CH 13 TESTING OF HYPOTHESIS

EXAMPLES

Example 13.1

Indicate the type of errors committed in the following cases:

(i) H_0: $\mu = 500$; H_1: $\mu \neq 500$. H_0 is rejected while H_0 is true

(ii) H_0: $\mu = 500$; H_1: $\mu < 500$. H_0 is accepted while true value of $\mu = 600$.

[(i) The hypothesis μ=500 is true and it has been rejected. Type I error has been committed

(ii) H_0 is false and has been accepted. Type II error has been committed.]

Example 13.2

Past records show that the average score of students in statistics is 57 with standard deviation 10. A new method of teaching is employed and a random sample of 70 students is selected. The sample average is 60. Can we conclude on the basis of these results, at 5% level of significance, that the average score has increased?

[Z = 2.51 ; reject H_0]

Example 13.3

An electrical firm manufactures light bulbs that have a length of life that is approximately normally distributed with a mean of 812 hours and a standard deviation of 40 hours. Test the hypothesis that $\mu = 812$ against the alternative $\mu \neq 812$ hours if a random sample of 36 bulbs has an average life of 800 hours. Use a 5% level of significance.

[Z = –1.8 ; accept H_0]

Example 13.4

Ten dry cells were taken from store and voltage test gave the following results: 1.52, 1.53, 1.49, 1.48, 1.47, 1.49, 1.51, 1.50, 1.45, 1.46 volts. The mean voltage of the cells when stored was 1.51 volts. Assuming the standard deviation to remain unchanged at 0.02 volts, is there reason to believe that the cells have deteriorated?

[Z = –3.162 ; reject H_0]

Example 13.5

A home heating oil delivery company would like to estimate the annual usage for its customers who live in single-family homes. A sample of 100 customers indicated an average annual usage of 1103 gallons and a sample standard deviation of 327.8 gallons. At the 1% level of significance, is there evidence that the average annual exceeds 1000 gallons per year?

[Z = 3.14 ; reject H_0]

Example 13.6

A sample of 42 measurements was taken in order to test the null hypothesis that the population mean equals 8.5 against the alternative that it is different from 8.5. The sample mean and standard deviation were found to be .79 and 1.27, respectively. Perform the hypothesis test using 0.01 as the level of significance.

[z = 1.48 ; accept H_0]

Example 13.7

A manufacturing company making automobile tires claims that the average life of its product is 35000 miles. A random sample of 16 tires was selected; and it was found that the mean life was 34000 miles with a standard deviation s = 2000 miles. Test hypothesis H_0: $\mu = 35000$ against the alternative H_1: $\mu < 35000$ at $\alpha = 0.05$

[t = –2 ; reject H_0]

Example 13.8

A random sample of 8 cigarettes of a certain brand has an average nicotine content of 4.2 milligrams and a standard deviation of 1.4 milligrams. Is this in line with the manufacturer’s claim that the average nicotine content does not exceed 3.5 milligrams? Use 1% level of significance and assume the distribution of nicotine content to be normal.

[t = 1.414 ; accept H_0]

Example 13.9

A sample of 12 jars of butter was taken from a lot, each jar being labeled 8 ounces net weight. The individual weights in ounces are: 8.2, 8.0, 7.6, 7.6, 7.7, 7.5, 7.3, 7.4, 7.5, 8.0, 7.4 and 7.5. Test whether these values are consistent with a population mean of 8 ounces. Assume that the weights are normally distributed. Use $\alpha = 0.05$

[t = –4.45 ; reject H_0]

Example 13.10

Suppose you wish to estimate the effects of a certain sleeping pill on men and women. two samples are independently taken, and the relevant data are shown below:

	Sample I	Sample II
Sample size	$n_1 = 36$	$n_2 = 64$
Sample mean	$\bar{X}_1 = 8.75$	$\bar{X}_2 = 7.25$
Population variance	$\sigma_1^2 = 9$	$\sigma_2^2 = 4$

Test the null hypothesis H_0: $\mu_1 = \mu_2$ against the alternative hypothesis H_1: $\mu_1 > \mu_2$ at $\alpha = 0.05$

[Z = 2.683 ; reject H_0]

Example 13.11

Two astronomers recorded observations on a certain star. The mean of 30 observations obtained by first astronomer is 8.85 and mean of 40 observations made by second astronomer is8.20. Past experience shows that each astronomer obtained readings with variance of 1.2.Using $\alpha = 0.01$, can we say that the difference between two results is significant.

[Z = 2.407 ; accept H_0]

Example 13.12

Suppose that the two randomly selected samples yield the following information:

	Sample I	Sample II
Sample size	$n_1 = 82$	$n_2 = 41$
Mean	$\bar{X}_1 = 50$	$\bar{X}_2 = 55$
Variance	$s_1^2 = 405$	$s_2^2 = 324$

Test the null hypothesis that the two population means are equal that is, H_0: $\mu_1 = \mu_2$ against the alternative hypothesis H1: $\mu_1 < \mu_2$ at $\alpha = 0.01$

[Z = –1.40 ; accept H_0]

Example 13.13

Given two independent random samples with the following results:

$$n_1 = 100 , \bar{X}_1 = 950 , S_1 = 90 , n_2 = 100 , \bar{X}_2 = 985 , S_2 = 120$$

Do the data indicate a different in the population means? Use the 0.05 level of significance.

[Z = –2.33 ; reject H_0]

Example 13.14

Two samples are randomly selected from two classes of students who have been taught by different methods. An examination is given and the results are shown as follows:

	Class I	Class II
Sample size	$n_1 = 8$	$n_2 = 10$
Mean	$\bar{X}_1 = 95$	$\bar{X}_2 = 97$
Variance	$s_1^2 = 47$	$s_2^2 = 30$

On the assumption that the test scores of the two classes of students have identical variances, determine whether the two different methods of teaching are equally effective at $\alpha = 0.01$

[t = –0.689 ; accept H_0]

Example 13.15

Samples of two types of electric light bulbs were tested for length of life and the following data were obtained:

$$n_1 = 5 , \bar{X}_1 = 1224 , \sum (X_1 - \bar{X}_1)^2 = 6490 , n_2 = 7 , \bar{X}_2 = 1036 , \sum (X_2 - \bar{X}_2)^2 = 11200$$

Is the difference in the means significant? Assume that the two samples are drawn from normal populations with identical standard deviation. Use 2% level of significance.

[t = 7.63 ; reject H_0]

Example 13.16

Suppose that a shoe company wanted to test material for the sales of shoes. For each pair of shoes the new material was placed on one shoe and the old material was placed on the other shoe. After a given period of time a random sample of ten pairs of shoes was selected and the wear was measured on a ten-point scale with the following results:

Pair number	1	2	3	4	5	6	7	8	9	10
New material	2	4	5	7	7	5	9	8	8	7
Old material	4	5	3	8	9	4	7	8	5	6
Differences	–2	–1	+2	–1	–2	+1	+2	0	+3	+1

At the 0.05 level of significance, is there evidence that the average wear is higher for the new material than the old material?

[$t = 0.536$; accept H_0]

Example 13.17

Two varieties of wheat are each planted in ten localities with differences in yield as follows: 2, 4, 2, 2, 3, 6, 2, 2, 4, 3. Test the hypothesis that the population mean difference is zero, using $\alpha = 0.01$

[$t = 7.133$; reject H_0]

Example 13.18

In a poll of 1000 voters selected at random from all the voters in a certain district, it is found that 518 voters of a particular candidate. Test the null hypothesis that the proportion of all the voters in the district who favour the candidate is equal to or less than 50 percent against the alternative that it is greater than 50 percent at $\alpha = 0.05$

[$Z = 1.125$; accept H_0]

Example 13.19

At a certain college it is estimated that at most 25% of the students ride bicycles to class. Does this seem to be a valid estimate, if in a random sample of 90 college students, 28 are found to ride bicycles to class? Use a 5% level of significance.

[$Z = 1.32$; accept H_0]

Example 13.20

A coin is tossed 400 times and it turns up head 216 times. Test the hypothesis that coin is unbiased at 1% level of significance.

[$z = 1.6$; accept H_0]

Example 13.21

The cigarette-manufacturing firm distributes two brands of cigarettes. It is found that 56 of 200 smokers prefer brand ‘A’ and that 30 of 150 smokers prefer brand ‘B’. Test the hypothesis at 0.05 level of significance that brand ‘A’ outsells brand ‘B’ by 10% against the alternative hypothesis that the difference is less than 10%.

[$Z = -0.44$; accept H_0]

Example 13.22

A random sample of 150 high school students was asked whether they would turn to their fathers or their mothers for help with a home work assignment is mathematics and another random sample of 150 high school students was asked the same question with regard to a homework assignment in English. Use the result shown in the following table at the 0.01 level of significance to test whether or not there is a difference between the true proportions of high school students who turn to their fathers rather than mothers for help in these two subjects:

	Mathematics	English
Mother	59	85
Father	91	65

[$Z = 3.003$; reject H_0]

EXERCISE

Question 13.1

The heights of college male students are known to be normally distributed with a mean of 67.39 inches and $\sigma = 1.30$ inches. A random sample of 400 students showed a mean height of 67.47 inches. Using a 0.05 level of significance, test the hypothesis H_0: $\mu = 67.39$ against the alternative H_1: $\mu > 67.39$.

[$z = 1.231$; accept H_0]

Question 13.2

Past records show that the average score of students in statistics is 57 with standard deviation 10. A new method of teaching is employed and a random sample of 70 students is selected. The sample average is 60. Can we conclude on the basis of these results, at 5% level of significance, that the average score has increased?

[$Z = -2.5$; accept H_0]

Question 13.3

An electrical firm manufactures light bulbs that have a length of life that is approximately normally distributed with a mean of 812 hours and a standard deviation of 40 hours. Test the hypothesis that $\mu = 812$ hours against the alternative $\mu \neq 812$ hours if a random sample of 36 bulbs has an average life of 800 hours. Use a 5% level of significance.

[$Z = 2.61$; H0: $\mu = 32$; $\mu \neq 32$]

Question 13.4

Suppose that the variance of the IQ's of the high school students in a certain city is 225. A random sample of 36 students has a mean IQ of 106. If the level of significance is chosen at 0.05, should we conclude that the IQ's of the high school students in this city are higher than 100?

[H_0: $\mu \leq 100$; H_1: $\mu > 100$; $Z = 2.4$; reject H_0]

Question 13.5

Suppose that scores on an aptitude test used for determining admission to graduate study in statistics are known to be normally distributed with a mean of 500 and a population standard deviation of 100. If a random sample of 64 applicants from a college has a sample mean of 537, is there any evidence that their mean score is different from the mean expected of all applicants? Use $\alpha = 0.01$

[H_0: $\mu = 500$; H_1: $\mu \neq 500$; $Z = 2.96$; reject H_0]

Question 13.6

Let $X \sim N(\mu, 100)$ and $\bar{X}$ be the mean of a random sample of 64 observations of X, given that $\bar{X} = 15$. Test H0: $\mu = 12$ against the alternative H1: $\mu > 12$. Use $\alpha = 0.05$

[$Z = 2.4$; reject H_0]

Question 13.7

A random sample of 25 values gives the average of 83. Can this sample be regarded as drawn from the normal population with mean 80 and standard deviation 7 at 5% level of significance?

[H_0: $\mu = 80$; H_1: $\mu \neq 80$; $Z = 2.14$; reject H_0]

Question 13.8

A random sample of 64 drinks from a soft-drink machine has an average content of 21.9 deciliters, with a standard deviation of 1.42 deciliters. Test the hypothesis that $\mu = 22.2$ deciliters against the alternative hypothesis $\mu < 22.2$, at the 5% level of significance.

[$Z = -1.69$; reject H_0]

Question 13.9

A random sample of 200 trucks was driven on the average 16300 miles a year with a sample standard deviation of 3100 miles. Test the null hypothesis that the average truck mileage in the population is 17000 miles a year against the alternative hypothesis that the average is less. Use the 5% level of significance.

[H_0: $\mu = 17000$; H_1: $\mu < 17000$; $Z = -3.19$; reject H_0]

Question 13.10

A manufacturer of detergent claims that the mean weight of a particular box of detergent is 3.25 pounds. A random sample of 64 boxes revealed a sample average of 3.238 pounds with a standard deviation of 0.117 pounds. Using the 1% level of significance, is there evidence that the average weight of the boxes is different from 3.25 pounds?

[H_0: $\mu = 3.25$; H_1: $\mu \neq 3.25$; $Z = -0.82$; accept H_0]

Question 13.11

Past experience indicate that the time for high school seniors to complete a standardized test is a normal random variable with a mean of 35 minutes. If a random sample of 20 high school seniors took an average of 33.1 minutes to complete this test with a standard deviation s = 4.3 minutes against the alternative that $\mu < 35$ minutes.

[$t = -1.976$; accept H_0]

Question 13.12

A random sample of 10 from a population gave $\bar{X} = 20$ and sum of square of deviations from mean is 144 test H_0: $\mu = 19.5$ against H1: $\mu = 19.5$. At $\alpha = 0.05$

[$t = 0.395$; accept H_0]

Question 13.13

Ten cartons are taken at random from an automatic filling machine. The mean net weight of the ten cartons is 15.90 ounces and the sum of squared deviation from this mean is 0.276 $(\text{ounces})^2$. Does the sample mean differ significantly from the intended weight of 16 ounces? Use $\alpha = 0.02$.

[H_0: $\mu = 16$; H_1: $\mu \neq 16$; $t = -1.81$; accept H_0]

Question 13.14

In a sample survey, six estimates were made of the same mean. When the population mean become known, the following errors were computed: –35, 111, –88, 47, –12, and 26. Are these errors consistent with the hypothesis that the population of errors has a zero mean? Assume that the errors are normally distributed. Use $\alpha = 0.01$.

[H_0: $\mu = 0$; H_1: $\mu \neq 0$; $t = 0.29$; accept H_0]

Question 13.15

A certain drug was given to ten patients and the following increments in their blood pressures were observed: 7, 3, –1, 4, –3, 5, 6, –4, 1, 2. Show that the data do not indicate that the drug was responsible for these increments. Use 5% level of significance.

[H_0: $\mu = 0$; H_1: $\mu \neq 0$; $t = 1.69$; accept H_0]

Question 13.16

Ten individuals are chosen at random from a population and their heights are found to be 63, 63, 64, 65, 66, 69, 69, 70, 70, and 71. Discuss the suggestion that the mean height in the universe is 65 inches given that for 9 d.f. the value of Student's t at 5% level of significance is 2.262.

[H_0: $\mu = 65$; H_1: $\mu \neq 65$; $t = 2.021$; accept H_0]

Question 13.17

Given the following information. What is your conclusion in testing each of the indicated null and alternative hypotheses?

	n	$\bar{X}$	s^2	α	H_0	H_1
(i)	25	8	64	0.05	$\mu \geq 10$	$\mu < 10$
(ii)	9	12	36	0.01	$\mu = 10$	$\mu > 10$
(iii)	16	13	64	0.05	$\mu = 10$	$\mu \neq 10$

[(i) $t = -1.25$, accept H_0 ; (ii) $t = 1$, accept H_0 ; (iii) $t = 1.5$, accept H_0]

Question 13.18

Suppose you wish to estimate the difference between the daily wages for machinists and carpenters. Two independent samples of 50 people each are respectively taken, and the data are shown as follows:

	Machinists	Carpenters
Sample size	50	50
Sample mean	172.5	170.0
Population variance	98	102

Should we reject the null hypothesis that the daily wages for machinists and carpenters are the same in favor of the alternative hypothesis that they are different at $\alpha = 0.05$

[H_0: $\mu_1 = \mu_2$; H_1: $\mu_1 = \mu_2$; $Z = 1.25$; accept H_0]

Question 13.19

A random sample of 100 workers in a large farm took an average of 14 minutes to complete a task. A random sample of 150 workers in another large farm took an average of 11 minutes to complete the task. Can it be assumed at 5% level of significance that the average time taken by the workers in the two farms is same, if the standard deviations of all the workers of first farm and second farm are 2 minutes respectively?

[H_0: $\mu_1 = \mu_2$; H_1: $\mu_1 = \mu_2$; $Z = 9.49$; reject H_0]

Question 13.20
The test was given to a group of 80female students and to a group of 100 male students. The mean score for the female students was 80 and the mean score for the male students was 78. Assuming a common population standard deviation of 5. Test whether the female student's performance in the test was better than that of male students? Use $\alpha = 0.05$.
[H_0: $\mu_1 \le \mu_2$; H_1: $\mu_1 > \mu_2$; Z = 2.67 ; reject H_0]
Question 13.21
A tire manufacturer wishes to test two types of tires. Fifty tyres of type 'A' has a mean life of 24000 miles with $S^2 = 6250000$. Forty tiles of type 'B' has a mean life of 26000 miles with $S^2 = 9000000$. Is there a significant difference between the two sample means? Use $\alpha = 0.05$
[H_0: $\mu_1 = \mu_2$; H_1: $\mu_1 = \mu_2$; Z = –3.38 ; reject H_0]
Question 13.22
A carpet manufacturer is studying difference between two of its major outlet stores. The company is particularly interested in the time it takes before customers receive carpeting that has been ordered from the plant. Data concerning a sample of delivery times for the most popular type of carpet are summarized as follows:

	A	B
$\bar{X}$	34.3 days	43.7 days
S	2.4 days	3.1 days
n	41	31

At the 0.01 level of significance, is there evidence of a difference in the average delivery times for the two outlet stores?
[H_0: $\mu_1 = \mu_2$; H_1: $\mu_1 = \mu_2$; Z = –14 ; reject H_0]
Question 13.23
For each of the following sets of data, what is your conclusion in testing each of the indicated null and alternative hypotheses?

(i) $n_1 = 50 , \sum X_1 = 490 , \sum (X_1 - \bar{X}_1)^2 = 900 , n_2 = 40 , \sum X_2 = 320 , \sum (X_2 - \bar{X}_2)^2 = 720 ,$

$$H_0: \mu_1 = \mu_2 , \mu_1 \neq \mu_2 , \alpha = 0.05$$

(ii) $n_1 = 380 , \sum X_1 = 228 , \sum X_1^2 = 1482 , n_2 = 32 , \sum X_2 = 176 , \sum X_2^2 = 1000$

$$H_0: \mu_1 \le \mu_2 , \mu_1 > \mu_2 , \alpha = 0.05$$

(iii) $n_1 = 65 , \bar{X} = 83 , \sum (X - \bar{X})^2 = 8905 , n_2 = 80 , \bar{Y} = 59 , \sum (Y - \bar{Y})^2 = 5040$

$$H_0: \mu_1 - \mu_2 \le 20 , \mu_1 - \mu_2 > 20 , \alpha = 1\%$$

(iv) $n_1 = 50, \bar{X}_1 = 87 , S_1 = 6 , n_2 = 50, \bar{X}_2 = 78 , S_2 = 5$

$$H_0: \mu_1 - \mu_2 \ge 12 , \mu_1 - \mu_2 < 12 , \alpha = 2\%$$

[(i) Z = 2, reject H_0 ; (ii) Z = 1.51, accept H_0 ; (iii) Z = 2.35, reject H_0 ; (iv) Z = –2.72, reject H_0]
Question 13.24
A random sample of 10 families in one city, spent on the average Rs. 987 per day for food with a standard deviation of Rs. 240; and a random sample of 12 families in another city, spent on the average Rs. 835 with a standard deviation of Rs. 200. Assume $\sigma_1^2 = \sigma_2^2$. Test the null hypothesis that the mean daily expenditure for food is the same for the two cities. Suppose the alternative is H_1: $\mu_1 > \mu_2$. Using a 5% level of significance.
[t = 1.62 ; accept H_0]
Question 13.25
In an examination, a class of 18 students had a mean of 70 with s = 6. Another class of 21 had a mean of 77 with s = 8 in the examination. Is there reason to believe that one class is significantly better than the other? Consider the students as samples from one population. Use a 5% level of significance.
[H_0: $\mu_1 = \mu_2$; H_1: $\mu_1 \neq \mu_2$; t = –3.05 ; reject H_0]

Question 13.26

Two random samples taken independently from normal populations with an identical variance yield the following results:

	Sample I	Sample II
Size	$n_1 = 10$	$n_2 = 18$
Mean	$\bar{X}_1 = 10$	$\bar{X}_2 = 25$
Variance	$s_1^2 = 1200$	$s_2^2 = 900$

Test the hypothesis that the true difference between the population means is 10, that is, H_0: $\mu_2 - \mu_1 = 10$, against the alternative H_1: $\mu_2 - \mu_1 > 10$ at the 5% level of significance.

[$t = 0.40$; accept H_0]

Question 13.27

The mean of two random samples of sizes 9 and 7 respectively are 196.42 and 198.82 respectively. The sums of the squares of the deviation from the mean are 26.94 and 18.73 respectively. Assume that the two samples are drawn from normal populations with identical variance. Test H_0: $\mu_1 = \mu_2$, against the alternative H_1: $\mu_1 < \mu_2$ at the 5% level of significance.

[$t = -2.631$; reject H_0]

Question 13.28

A random sample of 6 cows of breed A had daily milk yield in pounds as 16, 15, 18, 17, 19, and 17,while another random sample of 8 cows of breed B had daily milk yield in pounds as 18, 22, 21, 23, 19, 20, 24, and 21. Test if breed B is better than breed A at $\alpha = 0.05$. Assume yields of milk to be normally distributed with equal variance.

[H_0: $\mu_2 \leq \mu_1$; H_1: $\mu_2 > \mu_1$; $t = 4.16$; reject H_0]

Question 13.29

The heights of 6 randomly selected sailors are in inches: 62, 64, 67, 68, 70 and 71. Those of ten randomly selected soldiers are 62, 63, 65, 66, 69, 70, 71, 72 and 73. Discuss in the light of these data that soldiers are on the average taller than sailors. Use $\alpha = 0.05$. Assume that heights are normally distributed.

[H_0: $\mu_2 \leq \mu_1$; H_1: $\mu_2 > \mu_1$; $t = 0.53$; accept H_0]

Question 13.30

The weights of 4 persons before they stopped smoking and 5 weeks after they stopped smoking are as follows:

Person	1	2	3	4
Before	148	176	153	118
After	154	176	150	120

Use the t-test for paired observations to test the hypothesis at 0.05 level of significance that given up smoking has no effect on a person's weight.

[H_0: $\mu_1 = \mu_2$; H_1: $\mu_1 \neq \mu_2$; $t = -0.662$; accept H_0]

Question 13.31

An experiment was performed with five hop plants. On half of each plant was pollinated and the other half was non-pollinated. The yield of the seed of each hop plant is tabulated as follows:

Pollinated	0.78	0.76	0.43	0.92	0.86
Non-pollinated	0.21	0.12	0.32	0.29	0.30

Determine at the 5% level of significance whether the pollinated half of the plant gives a higher yield in seed than the non-pollinated half.

[H_0: $\mu_1 \leq \mu_2$; H_1: $\mu_1 > \mu_2$; $t = 5.102$; reject H_0]

Question 13.32

The following data give paired yield of two verities of wheat. Each pair was planted in a different locality. Test the hypothesis that the mean yields are equal at 5% level of significance.

Variety I	45	32	58	57	60	38	47	51	42	38
Variety II	47	34	60	59	63	44	49	53	46	41

[H_0: $\mu_1 = \mu_2$; H_1: $\mu_1 \neq \mu_2$; $t = 6.71$; reject H_0]

Question 13.33
A certain stimulus administered to each of the nine patients resulted in the following increase in blood pressure: 5, 1, 8, 0, 3, 3, 5, –2, 4. Can it be concluded that blood pressure in general is increased by administering the stimulus. Use $\alpha = 0.01$
[$H_0: \mu_D \leq 0$; $H_1: \mu_D > 0$; $t = 3$; reject H_0]
Question 13.34
Let X designates the defective parts produced by an automatic machine. From a randomly selected sample of 50 parts, 10 are defective. Let p be the true proportion of all the parts that are defective; test the null hypothesis H_0: $p = 0.1$ against the alternative hypothesis H_1: $p \neq 0.1$ at $\alpha = 0.01$
[$Z = 2.358$; accept H_0]
Question 13.35
A random sample of 200 workers was selected from a population and 140 workers were found to be skilled. The factory owner claimed that at least 80% workers were skilled in his factory. Is it possible to reject the claim of the factory owner at 5% level of significance?
[$H_0: p \geq 0.80$; $H_1: p < 0.80$; $Z = -3.534$; reject H_0]
Question 13.36
An electric company claimed that at least 85% of the parts which it supplied conformed to specifications. A random of 400 parts was tested and 75 did not meet specifications. Can we accept the company's claim at 1% level of significance?
[$H_0: p \geq 0.85$; $H_1: p < 0.85$; $Z = -2.095$; accept H_0]
Question 13.37
A coin is tossed 20 times resulting in 5 heads. Is this sufficient evidence to reject the hypothesis at the 5% level of significance that the coin is balanced in favour of the alternative that heads occur less than 50% of the times?
[$H_0: p = 0.5$; $H_1: p < 0.5$; $Z = -2.236$; reject H_0]
Question 13.38
A candidate for mayor in a large city believes that he appeals to at least 12 percent more of the women voters than the men voters. He hires the services of a poll-taking organization, and they find that 62 of 100 women interviewed support the candidate, and 69 of 150 men support him. At the 0.10 significance level, is the hypothesis accepted or rejected?
[$H_0: p_1 - p_2 \leq 0.12$; $H_1: p_1 - p_2 > 0.12$; $Z = 0.63$; accept H_0]
Question 13.39
An expert is interested in the proportion of males and females in a population that have a certain minor blood disorder. In a random sample of 100 males, 31 are found to be afflicted whereas only 24 of 100 females tested appear to have the disorder. Can we conclude at the 5% level of significance that the proportion of men in the population afflicted with this blood disorder is significantly greater than the proportion of women afflicted?
[$H_0: p_1 \leq p_2$ 0.12 ; $H_1: p_1 > p_2$; $Z = 1.109$; accept H_0]
Question 13.40
A company is considering two different radio ad (advertisements) for promotion of a new product. Management believes that ad A is more effective than ad B. Two test market areas with virtually identical consumer characteristics are selected; ad A is used in one area and ad B in the other area. In a random sample of 60 customers who heard ad A, 18 tried the product. In random sample of 100 customers who heard ad B, 22 tried the product. Does this indicate that ad A is more effective than ad B, if a 0.05 level of significance is used?
[$H_0: p_1 \leq p_2$; $H_1: p_1 > p_2$; $Z = 1.132$; accept H_0]
Question 13.41
Studies comparing the mathematical abilities of male and female students have produced conflicting conclusions. The distribution of grades earned in introductory statistics by a random sample of students at one institution is given below. Use these data to test the hypothesis that there is no difference in the population proportion of male that receive grade A. let $\alpha = 0.05$

Grade	A	B	C	D	E	Total
Males	15	18	16	8	11	68
Females	20	16	19	12	15	82

[$H_0: p_1 = p_2$; $H_1: p_1 \neq p_2$; $Z = -0.331$; accept H_0]

Question 13.42

Random samples of 200 bolts manufactured by machine A and 100 bolts manufactured by machine B showed 20 and 4 defective bolts respectively. Test the hypothesis that machine B is performing better then machine A. Use α 0.05 level of significance.

[H_0: $p_1 = p_2$; H_1: $p_1 < p_2$; $Z = -1.81$; reject H_0]

d.f.	0.25	0.20	0.15	0.10	0.05	0.025	0.02	0.01	0.005	0.0025	0.001	0.0005
1	1.000	1.376	1.963	3.078	6.314	12.71	15.89	31.82	63.66	127.3	318.3	636.6
2	0.816	1.061	1.386	1.886	2.92	4.303	4.849	6.965	9.925	14.09	22.33	31.6
3	0.765	0.978	1.250	1.638	2.353	3.182	3.482	4.541	5.841	7.453	10.21	12.92
4	0.741	0.941	1.190	1.533	2.132	2.776	2.999	3.747	4.604	5.598	7.173	8.61
5	0.727	0.920	1.156	1.476	2.015	2.571	2.757	3.365	4.032	4.773	5.893	6.869
6	0.718	0.906	1.134	1.44	1.943	2.447	2.612	3.143	3.707	4.317	5.208	5.959
7	0.711	0.896	1.119	1.415	1.895	2.365	2.517	2.998	3.499	4.029	4.785	5.408
8	0.706	0.889	1.108	1.397	1.860	2.306	2.449	2.896	3.355	3.833	4.501	5.041
9	0.703	0.883	1.100	1.383	1.833	2.262	2.398	2.821	3.250	3.69	4.297	4.781
10	0.700	0.879	1.093	1.372	1.812	2.228	2.359	2.764	3.169	3.581	4.144	4.587
11	0.697	0.876	1.088	1.363	1.796	2.201	2.328	2.718	3.106	3.497	4.025	4.437
12	0.695	0.873	1.083	1.356	1.782	2.179	2.303	2.681	3.055	3.428	3.930	4.318
13	0.694	0.87	1.079	1.350	1.771	2.160	2.282	2.65	3.012	3.372	3.852	4.221
14	0.692	0.868	1.076	1.345	1.761	2.145	2.264	2.624	2.977	3.326	3.787	4.14
15	0.691	0.866	1.074	1.341	1.753	2.131	2.249	2.602	2.947	3.286	3.733	4.073
16	0.690	0.865	1.071	1.337	1.746	2.120	2.235	2.583	2.921	3.252	3.686	4.015
17	0.689	0.863	1.069	1.333	1.740	2.110	2.224	2.567	2.898	3.222	3.646	3.965
18	0.688	0.862	1.067	1.330	1.734	2.101	2.214	2.552	2.878	3.197	3.611	3.922
19	0.688	0.861	1.066	1.328	1.729	2.093	2.205	2.539	2.861	3.174	3.579	3.883
20	0.687	0.86	1.064	1.325	1.725	2.086	2.197	2.528	2.845	3.153	3.552	3.85
21	0.686	0.859	1.063	1.323	1.721	2.08	2.189	2.518	2.831	3.135	3.527	3.819
22	0.686	0.858	1.061	1.321	1.717	2.074	2.183	2.508	2.819	3.119	3.505	3.792
23	0.685	0.858	1.060	1.319	1.714	2.069	2.177	2.500	2.807	3.104	3.485	3.768
24	0.685	0.857	1.059	1.318	1.711	2.064	2.172	2.492	2.797	3.091	3.467	3.745
25	0.684	0.856	1.058	1.316	1.708	2.060	2.167	2.485	2.787	3.078	3.450	3.725
26	0.684	0.856	1.058	1.315	1.706	2.056	2.162	2.479	2.779	3.067	3.435	3.707
27	0.684	0.855	1.057	1.314	1.703	2.052	2.158	2.473	2.771	3.057	3.421	3.69
28	0.683	0.855	1.056	1.313	1.701	2.048	2.154	2.467	2.763	3.047	3.408	3.674
29	0.683	0.854	1.055	1.311	1.699	2.045	2.150	2.462	2.756	3.038	3.396	3.659
30	0.683	0.854	1.055	1.31	1.697	2.042	2.147	2.457	2.750	3.030	3.385	3.646
40	0.681	0.851	1.050	1.303	1.684	2.021	2.123	2.423	2.704	2.971	3.307	3.551
50	0.679	0.849	1.047	1.299	1.676	2.009	2.109	2.403	2.678	2.937	3.261	3.496
60	0.679	0.848	1.045	1.296	1.671	2.000	2.099	2.390	2.66	2.915	3.232	3.46
80	0.678	0.846	1.043	1.292	1.664	1.99	2.088	2.374	2.639	2.887	3.195	3.416
100	0.677	0.845	1.042	1.290	1.660	1.984	2.081	2.364	2.626	2.871	3.174	3.39
1000	0.675	0.842	1.037	1.282	1.646	1.962	2.056	2.330	2.581	2.813	3.098	3.3
Z*	0.674	0.841	1.036	1.282	1.645	1.96	2.054	2.326	2.576	2.807	3.091	3.291
	50%	**60%**	**70%**	**80%**	**90%**	**95%**	**96%**	**98%**	**99%**	**99.50%**	**99.80%**	**99.90%**