1. In a sample of 25 observations from a normal distribution with mean 98.6 and standard deviation 17.2, what is \( P(92 < \bar{X} < 102) \)?
   a) 0.3412  b) 0.6823  c) 0.7228  d) 0.8115  e) 0.5882

2. You are given the responsibility to run a whole series of tests on 36 different engines. The engines are tested one after the other. The time to complete the test on average takes 2 hours with a standard deviation of 1 hour. What is the probability that you will be able to test the 36 engines in less than 75 hours?
   a) .03  b) .16  c) .41  d) .69  e) .82

3. In a normal distribution with mean 56 and standard deviation 21, how large a sample must be taken so that there will be at least a 90 percent chances that its mean is greater than 52?
   a) 40  b) 46  c) 54  d) 60  e) 66

4. The shopping times were recorded for \( n = 64 \) randomly selected customers for a local supermarket. The average and variance of the 64 shopping times were 33 minutes and 256 respectively. Estimate the true average shopping time per customer, \( \mu \), with a confidence coefficient of 90%.
   a) (9.71, 56.29)  b) (14.71, 51.29)  c) (19.71, 46.29)  d) (29.71, 36.29)  e) (31.71, 34.29)

5. Consider the following sample of fat content (in percentage) of \( n=10 \) randomly selected hot dogs.
   25.2  21.3  22.8  17.0  29.8  21.0  25.5  16.0  20.9  19.5
   Assuming that these were selected from a normal population distribution, construct a 90% confidence interval of the population mean fat content.
   a) [18.95, 24.85]  b) [19.21, 23.99]  c) [19.51, 24.29]  d) [20.21, 22.99]  e) [20.71, 22.49]

6. Two groups of workers were timed on the completion of a complex assembly task. One group had been on the job 6 months and the other had been on the job 2 years.
   
<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Average</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>61</td>
<td>4.3 hours</td>
<td>1.6 hours</td>
</tr>
<tr>
<td>B</td>
<td>41</td>
<td>3.8 hours</td>
<td>1.4 hours</td>
</tr>
</tbody>
</table>

   Find a 90% confidence interval on the mean improvement in performance from six months to two years.
   a) (0.007, 0.993)  b) (0.104, 0.896)  c) (0.204, 0.796)  d) (0.304, 0.696)  e) (0.404, 0.596)
7. A Wall Street Journal (July 23, 1981) report on a survey by an advertisement agency indicates that matters of taste cannot be ignored in television advertising. Based on a mail survey of 3440 people, 40% indicated that they found TV commercials to be poor in taste.

Find a 95% confidence interval for the percentage of TV viewers who find TV commercials to be poor in taste.

a) (0.394, 0.406)  b) (0.384, 0.416)  c) (0.374, 0.426)  d) (0.364, 0.436)  
   e) (0.354, 0.446)

8. A random sample of 21 engineers was selected from a large group of engineers employed by an electronic manufacturer. The standard deviation of working hours per week was 7 hours. Determine a 90% confidence interval for the population variance of working hours for all engineers employed by the manufacturer, assuming these measurements are normally distributed.

a) (11.20, 70.32)  b) (21.20, 80.32)  c) (31.20, 90.32)  d) (41.02, 100.32)  e) (51.20, 110.32)

9. Following data gives the variance of the number of finished products produced per day by 2 different assembly lines. Find the 95% confidence interval for \( \frac{\sigma_1^2}{\sigma_2^2} \)

<table>
<thead>
<tr>
<th>Assembly line 1</th>
<th>Assembly line 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>N_1=21 days</td>
<td>N_2=25 days</td>
</tr>
<tr>
<td>S_1^2=1500</td>
<td>S_2^2=3500</td>
</tr>
</tbody>
</table>

a) (0.184,1.033)  b) (0.123,0.765)  c) (0.567,1.987)  d) (0.456,1.654)  e) (0.150,0.876)

10. A chemist has prepared a product designed to kill 60% of a particular type of insects. What sample size should be used if she desires to be 95% confident that she is within 0.02 of the true fraction of insects killed.

a) 2305  b) 2505  c) 2705  d) 2905  e) 3105

11. Tests performed with a random sample of 40 diesel engines produced by a large manufacturer show that they have a mean thermal efficiency of 32.5% with a standard deviation of 1.6%. Let the null hypothesis be that the mean is 32.3% against the alternate hypothesis of mean is greater than 32.3%. What is the rejection region and what is the actual value of the test statistic. Let the Level of significance be 0.05.

a) Rejection Z>1.645, test stat Z=0.79  b) Rejection Z>1.645, test stat Z=1.42  
c) Rejection Z>1.96, test stat Z=0.079  d) Rejection Z>1.96, test stat Z=1.42  
e) Rejection Z>2.96, test stat Z=1.42

12. With reference to the above problem, what is the rejection region and what is the actual value of the test statistic if the Level of significance is 0.20.

a) Rejection Z>1.645, test stat Z=0.79  b) Rejection Z>1.45, test stat Z=1.42  
c) Rejection Z>0.84, test stat Z=0.79  d) Rejection Z>1.96, test stat Z=1.42  
e) Rejection Z>0.84, test stat Z=1.29

13. Given a random sample of 5 pints from different production lots, we want to test whether the fat content of a certain kind of ice cream exceeds 14%. If the sample has a mean 14.9% and standard deviation 0.42%. What is the rejection region and what is the actual value of the test statistic. Let level of significance be 0.05.
14. In a study designed to investigate whether certain detonators used with the explosives in coal mining meet the requirement that at least 90% will ignite the explosive when charged, it is found that 168 of 200 detonators function properly. Test the null hypothesis \( p = 0.90 \) against alternative hypothesis \( p < 0.90 \) at the 0.05 level of significance. What is the rejection region and what is the actual value of the test statistic?
   a) Rejection \( Z < -2.58 \), test stat \( Z = -2.12 \)
   b) Rejection \( Z < -2.58 \), test stat \( Z = -2.83 \)
   c) Rejection \( Z < -1.645 \), test stat \( Z = -2.12 \)
   d) Rejection \( Z < -1.645 \), test stat \( Z = -2.83 \)
   e) Rejection \( Z < -1.645 \), test stat \( Z = -1.83 \)

15. Ionizing radiation is being given increasing attention as a method for preserving horticultural products. The process was tested on garlic bulbs. Of 180 that received radiation 153 were still marketable after 240 days. Of 180 untreated bulbs only 119 were marketable after 240 days. The null hypothesis is that radiation was not beneficial. The alternative hypothesis is that radiation does improve the shelf-life (i.e. how long it can be sold) of a garlic bulb. The level of confidence to be used is 0.01. What is the rejection region to be used, what is the value of the test statistic and do you reject or not?
   a) rejection \( Z > 1.88 \), test stat \( z = 4.20 \) reject
   b) rejection \( Z > 2.33 \), test stat \( z = 2.15 \) do not reject
   c) rejection \( Z > 1.65 \), test stat \( z = 2.67 \) reject
   d) rejection \( Z > 1.88 \), test stat \( z = 1.15 \) do not reject
   e) rejection \( Z > 2.33 \), test stat \( z = 4.20 \) reject

16. Suppose that we want to investigate whether men earn more than $20 per week more than women in a certain industry. If the sample data show that 60 men earn on the average $292.50 per week with a standard deviation of $14.60. Sample data shows 60 women earn on the average $266.10 per week with a standard deviation of $12.20 per week. What is the rejection region and what is the actual value of the test statistic. Let level of significance be 0.01.
   a) Rejection \( Z > 2.33 \), test stat \( Z = 2.61 \)
   b) Rejection \( Z > 2.33 \), test stat \( Z = 2.07 \)
   c) Rejection \( Z > 2.58 \), test stat \( Z = 2.61 \)
   d) Rejection \( Z > 2.58 \), test stat \( Z = 2.07 \)
   e) Rejection \( Z > 2.33 \), test stat \( Z = 1.07 \)

17. A technology for pipeline rehabilitation uses a flexible liner threaded through existing pipe. The average tensile strength of the liner may be influenced by whether or not a specific fusion process is used. However, in this example we are interested only in the variability in the tensile strength as recorded by the “standard deviation.” (Assume normality.)
   \( s_1 = 277.3 \) and \( n = 11 \)
   \( s_2 = 205.9 \) and \( n = 11 \)
   The null hypothesis is that there is no difference in variability and the alternative hypothesis is there is a difference. The level of confidence to be used is 0.05. What is the rejection region to be used, what is the value of the test statistic and do you reject or not?
   a) rejection \( F > 1.02 \), test stat \( F = 1.81 \) reject
   b) rejection \( F > 3.72 \), test stat \( F = 1.81 \) do not reject
   c) rejection \( F > 4.43 \), test stat \( F = 1.81 \) reject
   d) rejection \( F > 3.72 \), test stat \( F = 3.81 \) do not reject
   e) rejection \( F > 4.43 \), test stat \( F = 3.81 \) do not reject
SOLUTIONS

1. D.

\[ n=25, \ \mu = 98.6, \ \sigma = 17.2 \]

\[ P(92<X<102) = P\left( \frac{92-98.6}{17.2} < Z < \frac{102-98.6}{17.2} \right) = P(-1.92<z<0.99) \]
\[ = 0.4726+0.3389 = 0.8115 \]

2. D

Normal Distribution; \( \mu = 2; \ \sigma = 1.0; \ \bar{y} = 75/36 = 2.08 \)

\[ P(\bar{y} < 2.08) = P(z < \frac{2.08 - 2}{1/\sqrt{36}}) = P(z < 0.5) = 0.6915 \]

3. B

\( \mu = 56, \ \sigma = 21 \)

\[ P(y>52) = P\left(z > \frac{52-56}{21/\sqrt{n}}\right) = P\left(z > -0.19* \sqrt{n}\right) = 0.90 \]

Or \( 0.19* \sqrt{n} = 1.28 \)
\[ n = 46 \]

4. D

\[ n = 64; \ \bar{x} = 33; \ s^2 = 256; \ s = \sqrt{256} = 16 \]
\[ \alpha = 0.10; \ \alpha/2 = 0.05; \ Z_{\alpha/2} = 1.645 \]

Confidence Interval is given by
\[ \bar{x} - z_{\alpha/2} \cdot s/\sqrt{n} \leq \mu \leq \bar{x} + z_{\alpha/2} \cdot s/\sqrt{n} \]

Thus \( 33-1.645*16/\sqrt{64} \leq \mu \leq 33+1.645*16/\sqrt{64} \)
\[ 29.71 \leq \mu \leq 36.29 \]

5. C

Small sample size, t

\[ \bar{x} \pm t_{\alpha/2} \cdot \sqrt{S/\sqrt{n}} = 21.9 \pm (4.13/10^{0.5}) \cdot t_{0.05} = (19.51, 24.29) \]

6. A

Large sample test

\[ (4.3-3.8) \pm 1.645 \sqrt{((1.6^2)/61) + (1.4^2)/41)} = (0.007, 0.993) \]

7. B

\[ n = 3440; \ \alpha = 0.05; \ \alpha/2 = 0.025; \ Z_{\alpha/2} = 1.96; \ \hat{p} = 0.40; \ \hat{q} = 0.60; \]

Confidence Interval for Population Proportion is given by
\[ \hat{p} - z_{\alpha/2} \cdot \sqrt{\hat{p}\hat{q}/n} \leq p \leq \hat{p} + z_{\alpha/2} \cdot \sqrt{\hat{p}\hat{q}/n} \]
0.40 - 1.96 * \sqrt{\frac{0.40 * 0.60}{3440}} \leq p \leq 0.40 + 1.96 * \sqrt{\frac{0.40 * 0.60}{3440}}

0.384 \leq p \leq 0.416

8. C
n = 21; \quad s = 7; \quad \alpha = 0.10; \quad \alpha / 2 = 0.05; \quad \text{degrees of freedom} = 21 - 1 = 20;
\chi^2\frac{0.20}{2} = 31.4104; \quad \chi^2\frac{1.0.20}{2} = 10.8508

confidence interval on variance is given by

\frac{(n-1)s^2}{\chi^2\frac{0.20}{2}} \leq \sigma^2 \leq \frac{(n-1)s^2}{\chi^2\frac{1.0.20}{2}}

\frac{20*(7*7)}{31.4104} \leq \sigma^2 \leq \frac{20*(7*7)}{10.8508}

31.20 \leq \sigma^2 \leq 90.32

9. A
95% CI is given by
(\frac{1500}{3500})(1/2.33) \leq \sigma_1^2 / \sigma_2^2 \leq (\frac{1500}{3500}) 2.41 = (0.184, 1.033)

10. A
\alpha = 0.05; \quad p = 0.60; \quad q = 1-p = 1-0.60 = 0.40; \quad H = 0.02; \quad Z_{\alpha/2} = 1.96;

Sample size for estimating Sample proportion is given by

N = \left(\frac{Z_{\alpha/2}}{H}\right)^2 \cdot p \cdot q = (1.96/0.02)^2 \cdot 0.6 \cdot 0.4 = 2305

11. A
N=40; \quad \bar{y} = 32.5%; \quad s = 1.6%; \quad \alpha = 0.05;

Large Sample Test About a Population Mean
One Tailed Test
H_0: \mu = 32.3%;
H_a: \mu > 32.3%;

Test Statistic: \quad z = \frac{\bar{y} - \mu_0}{s/\sqrt{n}} = \frac{32.5 - 32.3}{1.6/\sqrt{40}} = 0.79;

Rejection Region \quad Z > Z_{0.05}; \quad Z_{0.05} = 1.645;

12. C
Test statistic remains the same.
Rejection Region \quad Z > Z_{0.20}; \quad Z_{0.20} = 0.84;

13. B
N=5; \quad \bar{y} = 14.9%; \quad s = 0.42%; \quad \alpha = 0.05;

Small Sample Test About a Population Mean
One Tailed Test
H_0: \mu = 14%;
Hₐ: μ > 14%;

Test Statistic: $t = \frac{\bar{y} - \mu_0}{\sqrt{s/\sqrt{n}}} = \frac{14.9 - 14}{0.42/\sqrt{5}} = 4.79$;

Rejection Region $t > t_{0.05}; \quad t_{0.05,4} = 2.132$

14. D

N= 200; \quad \hat{p} = 168/200 = 0.84; \quad \alpha = 0.05;

Large Sample Test about a Population Proportion
One tailed test
H₀: p= 0.90;
Hₐ: p< 0.90;

Test Statistic: $z = \frac{\hat{p} - p_0}{\sqrt{p_0q_0/n}} = \frac{0.84 - 0.90}{\sqrt{0.90 \times (1 - 0.90) / 200}} = -2.83$

Rejection region: $Z < -Z_{0.05}; \quad -Z_{0.05} = -1.645$;

15. E

One tail test:
Reject Region : $Z > Z_{\alpha} = Z_{0.01} = 2.33$;

$p = (153+119)/(180+180) = 0.756$

test statistic $Z = \frac{153/180 - 119/180}{\sqrt{0.756 \times 0.244 \times (1/180 + 1/180)}} = 4.20$

Reject Null Hypothesis since $Z > Z_{\alpha}$

16. A

N₁= 60; \quad \bar{y}_1= 292.50; \quad s_1= 14.60;
N₂= 60; \quad \bar{y}_2= 266.10; \quad s_2= 12.20;

Large Sample Test of Hypothesis about difference in means: Independent Samples
One Tailed test
H₀: $\mu_1 - \mu_2 = 20$;
Hₐ: $\mu_1 - \mu_2 > 20$; Test Statistic : $z = \frac{(\bar{y}_1 - \bar{y}_2) - D_0}{\sqrt{s^2/\sqrt{n_1} + s^2/\sqrt{n_2}}} = \frac{(292.5 - 266.1) - 20}{2.45} = 2.61$

Rejection Region = $Z > Z_{0.01}; \quad Z_{0.01} = 2.33$;

17. B

Two tail test of two population variances (Page 476 of text)
Degrees of freedom for $s_1 = 11-1 = 10$
Degrees of freedom for $s_2 = 11-1 = 10$

Rejection region $F > F_{\alpha/2} = F_{10,10,0.025} = 3.72$

Test statistic $F = S_1^2 / S_2^2 = 277.3^2 / 205.9^2 = 1.81$
Do not reject Null Hypothesis since F is not greater than $F_{\alpha/2}$