

Instructions: This exam is a tool to help me (and you) assess how well you are learning the course material. As such, you should report enough written detail for me to understand how you are thinking about each problem. (100 points total)

1. Here is part of a recent article from the BBC News website reporting on a study:

A US team found 55% of Parkinson's patients had insufficient levels of vitamin D, compared to 36% of healthy elderly people. However, the Emory University researchers do not yet know if the vitamin deficiency is a cause or the result of having Parkinson's. The study appears in the journal *Archives of Neurology*.

Parkinson's disease affects nerve cells in several parts of the brain, particularly those that use the chemical messenger dopamine to control movement. The most common symptoms are tremor, stiffness and slowness of movement. These can be treated with oral replacement of dopamine.

Previous studies have shown that the part of the brain affected most by Parkinson's, the substantia nigra, has high levels of the vitamin D receptor, which suggests vitamin D may be important for normal functions of these cells. Vitamin D is found in the diet, but is primarily formed in the skin by exposure to sunlight. However, the body's ability to produce the vitamin decreases with age, making older people more prone to deficiency.

One theory is that people with Parkinson's may be particularly vulnerable because their condition limits the amount of time they spend out of doors. However, scientists say it may also be possible that low vitamin D levels are in some way related to the genesis and origin of the disease.

The researchers examined vitamin D levels in 100 people with Parkinson's, 100 with Alzheimer's disease and 100 who were healthy. The groups were matched for age and economic circumstance. Among the Parkinson's group 23% of patients had vitamin D levels so low that they could be described as deficient. In the Alzheimer's group the figure was 16%, and in the healthy group 10%. The researchers said the findings were striking because the study group came from the South West of the US, where sunny weather is the norm.

- (a) What broad question is the study addressing? (3 points)
- (b) Is this study experimental or observational? (3 points)
- (c) What variable is measured on each subject in this study? (4 points)
- (d) What is the parameter of interest in this study? (4 points)
- (e) Suppose the value of 55% mentioned in the first paragraph had instead been 38%. Explain why the difference between 38% and 36% might not be *statistically significant*. (3 points)

2. You are designing an experiment to see how sleep deprivation affects performance on a short-term memory test. You will use two treatments: one is to keep the subject awake for 24 hours before administering the memory test and the other is to have the subject get a full night's sleep before administering the test. You have 10 student volunteers willing to participate in the experiment.

- (a) Describe a matched pairs design for this experiment. (5 points)
- (b) Below are the names of the 10 students who have volunteered. Use Table B starting at Line 131 to assign five students to the first experimental group. (5 points)

Timothy	Nora	Richie	Emmett	Denisha
Dakota	Blair	Jan	Harris	Edith

3. You are interested in how much time UPS students who live in residence halls spend off campus. You plan to survey a sample of UPS students living in residence halls. To get a sample, you first choose a simple random sample of rooms from a list of all the residence hall rooms on campus. You then go to each room in that sample and survey the person who answers the door.

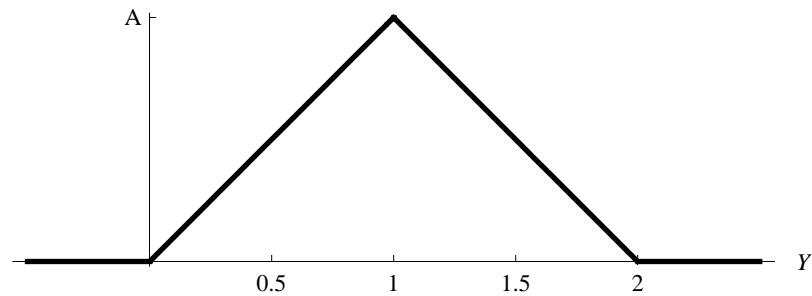
- (a) Explain why the sample of students you end up with is *not* a simple random sample of UPS students living in residence halls. (5 points)
- (b) Describe a potential factor in this method of sampling that might bias your results on the question you are studying. (5 points)

4. The M&M's web site gives the following proportions for colors the company produces:

Color	Brown	Yellow	Red	Blue	Orange	Green
Proportion	0.13	0.14	0.13	0.24	0.20	0.16

- (a) Consider the process of buying a bag of M&M's at the store and then selecting one M&M at a time from the bag without looking. Explain why it is reasonable to use the proportions given above as probabilities for the color of the selected M&M. (3 points)
- (b) Is M&M color a random variable? (2 points)
- (c) Determine the probability that the color of a selected M&M is neither red nor green. (5 points)
- (d) Consider selecting 2 M&M's at random and independently. Determine the probability that the two M&M's are the same color. (5 points)
- (e) Consider selecting 5 M&M's at random and independently. Determine the probability that at least one of the M&M's is orange. (4 points)
5. Consider a nonstandard die with six sides as usual but with an extra value of 6 in place of the 2. That is, the six faces have labels 1,6,3,4,5,6. Let X be the value face up on one toss.
- (a) Give the probability for each value of X . (4 points)
- (b) Determine the mean value for X . (4 points)
- (c) Determine the standard deviation for X . (4 points)

6. Consider using an ideal spinner to pick a number between 0 and 1 at random. Take Y to be the sum of the two values from two independent spins. The density curve for Y is shown below.



- (a) Explain why the value labeled A in the plot must be 1. (4 points)
- (b) Determine the probability that Y is less than 0.5. (4 points)
7. Gala apples (a particular variety) have weights when ripe that are normally distributed with a mean of 210 grams and a standard deviation of 30 grams. If you walk into a Gala apple orchard and pick a ripe apple at random, what is the probability of getting an apple with weight greater than 240 grams? (6 points)
8. An annual relay race for charity consists of two legs with one person running the first leg and a second person biking the second leg. Information collected over many years shows that times for the running leg have a mean of 36 minutes with a standard deviation of 12 minutes while the times for the biking leg have a mean of 48 minutes with a standard deviation of 9 minutes.
- (a) What is the mean of total times for the race? (5 points)
- (b) What is the standard deviation of total times for the race? (5 points)
9. You and a friend are bored one night and decide to make up a game. One of you will be the player and the other will be the casino. The player will pay \$1 to roll a die. The casino will pay out \$5 for a 6, \$1 for a 5 or 4, and \$0 for a 3, 2, or 1. You plan to play many times. Would you choose to be the player or the casino? Explain how you reach your conclusion. (8 points)