This handout contains sample questions similar to those which may appear on the final examination. The final examination is comprehensive and thus may include some topics which do not appear on this review sheet. In addition to looking over this sheet you should study your class notes, your textbook, your homework assignments, and other tests.

1. Many companies today have a mandatory drug testing policy for their employees. To minimize the cost of testing, samples from 6 people are combined. If the mixture tests negative then all 6 individual employees are also negative. Find the probability of a positive result for 6 samples combined into 1 mixture assuming the probability of an individual sample testing positive is 0.01.

A mixture of 6 samples will test positive if at least one of the individual samples in the mixture is positive. The probability of at least one positive individual in a mixture of 6 is

\[
P(\text{at least one positive}) = 1 - P(\text{no positive})
= 1 - P(6 \text{ negative})
= 1 - (0.99)^6
\approx 0.0585
\]

2. Mars, Inc. claims that 20% of its plain M&M candies are red.

(a) Find the probability that when 15 plain M&M candies are randomly selected, exactly 20% are red.

The probability that an individual candy is red is \( p = 0.20 \). A candy is either red or not red, so we may treat the number of red candies as a binomial random variable. 20% of 15 is 3, so if \( X \) is the value of the binomial random variable representing the number of red candies out of 15, we are asked to find \( P(X = 3) = 0.250 \) according to Table 2 \((n = 15, x = 3, p = 0.20)\).

(b) Find the probability that when 15 plain M&M candies are randomly selected, less than 20% are red.

Less than 20% means less than 3, in other words 0, 1, or 2.

\[
P(X < 3) = P(X = 0) + P(X = 1) + P(X = 2)
= 0.035 + 0.132 + 0.231
= 0.398
\]

3. In a holiday poll, respondents were asked how a fruitcake should be used. One hundred thirty-two people said a fruitcake should be used as a doorstop, and 880 others indicated other uses (birdfeed, landfill, gift, etc). If one of these people is randomly selected, what is the probability of getting someone who recommends using a fruitcake as a doorstop?
There were a total of $n = 132 + 880 = 1012$ people who responded to the poll. Out of this total $x = 132$ said that a fruitcake should be used as a doorstop. Thus the desired probability is

$$p = \frac{x}{n} = \frac{132}{1012} \approx 0.130$$

4. A state health department reports a 10% rate of HIV infection for an “at-risk” population. In one region, an intensive education program is used in an attempt to lower that 10% rate. After the program, a follow-up study of 200 at-risk individuals is conducted.

(a) If the education program had no effect on the HIV infection rate, find the mean and standard deviation for the number of HIV cases in a group of 200 at-risk people.

A person is either HIV infected or not, so we can treat the number of people out of 200 who are HIV infected as a binomial random variable. Then if the number of trials is $n = 200$ and the probability of an individual being infected is $p = 0.10$, then

$$\mu = np = (200)(0.10) = 20.0$$

$$\sigma = \sqrt{npq} = \sqrt{(200)(0.10)(0.90)} \approx 4.2$$

(b) What is the probability that in a sample of $n = 200$ at-risk people there will be between 15 and 30 HIV-infected people?

Since $np = (200)(0.10) = 20.0 > 5$ and $nq = (200)(0.90) = 180 > 5$, we can use the normal probability distribution as an approximation to the binomial probability distribution. In this case we must apply a continuity correction to the discrete interval $[15, 30]$. The values of a continuous random variable that would be rounded to a discrete random variable in the interval $[15, 30]$ are $[14.5, 30.5]$. For the numbers 14.5 and 30.5 we must calculate $z$-scores.

$$x = 14.5 : z = \frac{14.5 - 20.0}{4.2} \approx -1.31$$

$$x = 30.5 : z = \frac{30.5 - 20.0}{4.2} \approx 2.50$$

Thus from the normal probability table we see that

$$P(15 \leq x \leq 30) \approx P(14.5 \leq x < 30.5) = P(-1.31 \leq z \leq 2.50) = 0.4049 + 0.4938 = 0.8987.$$
(c) Among the 200 people in the follow-up study, 7% tested positive for the HIV virus. Does this result suggest that the program is effective in reducing the HIV infection rate among at-risk populations? Please justify your answer.

We must determine if the 7% infection rate among a sample of 200 people is unusual or typical. Seven percent of 200 is 14, so we will calculate the z-score associated with $x = 14$.

$$z = \frac{x - \mu}{\sigma} = \frac{14 - 20}{4.2} \approx -1.41$$

Since this z-score falls between −2 and 2 it is considered typical and not unusual. This suggests that the program is not effective in reducing the HIV infection rate, since this sample could have occurred by chance.

5. A study of consumer smoking habits includes 200 married people (54 of whom smoke), 100 divorced people (38 of whom smoke), and 50 adults who never married (11 of whom smoke). If 1 person is randomly selected from this sample, find the probability of getting someone who is divorced or smokes.

We can summarizes the data given in the following table.

<table>
<thead>
<tr>
<th>Marital Status</th>
<th>Smoker</th>
<th>Non-smoker</th>
</tr>
</thead>
<tbody>
<tr>
<td>Married</td>
<td>54</td>
<td>146</td>
</tr>
<tr>
<td>Divorced</td>
<td>38</td>
<td>62</td>
</tr>
<tr>
<td>Never married</td>
<td>11</td>
<td>39</td>
</tr>
</tbody>
</table>

Using the Addition Rule for probability we find that

$$P(\text{Divorced OR Smoker}) = P(\text{Divorced}) + P(\text{smoker}) - P(\text{Divorced AND Smoker})$$

$$= \frac{100}{350} + \frac{103}{350} - \frac{38}{350}$$

$$\approx 0.471.$$  

6. Find the probability of getting at least one girl when a couple has 7 children. Assume that boys and girls are equally likely and that the gender of any child is independent of the others. 

We will assume that the probability of a girl being born is $p = 0.50$, which would also be the probability that a boy is born.

$$P(\text{at least one girl}) = 1 - P(\text{no girls})$$

$$= 1 - (0.50)^7$$

$$\approx 0.992.$$  

7. The number of golf balls ordered by customers at a pro shop has the following probability distribution.

<table>
<thead>
<tr>
<th>$x$</th>
<th>$P(x)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0.14</td>
</tr>
<tr>
<td>6</td>
<td>0.29</td>
</tr>
<tr>
<td>9</td>
<td>0.36</td>
</tr>
<tr>
<td>12</td>
<td>0.11</td>
</tr>
<tr>
<td>15</td>
<td>0.10</td>
</tr>
</tbody>
</table>
Find the mean and variance in the number of golf balls ordered.

The formulas for mean and variance of a discrete random variable $X$ with probability distribution $P(X)$ are

$$\mu = \sum (xP(x)) \quad \text{and} \quad \sigma^2 = \sum (x^2P(x)) - \mu^2.$$

Thus if we add some extra columns to the table given above we find that

<table>
<thead>
<tr>
<th>$x$</th>
<th>$P(x)$</th>
<th>$xP(x)$</th>
<th>$x^2P(x)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0.14</td>
<td>0.42</td>
<td>1.26</td>
</tr>
<tr>
<td>6</td>
<td>0.29</td>
<td>1.74</td>
<td>10.44</td>
</tr>
<tr>
<td>9</td>
<td>0.36</td>
<td>3.24</td>
<td>29.16</td>
</tr>
<tr>
<td>12</td>
<td>0.11</td>
<td>1.32</td>
<td>15.84</td>
</tr>
<tr>
<td>15</td>
<td>0.10</td>
<td>1.50</td>
<td>22.50</td>
</tr>
<tr>
<td>Total</td>
<td>1.00</td>
<td>8.22</td>
<td>79.20</td>
</tr>
</tbody>
</table>

Thus we see that

$$\mu = 8.22 \quad \text{and} \quad \sigma^2 = 79.20 - (8.22)^2 \approx 11.63$$

8. On a multiple-choice test with 50 questions, each question has possible answers of a, b, c, d, and e, one of which is correct. For students who guess at all answers, find the mean and standard deviation for the number of correct answers.

A guess on the multiple-choice test is either correct or incorrect, thus the number of correct guesses is a binomial random variable. The number of trials is $n = 50$ and the probability of guessing correctly on a single question is $p = 1/5 = 0.20$.

$$\mu = np = (50)(0.20) = 10.0$$
$$\sigma = \sqrt{npq} = \sqrt{(50)(0.20)(0.80)} \approx 2.8$$

9. A woman pays $206 for a one-year life insurance policy with coverage of $60,000. If the probability that she will live through the year is 0.9994, what is the expected value for the insurance policy?

We can think of the insurance policy as a discrete random variable with a value of $-\$206$ if the woman survives the year and a value of $\$60,000 - \$206 = \$59,794$ if she dies. The expected value (or mean) of the random variable is

$$\mu = \sum (xP(x)) = (-206)(0.9994) + (59794)(0.0006) = -\$170.$$

10. If you randomly select a person from the population of people who have died in recent years, there is a 0.0478 probability that the person’s death was caused by an accident. A police detective is suspicious about 5 persons whose deaths were categorized as accidental. Find the probability that when 5 dead persons are randomly selected, their deaths were all accidental.

Assuming that all five deaths are independent of one another then

$$P(5 \text{ accidental deaths}) = (0.0478)^5 \approx 0.000000250$$
11. The probability of winning the Keystone Jackpot is $1/36,549,744$. If you play the lottery each week for 50 years (or 2600 times), find the mean and standard deviation for the number of wins (express your answers with three significant digits).

When you play the lottery you either win the jackpot or you do not. Thus the number of wins can be thought of as a binomial random variable. The number of trials is $n = 2600$ and the probability of success on a single trial is $p = 1/36,549,744$.

\[ \mu = np = (2600) \left( \frac{1}{36549744} \right) \approx 0.0000711 \]

\[ \sigma = \sqrt{np(1-p)} = \sqrt{(2600) \left( \frac{1}{36549744} \right) \left( \frac{36549743}{36549744} \right)} \approx 0.00843 \]

12. When playing blackjack with a single 52-card deck of cards at a casino, you are dealt the first card from the top of a shuffled deck.

(a) What is the probability you get a club or an ace?

Using the Addition Rule for probability we find that

\[ P(\text{Club OR Ace}) = P(\text{Club}) + P(\text{Ace}) - P(\text{Club AND Ace}) \]

\[ = \frac{13}{52} + \frac{4}{52} - \frac{1}{52} \]

\[ \approx 0.308. \]

(b) What is the probability you get a two or an ace?

Using the Addition Rule for probability we find that

\[ P(\text{Two OR Ace}) = P(\text{Two}) + P(\text{Ace}) - P(\text{Two AND Ace}) \]

\[ = \frac{4}{52} + \frac{4}{52} - 0 \]

\[ \approx 0.154. \]

Note that the $P(\text{Two AND Ace}) = 0$ since the events of a card being a two and being an ace are mutually exclusive.

13. In a criminal case 9 different crime victims listened to voice recordings of 5 different men. All 9 victims identified the same voice as that of the criminal. If the voice identifications were all made independently and are random guesses, find the probability that all 9 victims would select the same voice. What does this probability imply about the guilt or innocence of the man identified? You must justify your answer.

Think of the victims as being numbered 1 through 9 and suppose they make the identifications in that order. The first victim can pick any one of the five voices. The remaining eight victims must then pick the same voice as the first victim. Thus the probability that all nine victims pick the same voice is really just the probability that the last eight victims pick the same voice as the first victim. Since there are five voices from which to pick the probability of a single victim picking one voice is $p = 1/5 = 0.20$.

\[ P(9 \text{ victims pick same voice}) = (0.20)^8 \approx 0.00000256 \]
14. When the contents of 1200 boxes of cereal were weighed, 432 were found to be underweight. Construct the 96% confidence interval estimate for the proportion of cereal boxes which are underweight.

A cereal box is either underweight or not, so this is yet another example of a binomial experiment. The sample size is large \( n = 1200 > 30 \). The random variable describing the number of underweight boxes in the sample is \( x = 432 \). The sample proportion of underweight cereal boxes is

\[
\hat{p} = \frac{x}{n} = \frac{432}{1200} = 0.360
\]

The sample of proportion of non-underweight boxes is

\[
1 - \hat{p} = 1 - 0.360 = 0.640.
\]

We will use the normal distribution to approximate the binomial distribution. At the 96% confidence level the value of \( \alpha = 0.04 \) and thus \( \alpha/2 = 0.02 \). The critical value corresponding to probability \( 0.5 - 0.02 = 0.48 \) is \( z_{\alpha/2} = 2.054 \) according to Table V. Thus the margin of error in this estimate of the population proportion is

\[
E = z_{\alpha/2} \sqrt{\frac{\hat{p}(1 - \hat{p})}{n}} = 2.054 \sqrt{\frac{(0.360)(0.640)}{1200}} \approx 0.028
\]

Note that we are rounding the margin of error to three decimal places just like the sample proportions. Therefore the 96% confidence interval estimate of the sample proportion of underweight cereal boxes is

\[
(\hat{p} - E, \hat{p} + E) = (0.360 - 0.028, 0.360 + 0.028) = (0.332, 0.388).
\]

15. An earlier survey showed that 57% of adults had seen the movie Titanic.

(a) How many people must be surveyed to produce a sample proportion in error by no more than 3% at the 95% confidence level?

We are being asked to estimate a sample size when we know a previous estimate of the proportion of adults who have seen the movie is 57% or in other words \( \hat{p} = 0.570 \). Therefore \( 1 - \hat{p} = 1 - 0.570 = 0.430 \). The margin of error in our estimate should be 3% or \( E = 0.03 \). At the 95% confidence level the value of \( \alpha = 0.05 \) and thus \( \alpha/2 = 0.025 \). The critical value corresponding to probability \( 0.5 - 0.025 = 0.475 \) is \( z_{\alpha/2} = 1.960 \) according to Table V. Thus the sample size needed for this estimate is

\[
n = \left( \frac{z_{\alpha/2}}{E} \right)^2 \hat{p}(1 - \hat{p}) = \left( \frac{1.96}{0.03} \right)^2 (0.570)(0.430) = 1046.2 \approx 1047
\]

Notice that we must always round sample sizes up to the next whole number.

(b) How many people must be surveyed if no prior estimate of the sample proportion is available?

We are being asked to estimate a sample size when no previous estimate of the proportion of adults who have seen the movie is available, in other words we do not know \( \hat{p} \). The margin of error in our estimate should be 3% or \( E = 0.03 \). At the 95% confidence level the value of \( \alpha = 0.05 \) and thus \( \alpha/2 = 0.025 \). The critical value corresponding to
probability $0.5 - 0.025 = 0.475$ is $z_{\alpha/2} = 1.960$ according to Table V. Thus the sample size needed for this estimate is

$$n = \left( \frac{z_{\alpha/2}}{E} \right)^2 \cdot 0.25 = \left( \frac{1.96}{0.03} \right)^2 \cdot 0.25 = 1067.1 \approx 1068$$

Notice that we must always round sample sizes up to the next whole number. Also notice that when no prior estimate of sample proportion is available we must take a larger sample.

16. An advertising agency claims that the mean length of television commercials is less than 30 seconds.

(a) Express the claim in symbolic form.

If $\mu$ represents the mean length of commercials, then the claim above can be expressed in the symbolic form: $\mu < 30$.

(b) Identify the null hypothesis.

Since the null hypothesis always contains a condition of equality then the null hypothesis is the logical opposite of the claim above. The null hypothesis can be expressed symbolically as, $H_0 : \mu = 30$.

(c) Identify the alternative hypothesis.

The alternative hypothesis does not contain a condition of equality, thus the alternative hypothesis is the original claim in this case. It can be expressed symbolically as, $H_1 : \mu < 30$.

(d) Identify the test as being left-tailed, right-tailed, or two-tailed.

The alternative hypothesis can be used to determine whether a test is left-tailed, right-tailed, or two-tailed. The inequality symbol always “points” in the direction of the tail of the test. In this example the inequality symbol is “less than” ($<$) and therefore this is a left-tailed test.

(e) Assuming the conclusion is to reject the null hypothesis, state the conclusion in non-technical terms.

Since the original claim is the alternative hypothesis and the null hypothesis is rejected, the conclusion can be stated as,

“The sample data support the claim that the mean length of commercials is less than 30 seconds.”

(f) Assuming the conclusion is failure to reject the null hypothesis, state the conclusion in non-technical terms.

Since the original claim is the alternative hypothesis and the null hypothesis is not rejected, the conclusion can be stated as,

“There is not sufficient sample data to support the claim that the mean length of commercials is less than 30 seconds.”

17. A pharmaceutical company makes a pill intended for children susceptible to seizures. The pill is supposed to contain 20.0 mg of phenobarbital. A random sample of 20 pills yielded the amounts (in mg) listed below. Do the pills contain the proper amount of phenobarbital
at the $\alpha = 0.01$ significance level? (Hint: The sample standard deviation of the weights is $s = 3.5$.)

\[
\begin{array}{cccccc}
27.5 & 26.0 & 22.9 & 23.5 & 23.0 \\
23.9 & 26.3 & 20.9 & 22.5 & 21.7 \\
28.4 & 16.1 & 19.3 & 17.2 & 17.9 \\
21.7 & 23.0 & 16.5 & 24.1 & 22.3 \\
\end{array}
\]

(a) State the original claim in symbolic form.

*If $\mu$ represents the mean amount of phenobarbital measured in milligrams in the pills, then the claim above can be expressed in the symbolic form: $\mu = 20.0$.*

(b) In non-technical language describe the type II error for this hypothesis test.

*A type II error occurs when we fail to reject a false null hypothesis. In this case a type II error occurs when we fail to reject claim that the pills contain an average of 20.0 milligrams of phenobarbital, when in fact they do not contain that amount.*

(c) Find the critical value of $t$ for this hypothesis test.

*Since the sample size is only $n = 20$, which is considered a small sample, we must use the Student-$t$ Distribution. The degrees of freedom becomes $df = 19$. The original claim is the null hypothesis. The alternative hypothesis is the claim that $\mu \neq 20.0$ and thus we are conducting a two-tailed test. The critical value of $t$ is the value of $t$ for a two-tailed test with $\alpha = 0.01$ and $df = 19$. From the Student-$t$ table this value is $t_{\alpha/2} = \pm 2.86$.*

(d) Do the pills contain the proper amount of phenobarbital at the $\alpha = 0.01$ significance level?

*We must calculate the sample mean before we can find the test statistic.*

\[
\overline{x} = \frac{\sum x}{n} = \frac{444.7}{20} \approx 22.24
\]

*The test statistic is then*

\[
t_0 = \frac{\overline{x} - \mu}{s/\sqrt{n}} = \frac{22.24 - 20.0}{3.5/\sqrt{20}} \approx 2.862.
\]

*The test statistic is (barely) larger than the critical value. Thus we reject the null hypothesis. We conclude that the sample data warrant rejection of the claim that the mean amount of phenobarbital in the pills is 20.0 milligrams.*

18. A newspaper survey was the basis for a report that “55% of gun owners favor stricter gun laws.” Assume that the survey group consisted of 504 randomly selected gun owners. Test the claim that the majority (more than 50%) of gun owners favor stricter gun laws. Use a 0.01 significance level.

(a) State the null and alternative hypotheses in symbolic form.

*The original claim is that the proportion of gun owners favoring stricter gun laws is greater than 0.50. The original claim lacks a condition of equality and is thus the alternative hypothesis. Therefore the null and alternative hypotheses can be expressed in symbolic form as*

\[
\begin{align*}
H_0 & : p = 0.50 \\
H_1 & : p > 0.50
\end{align*}
\]
(b) Find the value of the test statistic for this hypothesis test.

*Based on the survey data mentioned we see that the sample proportion of gun owners favoring stricter gun laws is $\hat{p} = 0.55$. The value of test statistic is then*

$$z_0 = \frac{\hat{p} - p}{\sqrt{\frac{p(1-p)}{n}}} = \frac{0.55 - 0.50}{\sqrt{\frac{0.50(1-0.50)}{504}}} \approx 2.24.$$  

(c) Find the critical value for this hypothesis test at the 0.01 significance level.

*By examining the alternative hypothesis, we see that we are conducting a right-tailed test with $\alpha = 0.01$. According to the normal probability table, the critical value $z_\alpha = 2.33$.  

(d) Test the claim that the majority (more than 50%) of gun owners favor stricter gun laws. 

*Since the test statistic does not fall in the critical region, we fail to reject the null hypothesis. Therefore we conclude that the sample data do not support the claim that the majority of gun owners favor stricter gun laws.*

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19. A dental X-ray machine bears a label stating that the machine gives radiation dosages with a mean of less than 5.00 milliroentgens. Sample data consist of 23 randomly selected observations with a mean of 4.13 milliroentgens and a standard deviation 1.91 milliroentgens. Using a 0.01 level of significance, test the claim stated on the label.

(a) State the label’s claim in symbolic form.

*If $\mu$ represents the mean X-ray dosage given by the machine, then the original claim is that $\mu < 5.00$. 

(b) Is the original claim the null or alternative hypothesis?

*Since the original claim does not contain a condition of equality, it is the alternative hypothesis, $H_1 : \mu < 5.00$. 

(c) Find the critical value for this hypothesis test.

*Since the sample size is only $n = 23$, which is considered a small sample, we must use the Student-t Distribution. The degrees of freedom becomes $df = n - 1 = 22$. The alternative hypothesis is the claim that $\mu < 5.00$ and thus we are conducting a left-tailed test. The critical value of $t$ is the value of $t$ for a one-tailed test with $\alpha = 0.01$ and $df = 22$. From the Student-t table this value is $t_\alpha = -2.51$. 

9
(d) Using a 0.01 level of significance, test the claim stated on the label.

The test statistic is

\[ t_0 = \frac{\bar{x} - \mu}{s/\sqrt{n}} = \frac{4.13 - 5.00}{1.9/\sqrt{23}} \approx -2.20. \]

The test statistic does not fall into the critical region and thus we fail to reject the null hypothesis. We conclude that the sample data do not support the claim that the mean radiation dosage given by the machine is less than 5.00 milliroentgens.

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20. The quality control manager of a company which produces telephone-answering machines considers production to be “out of control” when the overall rate of defects exceeds 4%. Testing of a random sample of 150 machines reveals that 9 are defective, so the sample percentage of defective answering machines is 6%. The manager claims that this is only a chance occurrence, so that production is not really out of control. Use a 0.05 significance level to test the manager’s claim.

In this example the important sample statistics are the sample size \( n = 150 \) and the sample proportion \( \hat{p} = x/n = 9/150 = 0.06 \).

The symbolic form of the claim made above is \( p \leq 0.04 \) where \( p \) represents the fraction of defective answering machines. Since the manager is claiming that production is not out of control then he is claiming that the defect rate is not exceeding (and therefore less than or equal to) 4%. Since this claim contains a condition of equality, it is the null hypothesis, \( H_0 : p \leq 0.04 \). Therefore the alternative hypothesis is \( H_1 : p > 0.04 \). The test to be performed is a right-tailed test at the \( \alpha = 0.05 \) significance level on a large sample (since \( n > 30 \)). Thus from the normal probability distribution, the critical value of \( z_\alpha = 1.645 \). The test statistic is

\[ z_0 = \frac{\hat{p} - p}{\sqrt{p(1-p)/n}} = \frac{0.06 - 0.04}{\sqrt{0.04(1 - 0.04)/150}} = 1.25. \]
Since the test statistic does not fall into the critical region, then the null hypothesis is not rejected. Now since the original claim is the null hypothesis and the null hypothesis is not rejected, the conclusion can be stated as,

“The sample data do not warrant rejection of the claim at the 0.05 significance level that the defect rate of the answering machines is less than or equal to 4%.”

Production does not seem to be out of control at the answering machine factory.

21. A newspaper ran a report about a University of Southern California poll of 1245 students from the western United States. It was reported that 8% of those surveyed believe that Jim Morrison (of The Doors) is still alive. The newspaper article began with the claim that “almost 1 out of 10” students thinks that Jim Morrison is alive. At the $\alpha = 0.025$ significance level, test the claim that the true percentage is less than 10%.

(a) Identify the type I error for this test.

Type I error is made when we reject a true null hypothesis. The original claim is that the proportion of students from the western US who believe Jim Morrison is still alive is less than 10%. Expressed in symbolic form this is $p < 0.10$. Since that statement does not contain a condition of equality, the original claim is the alternative hypothesis. The null hypothesis is $H_0: p \geq 0.10$. Thus the Type I error in this situation would be the mistake of rejecting the claim that at least 10% of students in the western US believe that Jim Morrison is still alive, when in fact it is true that at least 10% of students in the western US believe that Jim Morrison is still alive.

(b) Is the original claim the null or alternative hypothesis?

Based on the discussion in the answer to the previous point, the original claim is the alternative hypothesis.

(c) Find the critical value for this hypothesis test.

Examining the alternative hypothesis $H_1: p < 0.10$ we determine that we are conducting a left-tailed test. The significance level is $\alpha = 0.025$. From the normal probability table then the critical value of $z$ is $z_{\alpha} = -1.96$. 
(d) At the 0.025 significance level, test the claim that the true percentage is less than 10%.

*Based on the survey data mentioned we see that the sample proportion of gun owners favoring stricter gun laws is \( \hat{p} = 0.08 \). The value of test statistic is then*

\[
z_0 = \frac{\hat{p} - p}{\sqrt{\frac{p(1-p)}{n}}} = \frac{0.08 - 0.10}{\sqrt{(0.10)(1-0.10)\frac{1}{1245}}} \approx -2.35.
\]

*Since the test statistic falls in the critical region we reject the null hypothesis. Therefore we conclude that the sample data support the claim that the percentage of students in the western United States who believe that Jim Morrison is alive is less than 10%.*