Statistics 13V NAME:_____

Quiz 9 Last six digits of Student ID#:_____

For multiple choice questions circle the best answer. For other questions provide the information requested. Each problem is worth 10 points. ***Open book and notes.***

Scenario for Questions 1 to 5: A company is testing a newly designed computer keyboard to see if people can type faster with it, on average, then with the old style. If they conclude that the average speed is faster with the new keyboard, they will replace all of their old keyboards with the new style. They choose a random sample of 10 employees and time how long it takes them to type a page of text using each keyboard (with the order randomized to allow for learning effects). They then take the difference in times (old style – new style) for each person. Thus, a positive difference means that the page was typed faster with the new keyboard than with the old style. The mean difference for the sample is 5 seconds, and the standard deviation for the sample differences is 7.9 seconds. Assume that the population of differences is approximately normal.

1. State the null and alternative hypotheses in symbols. Be sure to use the correct symbols.

   Null hypothesis: H_0: $\mu_d = 0$, where μ_d is the mean difference for the population of all possible workers.
   Alternative hypothesis: H_a: : $\mu_d > 0$ (new keyboard is better)

2. Explain what a Type 2 error would be in this situation, and the consequence of it for the company.

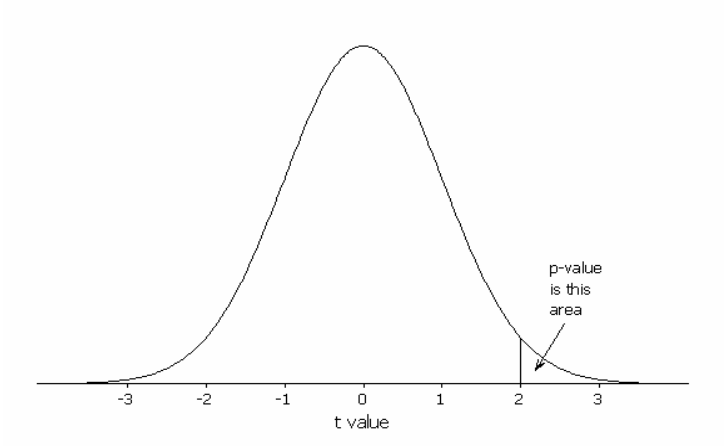
   A type 2 error occurs when the alternative hypothesis is true. In this situation, a type 2 error would be that the mean difference in the population is greater than 0, but the experimental data doesn't provide sufficient evidence to show that. Therefore, the company would not buy the new keyboards and may suffer in productivity as a result.

3. Calculate the value of the test statistic. Use appropriate notation. Show all of your work.

   There were three versions of the exam. Here are the calculations for the three versions:

$$t = \frac{\bar{d} - 0}{s/\sqrt{n}} = \frac{5-0}{7.9/\sqrt{10}} = \frac{5}{2.5} = 2.0 \quad t = \frac{\bar{d} - 0}{s/\sqrt{n}} = \frac{10-0}{15/\sqrt{9}} = \frac{10}{5} = 2.0 \quad t = \frac{\bar{d} - 0}{s/\sqrt{n}} = \frac{20-0}{40/\sqrt{16}} = \frac{20}{10} = 2.0$$

4. Draw a sketch of the appropriate distribution showing the p-value. Then find the p-value or p-value range for the test. Be clear about how you found it.



The p-value can be found in Table A.3 (page 729) and depends on which version of the test you had. Look in the column labeled 2.00, and the row with degrees of freedom n – 1.

Sample size	*degrees of freedom*	*p-value*
9	*8*	*.040*
10	*9*	*.038*
16	*15*	*.032*

Scenario continued from previous page...

5. Make a conclusion and state it in the context of the problem. (Use a .05 significance level, as usual.)

   For all three versions of the exam, p-value < .05, so we reject the null hypothesis. The company can conclude that the mean difference in times is greater than 0 in the population. There is statistically significant evidence that the mean time to type will be shorter with the new keyboards than with the old ones.

---

6. In general, the level of significance associated with a significance test is the probability
   A. of rejecting a true null hypothesis.
   B. of not rejecting a true null hypothesis.
   C. that the null hypothesis is true.
   D. that the alternative hypothesis is true.

7. Which of the following is *not* a correct way to state a null hypothesis?
   A. H_0: $\bar{d} = 0$ (This is stated in terms of a sample statistic rather than a population parameter.)
   B. H_0: $\mu_d = 10$
   C. H_0: $\mu = 0$
   D. H_0: $\mu = -10$

8. The t-distribution is the sampling distribution for which of the following?
   A. $\dfrac{\hat{p} - p}{\sqrt{\dfrac{p(1-p)}{n}}}$ B. $\dfrac{(\hat{p}_1 - \hat{p}_2)}{s.e.(\hat{p}_1 - \hat{p}_2)}$ ***C.*** $\dfrac{\bar{x} - \mu}{s/\sqrt{n}}$ D. $\dfrac{\bar{x} - \mu}{\sigma/\sqrt{n}}$

   The correct answer is C on this version of the exam. For a t-distribution, s rather than σ is used.

9. When comparing two proportions, the situation most likely to lead to a result that is statistically significant but of little practical importance is
   A. when the actual difference is large and the sample sizes are large.
   B. when the actual difference is large and the sample sizes are small.
   C. when the actual difference is small and the sample sizes are large.
   D. when the actual difference is small and the sample sizes are small.

10. The *p*-value for a one-sided test for a proportion was 0.02. The *p*-value for the corresponding two-sided test would be:
    A. 0.04
    B. 0.02
    C. 0.01
    D. It depends on whether the one-sided alternative hypothesis was $p > p_0$ or $p < p_0$.