# AP® STATISTICS
# 2011 SCORING GUIDELINES

## Question 3

### Intent of Question

The primary goals of this question were to assess students' ability to (1) describe a process for implementing cluster sampling; (2) describe a statistical advantage of stratified sampling over cluster sampling in a particular situation.

### Solution

**Part (a):**

The following two-step process can be used to select the eight apartments.

Step 1: Generate a random integer between 1 and 9, inclusive, using a calculator, a computer program, or a table of random digits. Select all four apartments on the floor corresponding to the selected integer.

Step 2: Generate another random integer between 1 and 9, inclusive. If the generated integer is the same as the integer generated in step 1, continue generating random integers between 1 and 9 until a different integer appears. Again select all four apartments on the floor corresponding to the second selected integer.

The cluster sample consists of the eight apartments on the two randomly selected floors.

**Part (b):**

Because the amount of wear on the carpets in apartments with children could be different from the wear on the carpets in apartments without children, it would be advantageous to have apartments with children represented in the sample. The cluster sampling procedure in part (a) could produce a sample with no children in the selected apartments; for example, a cluster sample of the apartments on the third and sixth floors would consist entirely of apartments with no children. Stratified random sampling, where the two strata are apartments with children and apartments without children, guarantees a sample that includes apartments with and without children, which, in turn, would yield sample data that are representative of both types of apartments.

### Scoring

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

**Part (a)** is scored as follows:

Essentially correct (E) if the response correctly addresses the following two components:
1. Indication that two floors are randomly selected, with all four apartments on each of the selected floors forming the sample (or that the entire floors should be carpeted).
2. Description of a valid random sampling procedure for selecting two floors that could be implemented after reading the response (so that two knowledgeable statistics users would use the same method to select the floors).

Partially correct (P) if the response includes exactly one of the two components listed above.

Incorrect (I) if the response includes neither of the two components listed above *OR* the response does not involve taking a random sample of two floors out of the nine.

*Note:* Some possible errors in component 2 include the following:
- Using 10 random digits rather than nine
- Failing to explicitly deal with the issue of potentially repeated random numbers

**Part (b)** is scored as follows:

Essentially correct (E) if the response indicates the following two components:

1. The amount of carpet wear could be different for apartments with and without children.
2. The stratified random sample ensures that some apartments with children will be selected.

Partially correct (P) if the response includes exactly one of the two components listed above.

Incorrect (I) if the response fails to meet the criteria for E or P.

*Notes*
- If the response in part (b) says that this stratified sampling method guarantees proportional representation of apartments with and without children, then the second component is satisfied.
- If the sampling procedure in part (a) divides the floors into two groups — those that have apartments with children and those that do not ("prestratification") — and then selects one floor from each group, score part (b) based on the degree to which a statistical advantage of the stratified sampling in part (b) is addressed.

**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*
> Two parts partially correct

**1      Minimal Response**

> One part partially correct and one part incorrect

3. An apartment building has nine floors and each floor has four apartments. The building owner wants to install new carpeting in eight apartments to see how well it wears before she decides whether to replace the carpet in the entire building.

The figure below shows the floors of apartments in the building with their apartment numbers. Only the nine apartments indicated with an asterisk (*) have children in the apartment.

| 11* | 12 |
|---|---|
| 1st Floor | |
| 14 | 13 |

| 21 | 22* |
|---|---|
| 2nd Floor | |
| 24 | 23* |

| 31 | 32 |
|---|---|
| 3rd Floor | |
| 34 | 33 |

| 41 | 42 |
|---|---|
| 4th Floor | |
| 44 | 43 |

| 51* | 52 |
|---|---|
| 5th Floor | |
| 54 | 53 |

| 61 | 62 |
|---|---|
| 6th Floor | |
| 64 | 63 |

* = Children in the apartment

| 71 | 72 |
|---|---|
| 7th Floor | |
| 74* | 73* |

| 81 | 82 |
|---|---|
| 8th Floor | |
| 84* | 83 |

| 91 | 92* |
|---|---|
| 9th Floor | |
| 94 | 93* |

(a) For convenience, the apartment building owner wants to use a cluster sampling method, in which the floors are clusters, to select the eight apartments. Describe a process for randomly selecting eight different apartments using this method.

Use digits 1-9. Let 1 represent Floor 1, 2 represent Floor 2, etc. Using a random number generator, select two floors. If a repeat occurs, select another number until two different floors have been selected. Carpet the eight apartments found on the two floors.

(b) An alternative sampling method would be to select a stratified random sample of eight apartments, where the strata are apartments with children and apartments with no children. A stratified random sample of size eight might include two randomly selected apartments with children and six randomly selected apartments with no children. In the context of this situation, give one statistical advantage of selecting such a stratified sample as opposed to a cluster sample of eight apartments using the floors as clusters.

When using the cluster sampling method, it is possible that no apartments with kids would be selected. This would occur if Floors 3 and 4, 3 and 6, or 4 and 6 were selected. This would be bad in this situation because kids tend to wear out carpets more than adults. so the owner could have concluded, based on adult-only apartments, that the carpets would not wear out easily, but then install them in every apartment and see them wear out in rooms with children. This stratified sample would work better because there is a guarantee that the owner can test out the carpets in apartments with and **GO ON TO THE NEXT PAGE.** without children.

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|----|----|
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|-----|----|
| 5th Floor | |
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| 6th Floor | |
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apartment

| 71 | 72 |
|----|----|
| 7th Floor | |
| 74* | 73* |

| 81 | 82 |
|----|----|
| 8th Floor | |
| 84* | 83 |

| 91 | 92* |
|----|-----|
| 9th Floor | |
| 94 | 93* |

(a) For convenience, the apartment building owner wants to use a cluster sampling method, in which the floors are clusters, to select the eight apartments. Describe a process for randomly selecting eight different apartments using this method.

You could randomly select 2 floors to carpet instead of randomly selecting individual rooms to carpet.

(b) An alternative sampling method would be to select a stratified random sample of eight apartments, where the strata are apartments with children and apartments with no children. A stratified random sample of size eight might include two randomly selected apartments with children and six randomly selected apartments with no children. In the context of this situation, give one statistical advantage of selecting such a stratified sample as opposed to a cluster sample of eight apartments using the floors as clusters.

An advantage to this would be to see if kids play a big role in the carpets wear because if you use a cluster sample on the floors you might not get any kids located on that floor.

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(a) For convenience, the apartment building owner wants to use a cluster sampling method, in which the floors are clusters, to select the eight apartments. Describe a process for randomly selecting eight different apartments using this method.

The way this method is used is a floor is first randomly selected, then an apartment in the floor is randomly selected. And you keep on doing it until the person selected eight different apartments.

(b) An alternative sampling method would be to select a stratified random sample of eight apartments, where the strata are apartments with children and apartments with no children. A stratified random sample of size eight might include two randomly selected apartments with children and six randomly selected apartments with no children. In the context of this situation, give one statistical advantage of selecting such a stratified sample as opposed to a cluster sample of eight apartments using the floors as clusters.

The advantage of this that you get to see how the carpet wears with an apartment with children and in an apartment without children. If you use the cluster sampling method is you run the risk of not selecting an apartment with children for example. Or maybe not maybe not enough to render it statistically significant. With the stratified random sample its a guarentee that you are going to get enough of both.

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## Question 3

**Overview**

The primary goals of this question were to assess students' ability to (1) describe a process for implementing cluster sampling; (2) describe a statistical advantage of stratified sampling over cluster sampling in a particular situation.

**Sample: 3A**
**Score: 4**

In part (a) the student assigns each floor a unique number, 1–9, and correctly describes the use of a random number generator to select two floors, including what to do in the case of repeated random numbers. The student then indicates that all eight apartments on the selected floors will be carpeted. Part (a) was scored as essentially correct. In part (b) the student begins by stating that for cluster sampling "it is possible that no apartments with kids would be selected," and gives the combinations of two floors for which this statement is true. The student argues that this is "bad … because kids tend to wear out carpets more than adults," and provides a consequence of such a sample for the owner. The student then states that a "stratified sample would work better" because the sample will contain "apartments with and without children." The strong response in this part was scored as essentially correct. Because both parts were scored as essentially correct, the response earned a score of 4.

**Sample: 3B**
**Score: 3**

In part (a) the student suggests that one "could randomly select 2 floors to carpet." Although this does not explicitly state that eight apartments are to be carpeted, the idea of carpeting entire floors is sufficient to indicate that four apartments on each floor will be carpeted. However, the student makes no attempt to implement a valid random sampling procedure for selecting the two floors. Part (a) was scored as partially correct. In part (b) the student indicates that the "advantage to this [the stratified sample] would be to see if kids play a big role in the carpets [*sic*] wear," as opposed to the cluster sample in which "you might not get any kids." The communication is weak, but the student does address the difference in carpet wear between the apartments with and without children and also indicates that a cluster sample might not include apartments with children. Part (b) was scored as essentially correct. Because one part was scored as essentially correct and one part was scored as partially correct, the response earned a score of 3.

**Sample: 3C**
**Score: 2**

In part (a) the student describes a non-cluster sample and does not describe a random sample of two floors from the nine. Part (a) was scored as incorrect. In part (b) the student indicates in the first two sentences that a stratified sample will have apartments with and without children (as opposed to the cluster sampling method) and that "you get to see how the carpet wears" in both types of apartments. This is sufficient to answer the question; the remaining sentences were considered extraneous and did not detract from the response. Part (b) was scored as essentially correct. Because one part was scored as essentially correct and one part was scored as incorrect, the response earned a score of 2.