values for the median and IQR *OR* provides only one correct value with no justification.

| 4 | **Complete Response** |

        Both parts essentially correct

| 3 | **Substantial Response** |

        One part essentially correct and one part partially correct

| 2 | **Developing Response** |

        One part essentially correct and one part incorrect

OR

        Both parts partially correct

| 1 | **Minimal Response** |

        One part partially correct and one part incorrect

Question 1

Intent of Question

The primary goals of this question were to assess students' ability to (1) compare three distributions of a quantitative variable; (2) construct a stemplot; (3) recognize that different graphical displays of the same data can reveal different characteristics of a distribution.

Solution

Part (a):

Comparing the medians reveals that the concentration of aldrin tends to be highest for River X and lowest for River Z. About 50 percent of the concentrations of aldrin for Rivers X and Y are higher than all of the concentrations for River Z. River X also displays the most variability in aldrin concentrations, as seen by the largest range and largest IQR, and River Z has the least variability, as judged by both IQR and range. The shapes of the three distributions differ, in that the distribution appears to be skewed to the right for River X, roughly symmetric for River Y and slightly skewed to the left for River Z.

Part (b):

Aldrin concentrations (in ppm) for River X
Leaf unit = 0.1 (for example, 3 | 4 represents 3.4 ppm)

```
3 | 47
4 | 0236678
5 | 13356
6 |
7 | 35
8 | 0267
```

Part (c):

The stemplot shows a gap in the distribution of aldrin concentrations for River X between the values of 5.6 and 7.3 ppm of aldrin. This gap is not apparent in the boxplot.

Scoring

Parts (a), (b) and (c) are each scored as essentially correct (E), partially correct (P) or incorrect (I).

Part (a) is scored as follows:

Essentially correct (E) if the response correctly describes, in context, the center, spread and shape (all three characteristics) of the three distributions *AND* makes a *comparative* statement involving all three distributions for at least one characteristic. Specific numerical values are not required.

Partially correct (P) if the response does not warrant an E, but it includes all three of the following components:
1. Mentions all three distributions
2. Correctly describes at least two of the characteristics (center, spread, shape) of at least two distributions
3. Includes a correct comparison of at least two distributions for at least one characteristic

OR

if the response describes all three characteristics of the three distributions but does not make a *comparison* across distributions.

Incorrect (I) otherwise.

Note: Context is required to earn an E but not to earn a P.

Part (b) is scored as follows:

Essentially correct (E) if a reasonable stemplot that includes a leaf unit key is provided. It is *not* necessary for the key to include measurement units (ppm).

Partially correct (P) if a reasonable stemplot without a leaf unit key is provided.

Incorrect (I) if an unreasonable stemplot or a graph other than a stemplot is provided.

Part (c) is scored as follows:

Essentially correct (E) if the response includes a recognition of the gap in the stemplot *AND* gives an indication of where the gap occurs, *OR* if the response comments on bimodality *AND* specifies where the modes/clusters occur.

Partially correct (P) if the response indicates there is a gap or bimodality in the stemplot but does not give an indication of where the gap occurs.

Incorrect (I) otherwise. For example, the response might indicate that the numerical values can be seen in the stemplot but not the boxplot, or that the mean and standard deviation can be computed with the stemplot but not the boxplot, or only that the distribution is skewed to the right.

Note: The scoring system counts part (a) at *double weight*. In other words, an E counts as 2 points in part (a) and as 1 point in each of parts (b) and (c). Similarly, a P counts as 1 point in part (a) and as ½ point in parts (b) and (c).

Question 1 (continued)

4   **Complete Response**

3   **Substantial Response**

2   **Developing Response**

1   **Minimal Response**

If a response is between two scores (for example, 2½ points), use a holistic approach to determine whether to score up or down, depending on the overall strength of the response and communication.