2. The Colorado Rocky Mountain Rescue Service wishes to study the behavior of lost hikers. If more were known about the direction in which lost hikers tend to walk, then more effective search strategies could be devised. Two hundred hikers selected at random from those applying for hiking permits are asked whether they would head uphill, downhill, or remain in the same place if they became lost while hiking. Each hiker in the sample was also classified according to whether he or she was an experienced or novice hiker. The resulting data are summarized in the following table.

	Direction		
	Uphill	Downhill	Remain in Same Place
Novice	20	50	50
Experienced	10	30	40

Do these data provide convincing evidence of an association between the level of hiking expertise and the direction the hiker would head if lost?

Give appropriate statistical evidence to support your conclusion.

3. The dentists in a dental clinic would like to determine if there is a difference between the number of new cavities in people who eat an apple a day and in people who eat less than one apple a week. They are going to conduct a study with 50 people in each group.

Fifty clinic patients who report that they routinely eat an apple a day and 50 clinic patients who report that they eat less than one apple a week will be identified. The dentists will examine the patients and their records to determine the number of new cavities the patients have had over the past two years. They will then compare the number of new cavities in the two groups.

a. Why is this an observational study and not an experiment?

b. Explain the concept of confounding in the context of this study. Include an example of a possible confounding variable.

c. If the mean number of new cavities for those who ate an apple a day was statistically significantly smaller than the mean number of new cavities for those who ate less than one apple a week, could one conclude that the lower number of new cavities can be attributed to eating an apple a day? Explain.

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4. A company is considering implementing one of two quality control plans for monitoring the weights of automobile batteries that it manufactures. If the manufacturing process is working properly, the battery weights are approximately normally distributed with a specified mean and standard deviation.

   Quality control plan A calls for rejecting a battery as defective if its weight falls more than 2 standard deviations below the specified mean.

   Quality control plan B calls for rejecting a battery as defective if its weight falls more than 1.5 interquartile ranges below the lower quartile of the specified population.

   Assume the manufacturing process is under control.

   a. What proportion of batteries will be rejected by plan A ?

   b. What is the probability that at least 1 of 2 randomly selected batteries will be rejected by plan A ?

   c. What proportion of batteries will be rejected by plan B ?

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Question 3

Note To Readers:

Holistic grading is essential for evaluating student responses to this question. In judging the responses for each individual question as correct, weak, or incorrect, the total response to all questions (a), (b), and (c) should be read and evaluated. If the reader can construct an unambiguous correct response to (a), for example, from the student's total response, then question (a) should be counted as "correct."

Solution
This problem has three parts.

a. The student can appeal to any of three reasons in judging this study not an experiment:

    1. there is no random assignment of subjects to treatments;
    2. there are no treatments imposed;
    3. existing data is being used.

b. Two variables are confounded if their effect on the number of new cavities cannot be distinguished from one another. The student must mention not only that the confounding variables may affect the outcome but that they have differential effects within the two groups. For instance: confounding would occur if patients who eat an apple a day differ from those who eat less than one apple a week **on some variable that is related to dental health**. In this example, diet or general level of health are examples of what might be confounding variables. For example, it is possible that people who eat an apple a day are more nutrition conscious and have a more healthy diet in general than those who eat one or fewer apples per week, and this might explain the observed difference in dental health.

Note:
There are many possible examples of confounding variables. Any reasonable example of a confounding variable is acceptable, as long as a good explanation is given and the connection between the confounding variable and group membership is clear. Lack of a definition here can be rectified by a response in (c) that demonstrates a clear understanding of the concept of confounding variable.

c. No, because it is not an experiment, and cause-and-effect conclusions cannot be drawn from an observational study.

    OR

    No, because there are possible confounding variables.

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Question 3 (cont.)

Notes:

1. In b), a good definition of confounding with a bad example should be regarded as temporarily weak. An example that does not mention group affiliation can be recovered in part c). To recover the definition of confounding in c) they must connect the term with the definition. To recover the group affiliation, they may do by example in c).

2. If the student, in attempting to discuss group differentiation, only mentions one of the groups, that is OK - we will consider the other implied. For example, it is counted correct if the student says, "The apple-eating group may be more health-conscious…" they need not explicitly deny health-consciousness to the one-apple-a-week group.

3. The constructions "Some people" and "A person in the apple-eating group may …" are NOT enough to establish group differentiation; this construction suggests only that some subset of the group may differ from the rest of the group. This is just natural variation. The construction "A person who is an apple-eater may …" can establish group differentiation if it is clear that this is describing a representative member of the group.

4. Mentioning initial non-equivalence of groups without tying that non-equivalence to the outcome is not correct. Mentioning concepts such as self-reporting bias, social desirability, etc. may constitute measurement error in the study but is not confounding.

5. In (c), appealing to the definition of confounding variables in (b) would get a "correct" for (c) if the definition in (b) is correct. If the definition in (b) is weak, that appeal alone would not get credit.

6. If the definition in (b) is "there are other variables that affect the outcome measure, such as age, health, etc," this is **not** regarded as a correct definition for purposes of appealing to the definition from (c). For purposes of reading part (b), this definition would be regarded as weak.

7. If in (c), they give an example which is the equivalent of confounding, and **refer to this as confounding**, they would get credit for (b).

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Question 3 (cont.)

Points:

4 Complete Response
All 3 of the following must be correct:

- Gives a correct explanation of why this is an observational study or is not an experiment.
- Gives an acceptable explanation of confounding and a reasonable example of a possible confounding variable
- Correctly states that a causal relationship cannot be inferred from the results of an observational study
-

3 Substantial Response
2 correct and 1 weak response.

2 Developing Response
2 correct and 1 incorrect
OR
1 correct and 2 weak

1 Minimal Response
1 correct
OR
2 or 3 weak

0 1 weak

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