Question 1

Alex and Sarah enjoy riding their bikes around Valley Forge park. Alex rode 25 laps, averaging 40 minutes with a standard deviation of 5 minutes, and Sarah rode 36 laps, averaging 43 minutes with a standard deviation of 4 minutes.

1. What are the null and alternative hypotheses for Alex and Sarah having the same mean lap time?

2. What is the test statistic for the null hypothesis? Do you reject at the $\alpha = .01$ level?

3. What is the 98% confidence interval for the difference in times of Alex and Sarah.

Question 2

Alex is teaching two classes, one in the business school with 64 students and one in the college with 49 students. He thinks the business school students are equally likely to support a flat tax as his students in the college. He takes a poll and 32 students in the business school section support a flat tax and 19 in the college section support a flat tax.
1. What are the null and alternative hypotheses?

2. What is the test statistic? Do you reject at the $\alpha = .05$ level?

3. What is the 90% confidence interval for the difference in proportions of students who support a flat tax.

**Question 3 - Bayes Theorem revisited**

For a 3 events we have the following conditional probability formula:

$$P(A_1|B) = \frac{P(B|A_1)P(A_1)}{P(B|A_1)P(A_1) + P(B|A_2)P(A_2) + P(B|A_3)P(A_3)}$$

(1)

You have a bag with 1000 coins. 30 are trick coins, with two heads, 900 are fair coins, where the probability of flipping heads is .5, and the remaining 70 are unfair coins, where the probability of flipping heads is 2/3.

1. You have one of each type of coin. What is the probability of flipping at least one head?
2. You have one of each type of coin. What is the probability of flipping at least one tail?

3. You randomly pick a coin out of the bag. What is the probability that the coin was a trick coin, conditional on the coin you picked out not being a fair coin?

4. You randomly pick a coin out of the bag, flip it 10 times and observe 6 heads. What is the probability that this coin is the fair coin?

5. You randomly pick a coin out of the bag, flip it 10 times and observe 6 heads. What is the probability that this coin is the coin with a 2/3 probability of flipping heads?

**Question 4**

Alex travels between Philly and NYC a lot. Because he is a Statistics professor he keeps track of his travel times. His average travel time is 142 minutes and the standard deviation of his trip times is 107 minutes. The histogram of his 11 trip times is below.
1. Perform a hypothesis test that his mean travel time is equal to 2 hours. What is the p-value?

2. Construct a 99.9% CI. Explain why this does or does not make sense.

3. Now assume that travel times are normally distributed with a mean of 2 hours and a standard deviation of 1 hour. What is the probability of observing a travel time of 142 minutes or more?

**Question 5**

Alex has a magic beer fridge in which he places 6 blue moons and 3 coors lights. Each time he takes a blue moon out of the fridge another blue moon magically appears in the fridge. Each time he takes a coors light, two coors lights magically appear in the fridge. When Alex takes multiple beers out of the fridge, he takes them one at a time, so that the new beers can magically appear before he selects his next beer.

1. Alex chooses two beers at random out of the fridge. What is the probability that they are both blue moons?
2. Alex chooses 3 beers out of the fridge. What is the probability distribution for the number of blue moons?

3. What is the mean number of blue moons Alex chooses?

4. What is the probability his 3rd beer is a blue moon?
Question 6

The total number of beers consumed at Phillies games has a standard deviation of 10,000.

1. Alex wants to know the mean number of beers consumed with a margin of error of 500 or less. How many games must he sample?

2. Alex wants to know the proportion of people that consume beers at Phillies games to within .05. How many people must he sample?

3. Now assume that we want to know if Phillies fans and fans of the visiting team drink the same number of beers at Phillies games. Alex takes a sample of 100 Phillies fans and finds that they drink 1.5 beers per game with a known standard deviation of .75. Alex takes a sample of 60 fans of the visiting team and finds that they drink 1.3 beers with a known standard deviation of .65 beers. Perform a hypothesis test with a 95% confidence level that the two groups have the same mean. Do we accept or reject the null?

4. What is the 95% CI for the difference between the two groups?