

Directions: Work on these sheets. Answer completely, but be concise. *Tables are attached.*

Part 1: Multiple Choice. Circle the letter corresponding to the best answer.

1. To use the two-sample t procedure to perform a significance test on the difference between two means, we assume that
- the populations' standard deviations are known.
 - the samples from each population are independent.
 - the distributions are exactly Normal in each population.
 - the sample sizes are large.
 - all of the above

2. A researcher wants to see if birds that build larger nests lay larger eggs. She selects two random samples of nests: one of small nests and the other of large nests. She weighs one egg from each nest. The data are summarized below.

	Small nests	Large nests
sample size	60	159
sample mean (g)	37.2	35.6
sample variance	24.7	39.0

A 95% confidence interval for the difference between the average mass of eggs in small and large nests is:

- $(37.2 - 35.6) \pm 2.000 \sqrt{\frac{24.7^2}{60} + \frac{39.0^2}{159}}$
- $(37.2 - 35.6) \pm 2.009 \sqrt{\frac{24.7^2}{59} + \frac{39.0^2}{158}}$
- $(37.2 - 35.6) \pm \sqrt{\frac{24.7}{59} + \frac{39.0}{158}}$
- $(37.2 - 35.6) \pm \sqrt{\frac{24.7^2 + 39.0^2}{59 + 158}}$
- None of these

3. In a large midwestern university (the class of entering freshmen being on the order of 6000 or more students), an SRS of 100 entering freshmen in 1993 found that 20 finished in the bottom third of their high school class. Admission standards at the university were tightened in 1995. In 1997 an SRS of 100 entering freshmen found that 10 finished in the bottom third of their high school class. Let p_1 and p_2 be the proportion of all entering freshmen in 1993 and 1997, respectively, who graduated in the bottom third of their high school class. What conclusion should we draw?
- We are 95% confident that the admissions standards have been tightened.
 - Reject H_0 at the $\alpha = 0.01$ significance level.
 - Fail to reject H_0 at the $\alpha = 0.05$ significance level.
 - There is significant evidence at the 5% level of a decrease in the proportion of freshmen who graduated in the bottom third of their high school class that were admitted by the university.
 - If we reject H_0 at the $\alpha = 0.05$ significance level based on these results, we have a 5% chance of being wrong.

4. The Excellent Drug Company claims its aspirin tablets will relieve headaches faster than any other aspirin on the market. To determine whether Excellent's claim is valid, random samples of size 15 are chosen from aspirins made by Excellent and the Simple Drug Company. An aspirin is given to each of the 30 randomly selected persons suffering from headaches and the number of minutes required for each to recover from the headache is recorded. The sample results are:

	\bar{x}	s^2
Excellent (E)	8.4	4.2
Simple (S)	8.9	4.6

A 5% significance level test is performed to determine whether Excellent's aspirin cures headaches significantly faster than Simple's aspirin.

The appropriate hypotheses to be tested are

- (a) $H_0: \mu_E - \mu_S = 0$; $H_a: \mu_E - \mu_S > 0$
 (b) $H_0: \mu_E - \mu_S = 0$; $H_a: \mu_E - \mu_S \neq 0$
 (c) $H_0: \mu_E - \mu_S = 0$; $H_a: \mu_E - \mu_S < 0$
 (d) $H_0: \mu_E - \mu_S < 0$; $H_a: \mu_E - \mu_S = 0$
 (e) $H_0: \mu_E - \mu_S > 0$; $H_a: \mu_E - \mu_S = 0$
5. 42 of 65 randomly selected people at a baseball game report owning an iPod. 34 of 52 randomly selected people at a rock concert occurring at the same time across town reported owning an iPod. A researcher wants to test the claim that the proportion of iPod owners at the two venues is not the same. A 90% confidence interval for the difference in population proportions is $(-0.154, 0.138)$. Which of the following gives the correct outcome of the researchers' test of the claim?
- (a) Since the confidence interval includes 0, the researcher can conclude that the proportion of iPod owners at the two venues is the same.
 (b) Since the confidence interval includes 0, the researcher can conclude that the proportion of iPod owners at the two venues may be the same.
 (c) Since the confidence interval includes 0, the researcher can conclude that the proportion of iPod owners at the two venues is different.
 (d) Since the confidence interval includes more positive than negative values, we can conclude that a higher proportion of people at the baseball game own iPods than at the rock concert.
 (e) We cannot draw a conclusion about a claim without performing a significance test.
6. The following are percents of fat found in 5 samples of each of two brands of ice cream:

A	5.7	4.5	6.2	6.3	7.3
B	6.3	5.7	5.9	6.4	5.1

Which of the following procedures is appropriate to test the hypothesis of equal average fat content in the two types of ice cream?

- (a) Paired t test with 5 df.
 (b) Two-sample t test with 4 df.
 (c) Paired t test with 4 df.
 (d) Two-sample t test with 9 df.
 (e) Two-proportion z test

Part 2: Free Response

Answer completely, but be concise. Communicate your thinking clearly and completely.

7. A study of iron deficiency among infants compared samples of infants following different feeding regimens. One group contained breast-fed infants, while the children in another group were fed a standard baby formula without any iron supplements. Here are the results on blood hemoglobin levels at 12 months of age.

Group	<i>n</i>	<i>x</i>	<i>s</i>
Breast-fed	23	13.3	1.7
Formula	19	12.4	1.8

- (a) Is there significant evidence that the mean hemoglobin level is higher among breast-fed babies? Give appropriate statistical evidence to support your conclusion.

- (b) Construct a 95% confidence interval for the mean difference in hemoglobin level between the two populations of infants. Interpret your interval in the context of this problem.

8. The pesticide diazinon is in common use to treat infestations of the German cockroach, *Blattella germanica*. A study investigated the persistence of this pesticide on various types of surfaces. Researchers applied a 0.5% emulsion of diazinon to glass and plasterboard. After 14 days, they placed 18 cockroaches on each surface and recorded the number that died within 48 hours. On glass, 9 cockroaches died, while on plasterboard, 13 died.

(a) Chemical analysis of the residues of diazinon suggests that it may persist longer on plasterboard than on glass because it binds to the paper covering on the plasterboard. The researchers therefore expected the mortality rate to be greater on plasterboard than on glass. Conduct a significance test to assess the evidence that this is true.

(b) Construct and interpret a 95% confidence interval for the difference in the two population proportions.

I pledge that I have neither given nor received aid on this test. _____

Test 13B

1. (b) 2. (a) 3. (d) 4. (c) 5. (b) 6. (b) 7. (a) **Step 1:** Let breast-fed infants be population 1, and formula-fed infants be population 2. μ is the mean hemoglobin level. Our hypotheses are $H_0: \mu_1 = \mu_2$ (or $\mu_1 - \mu_2 = 0$) and $H_a: \mu_1 > \mu_2$ (or $\mu_1 - \mu_2 > 0$). **Step 2:** SRS—We are not told that either sample is an SRS (or even random). This may limit our ability to generalize. Normality—The combined sample size is more than 30, so the t procedures for two samples should be robust against potential skewness, provided that there are no extreme outliers. Independence—We must assume that the two samples of measurements are independent. **Step 3:** The test statistic is: $t = \frac{13.3 - 12.4}{\sqrt{\frac{1.7^2}{23} + \frac{1.8^2}{19}}} = 1.6537$.

With $df = 18$, $0.05 < P\text{-value} < 0.10$. By TI calculator, $df = 37.5876$, and the $P\text{-value} = 0.0533$.

Step 4: There is only marginal evidence to reject H_0 . We are reluctant to conclude that the mean hemoglobin level is higher for breast-fed babies. These results are so close to the commonly accepted standard of $\alpha = 0.05$ that we would want to replicate this experiment before announcing any significant results. (b) A 95% CI for $\mu_1 - \mu_2$ is

$(13.3 - 12.4) \pm 2.101 \sqrt{(1.7^2/23) + (1.8^2/19)} = (-0.243, 2.043)$. By TI calculator: $(-0.2021, 2.0021)$. We

are 95% confident that the mean blood hemoglobin level at 12 months of age is anything from 0.243 units less in breast-fed babies to 2.043 units more in breast-fed babies than babies fed standard baby formula without any iron supplements.

8. **Step 1:** Let p_1 = the proportion of all cockroaches that would die on glass and p_2 = the proportion of all cockroaches that would die on plasterboard. Our hypotheses are $H_0: p_1 = p_2$ vs. $H_a: p_1 < p_2$. **Step 2:** SRS—We must assume that the cockroaches were randomly assigned to the two surfaces.

Independence—The hypothetical populations of cockroaches on glass and plasterboard should certainly include at least 180 cockroaches each. Normality—The pooled proportion of “successes” (cockroach death): $\hat{p} = (9+13)/(18+18) = 0.611$. $n_1\hat{p} = 11$, $n_1(1-\hat{p}) = 7$, $n_2\hat{p} = 11$, $n_2(1-\hat{p}) = 7$. All are at least 5.

Step 3: The test statistic is $z = (9/18 - 13/18) / \sqrt{0.611(1-0.611)(1/18 + 1/18)} = -1.366$ and the $P\text{-value} = 0.0853$. The TI calculator gives $z = -1.369$ and a $P\text{-value}$ of 0.086. **Step 4:** Since the $P\text{-value}$ is greater than 0.05, there is insufficient evidence to conclude that the mortality rate of cockroaches is greater on plasterboard than glass. (b) The counts of successes (deaths) and failures for both samples are all at least 5. Our 95% CI for $p_1 - p_2$ is $(9/18 - 13/18) \pm 1.96 \sqrt{[0.5(1-0.5)/18] + [0.722(1-0.722)/18]} = (-0.532, 0.088)$. TI calculator gives $(-0.5323, 0.0879)$. We are 95% confident that the difference in cockroach mortality rate between glass and plasterboard is between 53% greater on plasterboard and 9% greater on glass.