Directions: *Work on these sheets. Tables and formulas appear on a separate sheet.*

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

1. In preparing to use a *t* procedure, suppose we were not sure if the population was normal. In which of the following circumstances would we not be safe using a *t* procedure?
   (a) A stemplot of the data is roughly bell shaped.
   (b) A histogram of the data shows moderate skewness.
   (c) A stemplot of the data has a large outlier.
   (d) The sample standard deviation is large.
   (e) The *t* procedures are robust, so it is always safe.

2. The weights of 9 men have mean $\bar{x} = 175$ pounds and standard deviation $s = 15$ pounds. What is the standard error of the mean?
   (a) 58.3
   (b) 19.4
   (c) 5
   (d) 1.7
   (e) None of the above. The answer is _____ .

3. What is the critical value t^* that satisfies the condition that the *t* distribution with 8 degrees of freedom has probability 0.10 to the right of t^*?
   (a) 1.397
   (b) 1.282
   (c) 2.89
   (d) 0.90
   (e) None of the above. The answer is _____ .

4. Suppose we have two SRSs from two distinct populations and the samples are independent. We measure the same variable for both samples. Suppose both populations of the values of these variables are normally distributed but the means and standard deviations are unknown. For purposes of comparing the two means, we use
   (a) Two-sample *t* procedures
   (b) Matched pairs *t* procedures
   (c) *z* procedures
   (d) The least-squares regression line
   (e) None of the above. The answer is _____ .

5. The diameter of ball bearings is known to be normally distributed with unknown mean and variance. A random sample of size 25 gave a mean 2.5 cm. The 95% confidence interval had length 4 cm. Then

   (a) The sample variance is 4.86.
   (b) The sample variance is 26.03.
   (c) The population variance is 4.84.
   (d) The population variance is 23.47.
   (e) The sample variance is 23.47.

6. Bags of a certain brand of tortilla chips claim to have a net weight of 14 ounces. Net weights actually vary slightly from bag to bag and are normally distributed with mean μ. A representative of a consumer advocate group wishes to see if there is any evidence that the mean net weight is less than advertised and so intends to test the hypotheses

H_0: $\mu = 14$, H_a: $\mu < 14$.

To do this, he selects sixteen bags of this brand at random and determines the net weight of each. He finds the sample mean to be $\bar{x} = 13.82$ and the sample standard deviation to be s = 0.24.

We conclude that we would
(a) Reject H_0 at significance level 0.10 but not at 0.05.
(b) Reject H_0 at significance level 0.05 but not at 0.025.
(c) Reject H_0 at significance level 0.025 but not at 0.01.
(d) Reject H_0 at significance level 0.01.
(e) Fail to reject H_0 at the $\alpha = 0.10$ level.

Part 2: Free Response
Answer completely, but be concise. Write sequentially and show all steps.

Nitrites are often added to meat products as preservatives. In a study of the effect of these chemicals on bacteria, the rate of uptake of a radio-labeled amino acid was measured for a number of cultures of bacteria, some growing in a medium to which nitrites had been added. Here are the summary statistics from this study.

Group	n	$\bar{x}$	s
Nitrite	30	7880	1115
Control	30	8112	1250

7. Carry out a test of the research hypothesis that nitrites decrease amino acid uptake and report your results.

8. Do various occupational groups differ in their diets? A British study of this question compared 98 drivers and 83 conductors of London double-decker buses. The conductors' jobs require more physical activity. The article reporting the study gives the data as "Mean daily consumption ($\pm$ se)." Some of the study results appear below.

	Drivers	Conductors
Total calories	2821 ± 44	2844 ± 48
Alcohol (grams)	0.24 ± 0.06	0.39 ± 0.11

(a) Give $\bar{x}$ and s for each of the alcohol measurements.

(b) Construct a 95% confidence interval for the mean daily alcohol consumption of London double-decker bus conductors. Follow the Inference Toolbox.

(c) Construct a 99% confidence interval for the difference in mean daily alcohol consumption between drivers and conductors.

9. The National Endowment for the Humanities sponsors summer institutes to improve the skills of high school teachers of foreign languages. One such institute hosted 20 French teachers for four weeks. At the beginning of the period, the teachers were given the Modern Language Association's listening test of understanding of spoken French. After four weeks of immersion in French in and out of class, the listening test was given again. (The actual French spoken in the two tests was different, so that simply taking the first test should not improve the score on the second test.) Table 7.1 gives the pretest and posttest scores. The maximum possible score on the test is 36.

Teacher	Pretest	Posttest	Gain	Teacher	Pretest	Posttest	Gain
1	32	34	2	11	30	36	6
2	31	31	0	12	20	26	6
3	29	35	6	13	24	27	3
4	10	16	6	14	24	24	0
5	30	33	3	15	31	32	1
6	33	36	3	16	30	31	1
7	22	24	2	17	15	15	0
8	25	28	3	18	32	34	2
9	32	26	−6	19	23	26	3
10	20	26	6	20	23	26	3

We hope to show that attending the institute improves listening skills. Carry out an appropriate test of this claim at the $\alpha = 0.05$ level.

1. c   **2.** c   **3.** a   **4.** a   **5.** e   **6.** d

7. Use PHATS

Parameter:
Population 1 = all cultures of bacteria which are treated with nitrite
Population 2 = all cultures of bacteria which are not treated

We want to test a claim about the mean amino acid uptake in these 2 populations:

μ_1 = mean rate of amino acid uptake using nitrites
μ_2 = mean rate of amino acid uptake without nitrites

Hypotheses:
$H_0: \mu_1 = \mu_2$ $H_a: \mu_1 < \mu_2$

Assumptions:
Though it is not known whether an SRS was used, the large sample sizes should assure an approximately normal sampling distribution.

Test:
We will use a 2-sample t test with degrees of freedom = $30 - 1 = 29$

$$t(29) = \frac{7880 - 8112}{\sqrt{41440 + 52083}} = \frac{-232}{305.81} = -.7586$$

From Table C:
Since $-.854 < -.7586 < -.683$ then $.20 < \text{p-value} < .25$

(Using 2 Sample T Test on calculator… p-value = .23)

State Conclusion:
There is not enough evidence to reject H_0 (even at the .20 significance level) so based on this study, we cannot conclude that nitrites decrease amino acid uptake

8.   **a.** $SE = \dfrac{s}{\sqrt{n}}$ Drivers (n = 98): x = .24, s = .59
                          Conductors (n = 83): x = .39, s = 1.00

b. Use PAIS:

Parameter:
Our population is all London double-decker bus conductors.

Assumptions:
We are not told how the samples were obtained let alone if an SRS was used so may not be able to generalize our conclusions. The large sample sizes guarantee the normality we need to perform a confidence interval:

Interval:

95% T Interval = $x \pm t^* \dfrac{s}{\sqrt{n}}$ = $.39 \pm 1.990(.11) = (.17, .61)$

State Conclusion:
We are 95% confident that the mean daily alcohol consumption of London double-decker bus conductors is between .17 and .61 grams.

c. Use PAIS:

Parameter:
Population 1 = All London double-decker bus drivers
Population 2 = All London double-decker bus conductors

Assumptions:
See above

Interval:
We are constructing a 2-Sample T Interval for the difference in mean daily alcohol consumption between conductors and drivers ($\mu_C - \mu_D$)

99% CI for $\mu_C - \mu_D =$ (.39 - .24) ± 2.639 $\sqrt{1/83 + .3481/98}$ = (-.18, .48)

df = 82 (use df = 80)

State Conclusion:
We are 99% confident that the difference in mean daily alcohol consumption between   conductors and drivers of London double-decker buses is between -.18 and .48 grams.

9. Use PHATS

Parameter:
Our population is all high school foreign language teachers enrolled in a summer institute where

μ = mean gain in scores of French teachers enrolled in the institute

Hypotheses:
H_o: $\mu = 0$ H_a: $\mu > 0$

Assumptions:
Since SRS not noted and all teachers were French teachers, we may not be able to generalize our results. A boxplot and normal probability plot indicate normality with 1 potential outlier:

*
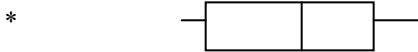
Test:
We will use a matched pairs t test 19 degrees of freedom

x = 2.5, s = 2.89, n = 20

t(19) = $\dfrac{2.5 - 0}{.6462}$ = 3.87

p > .001 for $t^* = 3.579$ (Using calculator, p = .0005)

State Conclusion:

We can reject H_o at the .01 significance level and conclude that the 4-week institute <u>did</u> improve listening skills of these foreign language teachers.