Inference Review – Free Response Questions

1. When the manufacturing process is working properly, NeverReady batteries have lifetimes that follow a slightly right-skewed distribution with $\mu = 7$ hours. A quality control supervisor selects a simple random sample of *n* batteries every hour and measures the lifetime of each. If she is convinced that the mean lifetime of all batteries produced that hour is less than 7 hours at the 5% significance level, then all those batteries are discarded.

   (a) Define the parameter of interest and state appropriate hypotheses for the quality control supervisor to test.

   (b) Since testing the lifetime of a battery requires draining the battery completely, the supervisor wants to sample as few batteries as possible from each hour's production. She is considering a sample size of $n = 4$. Explain why this sample size may lead to problems in carrying out the significance test from (a).

   (c) Describe a Type I and a Type II error in this situation and the consequences of each.

   (d) The quality control officer is considering changing the significance level of the test to 1%. Discuss the impact this might have on error probabilities and the power of the test, and describe the practical consequences of this change.

2. The CEO of a large company would like to increase the productivity of his employees. He has heard that listening to Pandora while working helps people stay focused and will increase productivity. However, he does not want to pay for the program (Pandora One with no commercials ☺) if it is ineffective. Given the following hypotheses, identify Type I and Type II errors and describe the consequences of each for the CEO. $H_0: \mu = 0$ and $H_a: \mu > 0$, where μ is the mean increase in productivity for his employees while listening to Pandora.

3. *Daphnia pulicaria* is a water flea—a small crustacean that lives in lakes and is a major food supply for many species of fish. When fish are present in the lake water, they release chemicals called kairomones that induce water fleas to grow long tail spines that make them more difficult for the fish to eat. One study of this phenomenon compared the relative length of tail spines in *Daphnia pulicaria* when kairomones were present to when they were not. Below are data on the relative tail spine lengths, measured as a percentage of the entire length of the water flea.

(a) Do the data provide convincing evidence that the mean relative tail spine length of *Daphnia* is longer in the presence of fish kairomones? Assume the conditions for inference have been met.

	Relative tail spine length		
	n	$\bar{x}$	s
Fish kairomone present	214	37.26	4.68
Fish kairomone absent	152	30.67	4.19

(b) What additional information would you need to confirm that the conditions for this test have been met?

4. Is the ratio of male births to female births even? A simple random sample of births in a major metropolitan area found 1345 boys among 2546 firstborn children. A 99% confidence interval for p = the proportion of male births in this population is given by (0.5028, 0.5538).

(a) Use the confidence interval to draw a conclusion about the hypothesis $H_0: p = 0.5$ against $H_a: p \neq 0.5$. Be sure to indicate the appropriate significance level.

(b) What information is provided by the confidence interval that would <u>not</u> be provided by a test of significance alone?

5. A French study was conducted in the 1990s to compare the effectiveness of using an instrument called a cardiopump with the effectiveness of using traditional cardiopulmonary resuscitation (CPR) in saving lives of heart attack victims. Heart attack patients in participating cities were treated with either a cardiopump or CPR, depending on whether the individual's heart attack occurred on an even-numbered or an odd-numbered day of the month. Before the start of the study, a coin was tossed to determine which treatment, a cardiopump or CPR, was given on the even-numbered days. The other treatment was given on the odd-numbered days. In total, 754 patients were treated with the cardiopump, and 37 survived at least one year; while 746 patients were treated with CPR, and 15 survived at least one year.

(a) Perform a statistical test to determine whether the survival rate for patients treated with a cardiopump is significantly higher than the survival rate for patients treated with CPR.

(b) Interpret the p-value in the context of the study.

6. A serum cholesterol level above 250 milligrams per deciliter (mg/dl) of blood is a risk factor for cardiovascular disease in humans. At a medical center in St. Louis, a study to test the effectiveness of a new cholesterol-lowering drug was conducted. One hundred people with cholesterol levels between 250 mg/dl and 300 mg/dl were available for this study. Fifty people were assigned at random to each of two treatment groups. One group received the standard cholesterol-lowering medication and the other group received the new drug. After taking the drug for 3 weeks, the 50 subjects who received the standard treatment had a mean decrease in cholesterol level of 10 mg/dl with a standard deviation of 8 mg/dl, and the 50 subjects who received the new drug had a mean decrease of 18 mg/dl with a standard deviation of 12 mg/dl.

(a) Construct and interpret a 95% confidence level for the mean difference in decrease in cholesterol – level between the standard drug and the new drug.

(b) Interpret the confidence level of 95% in context.