Math 1110 – Statistics **Name ______________________________________**
Problem Set 6 - Ch 8 Hypothesis Tests **20 pts**
Summer 2017 **Due: Monday, July 24**

For each of the problems, **1)** use either the ***critical value*** **or** ***p-value*** method for testing hypotheses. **2)** Identify the null and alternative hypotheses, test statistic, P-value (or range of P-values), critical value(s), using Tables A-2 and A-3 also include your ***calculator*** output and **3)** state your final conclusion that addresses the original claim.

1. Any basketball fan knows that Shaquille O'Neal, one of the NBA's most dominant centers of the last twenty years, always had difficulty shooting free throws. Over the course of his career, his overall made free-throw percentage was 53.3%. During one offseason, Shaq had been working with an assistant coach on his free-throw technique. During the next season, a simple random sample showed that Shaq made 26 of 39 free-throw attempts. Test the claim at the 0.05 SL that Shaq has significantly improved his free-throw shooting.

$H_0 : p = 0.533$
$H_a : p > 0.533$

$\hat{p} = \frac{26}{39} = 0.667$

With $\alpha = 0.05$ (right tail test), the critical value is $z_c = 1.645$

Test Statistic:

$$z = \frac{\hat{p} - p}{\sqrt{\frac{pq}{n}}} = \frac{0.667 - 0.533}{\sqrt{\frac{0.533 \cdot 0.467}{39}}} = 1.68 \qquad P(z > 1.68) = 0.0465$$

Critical Value Method: Since, 1.68 > 1.645, Reject H_0

P-Value Method: Since 0.0465 < 0.05 Reject H_0

Calculator Output: 1-PropZTest: z = 1.6731, p = 0.04715

There is sufficient evidence to support the claim that Shaq has improved his free-throw shooting.

2. The EPA reports that the exhaust emissions for a certain car model has had a normal distribution with a mean of 1.5 grams of nitrous oxide per mile and a standard deviation of 0.4. A simple random sample of 28 cars is taken and the mean level of exhaust emitted for this sample is 1.2 grams. Test the car manufacturer claim at the 0.01 SL that their new process reduces the mean level of exhaust for this car model.

$H_0 : \mu = 1.5$
$H_a : \mu < 1.5$

$\sigma = 0.4 \quad \bar{x} = 1.2 \quad n = 28$

With $\alpha = 0.01$ (left tail test), the critical value is $z_c = -2.33$

Test Statistic:

$$z = \frac{\bar{x} - \mu}{\sigma / \sqrt{n}} = \frac{1.2 - 1.5}{0.4 / \sqrt{28}} = -3.97 \qquad P(z < -3.97) = 0.0001$$

Critical Value Method: Since, -3.97 < -2.33, Reject H_0

P-Value Method: Since 0.0001 < 0.01 Reject H_0

Calculator Output: Z-Test: z = -3.9686, p = 0.000036

There is sufficient evidence to suggest the average exhaust emissions is less than 1.5 grams of nitrous oxide for this car model.

3. The amount of water consumed each week by Montana residences is normally distributed. A simple random sample of 10 residences was taken with a sample mean of 120.3 gallons and a standard deviation of 10.0 gallons. Test the claim at the 0.10 SL that the average amount of water consumed is not 125 gallons.

$H_0 : \mu = 125$
$H_a : \mu \neq 125$

$s = 10 \quad \bar{x} = 120.3 \quad n = 10$

With $\alpha = 0.01$ (two tail test) and 9 df, the critical value is $z_c = \pm 1.833$

Test Statistic:

$$t = \frac{\bar{x} - \mu}{s / \sqrt{n}} = \frac{120.3 - 125}{10 / \sqrt{10}} = -1.49 \qquad P(t < -1.49 \text{ or } t > 1.49) = 0.10 < P < 0.20$$

Critical Value Method: Since, -1.49 > -1.833, Fail to Reject H_0

P-Value Method: Since, P > 0.01 Fail to Reject H_0

Calculator Output: T-Test: t = -1.486, p = 0.17137

There is not enough sufficient evidence to suggest that the average amount of water consumed is not 125 gallons each week.

4. Two Polish math professors and their students spun a Belgian euro coin 250 times. It landed on heads 140 times. One of the professors concluded that the coin was minted asymmetrically. A representative from the Belgian mint said that the result was just by chance. Is the math professor or the representative from the Belgian mint correct? At the 0.01 SL test the math professor's claim that the coin is not fair.

$H_0 : p = 0.5$

$H_a : p > 0.5$

$\hat{p} = \dfrac{140}{250} = 0.56$

With $\alpha = 0.01$ (right tail test), the critical value is $z_c = 2.33$

Test Statistic:

$$z = \frac{\hat{p} - p}{\sqrt{\frac{pq}{n}}} = \frac{0.56 - 0.5}{\sqrt{\frac{0.5 \cdot 0.5}{250}}} = 1.90$$

Critical Value Method: Since, 1.90 < 2.33, Fail to Reject H_0

$P(z > 1.90) = 0.0287$ **P-Value Method:** Since 0.0287 > 0.01, Fail to Reject H_0

Calculator Output: 1-PropZTest: z = 1.897, p = 0.02889

There is not enough evidence to support the claim that the coin is not fair. Therefore, the representative from Belgian is correct.

5. In a random sample of 300 patients, 21 experienced nausea. A drug manufacturer claims that fewer than 10% of patients who take its new drug for treating Alzheimer's disease will experience nausea. Test this claim at the 0.05 SL.

$H_0 : p = 0.1$

$H_a : p < 0.1$

$\hat{p} = \dfrac{21}{300} = 0.07$

With $\alpha = 0.05$ (left tail test), the critical value is $z_c = -1.645$

Test Statistic:

$$z = \frac{\hat{p} - p}{\sqrt{\frac{pq}{n}}} = \frac{0.07 - 0.1}{\sqrt{\frac{0.1 \cdot 0.9}{300}}} = -1.73$$

Critical Value Method: Since, -1.73 < -1.645, Reject H_0

$P(z < -1.73) = 0.0418$ **P-Value Method:** Since 0.0418 < 0.05, Reject H_0

Calculator Output: 1-PropZTest: z = -1.7325, p = 0.04163

There is enough evidence to support the claim that fewer than 10% of patients who take the new drug experience nausea.

6. A credit card company wondered whether giving frequent flier miles for every purchase would increase card usage. The population mean had been $2500 per year. A simple random sample of 51 credit card customers found the sample mean to be $2542 with a standard deviation of $110. Test the claim at the 0.05 SL that the credit card mean usage for the population is now more than $2500 per year.

$H_0 : \mu = 2500$

$H_a : \mu > 2500$

$s = 110 \quad \bar{x} = 2542 \quad n = 51$ With $\alpha = 0.05$ (right tail test) and 50df, the critical value is $t_c = 1.676$

Test Statistic:

$$t = \frac{\bar{x} - \mu}{s/\sqrt{n}} = \frac{2542 - 2500}{110/\sqrt{51}} = 2.73$$

Critical Value Method: Since, 2.73 > 1.676, Reject H_0

$P(t > 2.73) < 0.005$ **P-Value Method:** Since, 0.005 < 0.05, Reject H_0

Calculator Output: T-Test: t = 2.7267, p = 0.0044

There is enough sufficient evidence to support the claim that the mean credit card usage for this population is more than $2500 per year.