

MATH 338

MIDTERM 1

WED/THURS, SEPTEMBER 27/28, 2017

Your name: \_\_\_\_\_

Your scores (to be filled in by Dr. Wynne):

Problem 1: \_\_\_\_/15

Problem 2: \_\_\_\_/11

Problem 3: \_\_\_\_/10

Problem 4: \_\_\_\_/19

Total: \_\_\_\_/55

You have 75 minutes to complete this exam.

You may refer to your (single-sided, prepared in advance) formula sheet. You may ask Dr. Wynne to clarify what a question is asking for. You may not ask other people for help or use any other resources.

For full credit, show all work except for final numerical calculations (which can be done using a scientific or graphing calculator).

1. The UPBEAT study investigated aerobic exercise as a treatment for depression in individuals with coronary heart disease. 37 participants were randomly assigned to a 16-week exercise regimen, 40 participants to take an antidepressant drug for 16 weeks, and 24 participants to take a placebo pill. The primary outcome measure was participants' score on the Hamilton Depression Rating Scale, which ranges from 0 to 52, with lower scores indicating less depression.

A) [1 pt] How many cases were there in this study?

B) [2 pts] Identify the factor (experimental) variable in this study and its levels.

C) [1.5 pts] At the beginning of the study, investigators recorded the age, gender, and initial score on the Hamilton Depression Rating Scale for each person enrolled in the study. Classify each variable as categorical or numerical by circling one answer for each variable below.

Age:	categorical	numerical
Gender:	categorical	numerical
Score:	categorical	numerical

D) [2 pts] Why did the investigators caution that “patients who were not interested in exercise or taking an antidepressant were unlikely to have volunteered” to be in the study?

1. (Continued) Refer to the two-way table below for Parts E and F. The row variable is gender and the column variable is type of treatment.

	Exercise	Antidepressant	Placebo
Female	13	15	4
Male	24	25	20

E) [2 pt] Report the marginal distribution of gender.

F) [2 pt] What is the probability that a randomly selected female subject received a placebo?

For Parts G through I, consider  $Y$ , a (continuous) uniform random variable with positive density between 3 and 8.

G) [1.5 pts] Sketch the density curve for  $Y$ .

H) [2 pts] Find  $P(6 \leq Y < 9)$ .

I) [1 pt] The median of  $Y$  can be found, using the density curve, to be (circle only one answer below):

0.2    0.5    1    4    4.5    5    5.5    7.5    8

2. In a lab experiment, students estimate the concentration of an unknown salt in solution. The solution is known to have a true value of 5% weight by volume, but students' results are known to follow approximately a normal distribution with a standard deviation of 0.09 percentage points.

A) [4 pts] Assuming that the student measurements are unbiased and independent, what proportion of students will obtain a concentration estimate greater than 5.06%?

B) [6 pts] Assuming that the student measurements are unbiased and independent, what proportion of classes of 20 students will obtain a sample mean concentration estimate greater than 5.06%?

C) [1 pt] Circle the name of a plot that could be used to display the distribution of the concentrations obtained by the class of 20 students (circle only one answer, though more may be correct):

time plot

bar plot

pie chart

stem plot

histogram

3. According to the NHANES-III survey, the incidence of urinary tract infections in adult women is 13,320 per 100,000 women per year (13.32%). A dipstick nitride test for urinary tract infections has a sensitivity of only 26.7% (roughly 4/15), and a specificity of 93.3% (roughly 14/15) (Zaman *et al.*, 1998).

A) [6 pts] Report and interpret the estimated positive predictive value (PPV) and negative predictive value (NPV) for this dipstick nitride test.

B) [2 pts] If the incidence of urinary tract infections decreased, which of the following would change (circle all values that would change)?

sensitivity

specificity

positive predictive value

negative predictive value

C) [2 pts] If the manufacturers of the test increase its sensitivity without changing its specificity, would the positive predictive value of the test increase or decrease? Explain your answer.

4. Melvin the Troll has just picked up the Bludgeon of Obfuscating Stupidity! The bludgeon has a chance to hit of 20%; that is, he only hits 20% of the time he swings. If he hits, he does 32 damage; otherwise, he misses and does no damage.

A) [1 pt] What is the probability that Melvin misses (does not hit) on his next swing?

B) [3 pts] Suppose Melvin swings 10 times, and every one of Melvin's swings is independent of the others. Explain why we can model the number of Melvin's hits as a binomial random variable.

C) [3 pts] What is the probability that Melvin hits exactly 2 times in 10 swings?

D) [3 pts] Which of the following statements are correct about the mean amount of damage Melvin does in 1000 swings? Circle the letter of each correct statement.

- a. This mean is constant, and we can find its value even before Melvin swings 1000 times.
- b. This mean is constant, and we don't know its value until we observe Melvin swing 1000 times.
- c. This mean is random, and we can find its value even before Melvin swings 1000 times.
- d. This mean is random, and we don't know its value until we observe Melvin swing 1000 times.
- e. If its value is 6, we can express that fact using the equation  $\mu = 6$ .
- f. If its value is 6, we can express that fact using the equation  $\bar{x} = 6$ .
- g. The shape of its sampling distribution is approximately normal.
- h. The mean of its sampling distribution is the same as if he took 10 swings.
- i. The standard deviation of its sampling distribution is the same as if he took 10 swings.
- j. It does not have a sampling distribution.

4 (continued). Currently, Melvin has equipped the Club of Ad Hominem. 20% of the time he swings the club, he misses and does no damage; 70% of the time, he hits and does 8 damage; and the remaining 10% of the time, he hits and does 12 damage.

E) [2 pts] Let  $X$  be the amount of damage Melvin does on a single swing of the Club of Ad Hominem. Write the probability distribution of  $X$ .

F) [5 pts] Using your distribution from Part (E), find the mean, variance, and standard deviation of  $X$ .

G) [2 pts] With which weapon will Melvin expect to do more damage per swing, the Bludgeon of Obfuscating Stupidity or the Club of Ad Hominem? Justify your answer.

Extra Space. The tables below show a number of critical values  $z$  for the standard normal variable  $Z \sim N(0, 1)$  and the corresponding cumulative proportions, corresponding to  $P(Z \leq z)$ .

z-score	Cumulative Proportion
-3.00	0.0013
-2.50	0.0062
-2.00	0.0228
-1.65	0.0495
-1.28	0.1003
-1.00	0.1587
-0.67	0.2514

z-score	Cumulative Proportion
0.67	0.7486
1.00	0.8413
1.28	0.8997
1.65	0.9505
2.00	0.9772
2.50	0.9938
3.00	0.9987

The rest of this space to be used for extra work: