

Math 102 Open Book Open Note Test
Chapters 9, 10, 11, 12

This is my own work. I have not collaborated with anyone else.

Name: _____

Directions: **Choose 8** problems. You need 2 from {1,2,3,4,5}, 2 from {6,7,8,9,10}, 2 from {11,12,13,14}, and 2 from {15,16,17,18}. For problems that require computation, **show what formula you are using.**

1. Identify as true or false and write a sentence to explain your answer.
 - a. The t confidence interval formula for estimating μ is appropriate when the population being sampled is approximately normally distributed.

 - b. The width of the confidence interval for μ decreases as the sample size increases.

2. If the distribution of a population is symmetric, both the sample mean and sample median give unbiased estimates of the population mean. What criteria would you consider in choosing which of these statistics to use if you wanted to estimate the population mean?

3. Eyestrain is thought to be associated with different types of office work. The Acme Temp-Help Company provides short-term employees to substitute for vacationing data entry personnel. Previous research has shown that approximately 21% of full time data entry personnel have eyestrain, and Acme would like to estimate the proportion, p , of their 6,000 part-time data entry employees that have eyestrain.
 - a) They would like to estimate p to within 0.05 with 95% confidence. If they accept the previous value of 0.21 as a reasonable initial estimate of p , what sample size should they use for their study?

- b) Suppose Acme thought that the working conditions of their temporary data entry personnel were different enough that they should not depend on the 0.21 as an initial estimate. In a few sentences, explain how your procedure for choosing a samples size would differ from your solution in part (a). (Do NOT recalculate a new estimate of the necessary sample size!)
4. a. Under what conditions is it reasonable to use the z confidence interval to estimate a population mean?
- b. Under what conditions is it reasonable to use the t confidence interval to estimate a mean?
5. a. When choosing a statistic to estimate a population characteristic, what factors should be considered?
- b. When the sample size is "large enough," the statistic $\hat{p}$ has an approximately normal sampling distribution. How does one determine if a sample size is large enough?

6. Children as young as 2 years of age, upon seeing an object placed under a pillow in a familiar setting at home, will remember where to look for it after an interval of time. Investigators believe this capability will be less pronounced in a laboratory situation, where the child is away from the familiar setting of home. Let p denote the proportion of 2-year-olds who have this understanding in the home situation, and suppose that $p = .35$. Investigators wish to determine whether the proportion that remembers is smaller when the child is away from home.

- a) What is the appropriate null hypothesis in this study?
- b) What is the appropriate alternative hypothesis in this study?
- c) In the context of this study, describe a Type I and a Type II error.

7. (a). What is a P-value and what is it used for?

- (b) Explain alpha and beta: Can you control both? How and why or why not?

8. The department of natural resources classifies a fish to be unsafe to eat if its polychlorinated biphenol (PCB) concentration exceeds 5 parts per billion (ppb). A random sample of 10 fish taken from a local lake resulted in the concentrations follows:

2.6, 6.6, 4.8, 5.4, 5.1, 4.5, 6.9, 4.9, 3.7, 3.8

Is there sufficient evidence to conclude that the mean PCB concentration for fish from this lake exceeds 5 ppb? Perform an appropriate test.

9. When performing hypothesis tests, there are assumptions that must be met in order for the test to be appropriate. Describe how you would check these assumptions for a hypothesis test about a population mean when the raw data from a small sample is available.

10. An important part of any dispensing process is statistical quality control. At the Billy Goat Gruff Inn, machines are set to dispense 600 ml of soda into every customer's glass. Over time, however, the machine can get "out of control" and dispense too much soda or too little. The machine needs adjustment if the mean amount dispensed is different from 600 ml. At a random point in time each clock hour, the owner dispenses and checks a glass of dispensed soda and determines the actual volume of soda dispensed. One day the volumes of the dispensed soda were:

600.15, 599.92, 599.85, 599.92, 599.81, 600.14, 600.04, 599.98

Is there sufficient evidence to conclude that the dispensing machine needs some adjustment? Tell how you chose the test you do and perform the appropriate test.

Downy Woodpecker

Bill Lengths (cm)

Male	Female
2.01	1.78
1.84	1.76
1.86	1.74
1.91	1.82
1.75	1.87
1.79	1.84
1.88	1.82
2.05	1.87
1.85	1.93
1.90	1.76
1.94	1.96
1.86	1.86

11. Male and female Downy Woodpeckers (*Picoides pubescens*) drill in different areas of trees. One theory about why this separation occurs is that there are physical characteristics of males and females that lead them to choose different foraging locations. One possibility is the bill length of the males and females; longer bills may let one gender or the other drill deeper into a tree.

The data in the table at left are the bill lengths of 12 male and 12 female randomly selected Downy Woodpeckers caught and released in a banding survey. The investigators would like to know whether these data provide evidence that the male and female Downy Woodpeckers differ in mean bill size.

a) Show an initial analysis of the data to establish the plausibility that the distributions of bill lengths are approximately normal.

b) Do these data provide evidence of a difference in mean bill lengths for male and female Downy Woodpeckers? Provide appropriate statistical justification for your conclusion by performing an appropriate test.

12. There are many theories that try to explain differences in the levels of physical activity behavior. Some theories suggest that activity level is affected by social and physical aspects of the environment. In a survey of randomly selected college students, study participants were asked about their physical activity level and various aspects of their environment. The study participants were classified as “Vigorous” or “Sedentary.” One environmental variable of interest to the researchers was the existence of enjoyable scenery. Forty-eight out of eighty-six “Vigorous” exercisers responded that their environment contained enjoyable scenery, while thirteen out of thirty-one “Sedentary” individuals responded that their environment contained enjoyable scenery.

Do these data support the hypothesis that the proportion that have enjoyable scenery in their environments is higher for vigorous individuals than for sedentary individuals? Test the appropriate hypotheses using a .05 level of significance.

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13. One of the most striking human accomplishments is the achievement of intelligible speech by age five. Males generally develop at a slower rate than females, and in a recent large study of speech development in young children, investigators hypothesized that a greater proportion of boys would have speech deficits for this reason. Random samples of healthy two-year-old males and females were followed over the course of a year, and at age 3 each child was classified as having a speech deficit or not. The data are given in the table below:

Speech delay and gender at 3 years old

Gender	Speech deficit	No Speech Deficit	Total
Female	22	280	302
Male	78	259	337
Total	100	539	639

a) At the .05 significance level, do the data provide evidence of the hypothesized developmental differences? Provide appropriate statistical evidence for your conclusion.

b) Is this an observational study or an experiment? Justify your response in a few sentences.

14. A common memory task involves the classification of objects into categories: a table is a piece of furniture; a dog is an animal, etc. In a recent study of divided attention, college psychology students were randomly selected and randomly assigned to one of two experimental conditions. Students in the "divided attention" group were asked to study a list of 36 words while simultaneously listening tape recordings. Students in a control group were told to study a list of 36 words but did not listen to a tape recording. Each student was then asked to classify the 36 words into 6 categories, and a summary of the number of words correctly classified are presented below. The distributions of number of correct classifications were determined to be approximately normal for each group.

Number of words correctly classified

Treatment Group	Sample size	Mean	Standard deviation
Divided	32	2.26	0.52
Control	32	3.75	0.61

a) Is there convincing evidence that the mean number of correct classifications differs for the two groups? Test the appropriate hypotheses using $\alpha = .05$.

b) Do you think that the results of this study can be generalized to high school students? Explain your reasoning in a few sentences.

15. A researcher is studying the purchasing behavior of individuals buying breakfast oatmeal. She hypothesizes that half the cereal purchases will be the big name brand, "Seabiscuit Oats" and that the remaining purchases will be divided equally between two local brands, "Secretariat Oats" and "Whirlaway Oats."

a) What are the null and alternative hypotheses that would be used to decide if there was convincing evidence against the researcher's hypothesized distribution of purchases across the three brands?

- b) Suppose that each individual in a random sample of 200 purchasers provides information about his or her choice of brand. What are the expected values for the three brand categories?
- c) How many degrees of freedom are associated with the chi-squared goodness-of-fit statistic?
- d) Suppose that $X^2 = 6.10$. What can be said about the P -value for this hypothesis test?

16. The arithmetic calculations for the test of homogeneity and the test of independence are the same.

- a) Explain in a few sentences what distinguishes these two hypothesis tests.
- b) To illustrate your answer in part (a), give an example of a research question that would require a test of homogeneity, and an example that would require a test of independence. Briefly describe the aspects of your examples that illustrate the distinguishing characteristics you mentioned in part (a).

17. The popular game of golf has potential ecological consequences due to the impact of golf courses: habitat fragmentation, chemical pollution from pesticides, and loss of native vegetation. Eastern bluebirds are particularly attracted to “birdhouses” such as those found on golf courses. Investigators monitored the reproductive success of these birds in birdhouses at nine golf courses and ten similar birdhouses at non-golf sites. They reasoned that if nest boxes on golf courses are less attractive to bluebirds, this would show up as a

difference in the distribution of occupancy frequencies between golf sites and non-golf sites. Data on nest boxes occupied only by bluebirds are presented in the table below.

Observed Number of Nests per Box by Location

Site	0 nests	1 nest	2 -3 nests	Total
Golf	48	80	55	183
Non-golf	62	74	26	162
Total	110	154	81	345

- a) Assuming no difference in the distribution of number of nests per box for golf and non-golf locations, calculate the expected numbers of nest boxes and fill in the values in the table below.

Expected Values for Numbers of Nests per Box by Location

Site	0 nests	1 nest	2 -3 nests
Golf			
Non-golf			

- b) The value of X^2 is 11.161 and the associated P -value is less than .005. Interpret this result in the context of the problem. Does it appear that the nest boxes on golf courses are less attractive to bluebirds?

18. In recent years, appointments to the United States Supreme Court have been hot political topics. The President nominates individuals, and they serve for life. Vacancies on the court occur due to death, retirement, and theoretically impeachment, though this has never occurred. Thus, the impact of filling a vacancy has long term implications. From 1837-1932 (a time over which the number on the court was 9), the proportions of the number of vacancies in a given year is shown below. A political scientist is wondering if the distribution of the number of vacancies in a year may have changed in the “modern” era (from 1932 to 2007.) He decides to use a chi-square goodness-of-fit test, and has gathered the data in the table below.

Supreme Court vacancies, 1933-2007

- a) Calculate the expected number of vacancies for 1933-2007 based on the 1837-1932 proportions and fill in the last column of the table.
- b) What is the appropriate number of degrees of freedom for this chi-square test?
- c) The value of X^2 is 0.1927. Interpret this result in the context of the problem.

Number of vacancies in a year	Proportions 1837-1932	Observed number of Vacancies in a year (1933-2007)	Expected number of Vacancies in a year (1933-2007)
0	0.6065	47	
1	0.3033	21	
>1	0.0902	7	