

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 an excerpt from an article appearing in the New York Times on March 5, 2008:

In marketing as in medicine, perception can be everything. A higher price can create the impression of higher value, just as a placebo pill can reduce pain.

Now researchers have combined the two effects. A \$2.50 placebo, they have found, works better than one that costs 10 cents.

The finding may explain the popularity of some high-cost drugs over cheaper alternatives, the authors conclude. It may also help account for patients' reports that generic drugs are less effective than brand-name ones, though their active ingredients are identical.

The research is being published on Wednesday in The Journal of the American Medical Association.

The investigators had 82 men and women rate the pain caused by electric shocks applied to their wrist, before and after taking a pill. Half the participants had read that the pill, described as a newly approved prescription pain reliever, was regularly priced at \$2.50 per dose. The other half read that it had been discounted to 10 cents. In fact, both were dummy pills.

The pills had a strong placebo effect in both groups. But 85 percent of those using the expensive pills reported significant pain relief, compared with 61 percent on the cheaper pills. The investigators corrected for each person's individual level of pain tolerance.

- (a) Identify the explanatory variable in this study and give the values for this variable that are used in this study. (4 points)
- (b) Identify the response variable for this study. (4 points)
- (c) Determine if this is an *experimental study* or an *observational study*. Explain how you reach your conclusion. (4 points)
- (d) The article does not explicitly mention randomization. Describe the role we can reasonably assume randomization had in this study. (3 points)
- (e) Suppose the value of 61 percent in the last paragraph had instead been 81 percent. Explain why the difference between the two values 85 percent and 81 percent might not be *statistically significant*. (3 points)

2. A recent New York Times/CBS News poll is described as “based on telephone interviews conducted Feb. 20 through Feb. 24 with 1,266 adults throughout the United States. Of these, 1,115 said they were registered to vote, including 427 self-described Democratic primary voters and 327 self-described Republican primary voters.”

One question posed to the Democratic primary voters was “Who do you think has the best chance of beating John McCain in the general election in November—Hillary Clinton or Barack Obama?” Percentages of responses are given in the following table.

Clinton	Obama	Equal chance	Neither	Don’t know/no answer
28%	59%	6%	1%	5%

Note: Responses of “Equal chance” and “Neither” were volunteered without specific prompt in the wording of the question.

- (a) What is the population of interest for this question? (4 points)
- (b) What parameter or parameters are of interest in this question? (4 points)
- (c) How do the values of 28% and 59% from the table relate to your response for (b)? (4 points)
- (d) The report on this poll includes the note “Candidate names rotated” alongside the poll question stated above. Explain what this means and why it is important. (4 points)
3. You want to know what proportion of students living in residence halls at UPS have a television in their room. (For this purpose, we’ll consider Langdon House as one of the residence halls.) You plan to gather data from a sample of residence rooms. Since you plan to visit each room in your sample, you will save travel time by first selecting a simple random sample of three residence halls from among the ten residence halls:

Anderson/Langdon	Harrington	Langdon	Reger	Schiff
Seward	Smith	Todd/Phibbs	Trimble	University

Use Line 185 in Table B to select an SRS of size 3. Give enough detail in your work for someone else to repeat your process. Give the names of the halls in your sample. (6 points)

4. A medical researcher is interested in comparing the effectiveness of three antibiotics (doxycycline, minocycline, and tetracycline) on minor skin infections. The researcher thinks that one of these may be more effective for children less than 15 years old and another one may be more effective for those 15 or older. Describe how you would design an experiment to test the effectiveness of these antibiotics on minor skin infections. Assume you have an available pool of 120 patients with minor skin infections, 36 of whom are less than 15 years old. Each of these antibiotics is given in a daily dose of one pill for 10 consecutive days. (8 points)

5. A die is loaded so that the probabilities for each side are not equal. The probabilities for this loaded die are given in the following table.

Value	1	2	3	4	5	6
Probability	0.20	0.25	0.10	0.15	0.15	0.15

- (a) What is probability of getting at least a 4? (4 points)
- (b) What is the probability of getting at 1 on two consecutive rolls? (4 points)
- (c) What is the probability of getting the same number on two consecutive rolls? (4 points)
- (d) Imagine rolling this die 1000 times and keeping track of the 1000 values that result. Approximately what would you expect for the mean of these 1000 values? Explain how you arrive at your conclusion. (6 points)
6. The manufacturer of a wing strut for the new Boeing 787 takes X-rays of each strut it produces. For struts with an internal flaw, a single X-ray scan is successful in detecting the flaw 90% of the time. Suppose a flawed strut is scanned three times.
- (a) List all eight possible outcomes using the notation D for “flaw detected” and M for “flaw missed”. (4 points)
- (b) Determine the probability for each of the outcomes you list in (a). (6 points)
- (c) The contract that the manufacturer has with Boeing requires that fewer than 0.1% of the struts sent by the manufacturer have a flaw. If the manufacturer only sends struts for which three X-ray scans do not detect a flaw (and discards the rest), is it likely that the terms of the contract will be met? (3 points)
7. The heights of Douglas fir trees in a 30 year old planation forest are normally distributed with a mean of 80 feet and a standard deviation of 10 feet. Let X be the height of a Douglas fir selected at random from the forest.
- (a) Is X a discrete random variable or a continuous random variable? Justify your conclusion. (2 points)
- (b) Sketch a plot of the relevant probability distribution and use the plot to illustrate the probability $P(X \geq 90)$. (4 points)
- (c) Use the 68-95-99.7 rule to determine $P(X \geq 90)$. (4 points)
- (d) How does $P(X > 90)$ compare with your result for (b)? (2 points)
8. The average body height of women age 20-29 years can be approximated as a normally distributed random variable with mean 64.0 inches and standard deviation 2.7 inches. Now consider adding the heel height of shoes to get a total height when wearing shoes. Suppose heel heights have a mean of 1.1 inch and a standard deviation of 0.4 inches.
- (a) Find the mean and standard deviation of total height assuming that body height and heel height are independent variables. (6 points)
- (b) Give a reasonable argument for why this assumption of independence *might not* be appropriate. (3 points)