THE UNIVERSITY OF WESTERN ONTARIO
DEPARTMENT OF STATISTICAL AND ACTUARIAL SCIENCES
KING'S UNIVERSITY COLLEGE
STATISTICS 1024B FINAL EXAMINATION - REWRITE

Tuesday, April 27th, 2010, 1:00 - 4:00 PM

**EXAM CODE 807**

INSTRUCTIONS:

- This is a closed book examination. Tables A and C from the text and a formula sheet are attached. There are some blank pages at the end for rough work.
- There are 50 multiple choice questions to be answered using the provided Scantron sheet.
- Only non-programmable calculators are permitted.
- Use only an HB pencil for the Scantron sheet.
- Print your name, instructor and course (SS 1024B) on your Scantron sheet, and sign it.
- Fill in STUDENT NUMBER and SECTION on the Scantron sheet.
- Enter 807 as your EXAM CODE on the Scantron sheet.
- Leave the ANSWER SHEET NUMBER blank on the Scantron sheet.
- Code your answers on the Scantron sheet and submit it. The question sheet must also be handed in.
- **NO EXTRA TIME WILL BE GIVEN TO CODE YOUR ANSWERS!!**

**GOOD LUCK!**

**1)** The Human Resources Department of London City Council generally uses 90% confidence in its annual statistical reports. One report gives a 90% confidence interval for the mean hourly earnings in year 2001 as \$15.49 to \$16.11. This result was calculated using SRS techniques.

If a 95% confidence interval is constructed using the same data, the confidence interval would be
(A) narrower (B) wider (C) the same (D) invalid

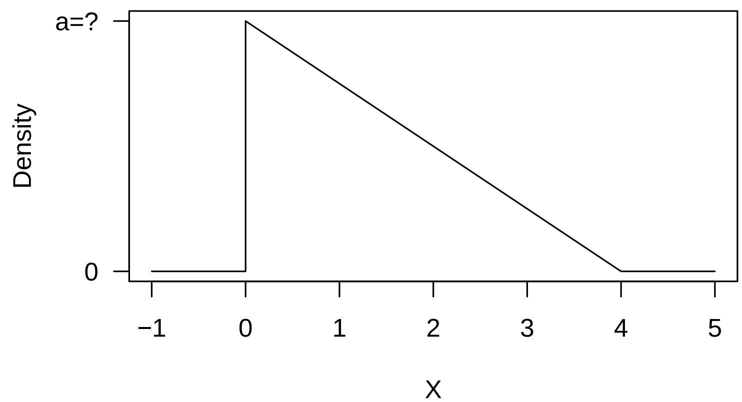
**2)** Diastolic blood pressure has a distribution which is slightly skewed to the right. The mean and standard deviation were calculated for the diastolic blood pressures of a random sample of 30 men. Which of the following statements is true?

(A) There would be fewer observations below the mean than above it.
(B) About 95% of observations would be expected to be within two standard deviations of the mean.
(C) The standard deviation would be approximately equal to the mean.
(D) All of the above.

**3)** The null hypothesis in a statistical test is

(A) determined by looking at the data.
(B) statistically significant.
(C) the statement being tested and we look for evidence against it.
(D) known to be true.

**4)** A triangular probability density function for a random variable $X$ defined on the interval from 0 to 4 is shown in the figure below.




First determine $a$, and then determine the probability that $X > 1$. The probability is
(A) 5/8 (B) 9/16 (C) 1/2 (D) 3/4 (E) 1/4

**5)** Two matched pairs experiments were done comparing treatments A and B. In the first experiment there were 25 matched pairs and in the second there were 50. The differences in outcomes is assumed normally distributed with unknown mean and standard deviation. By a remarkable coincidence, both experiments had $\bar{x} = 10$ and $s = 3.5$. In the first experiment a 95% confidence interval for the mean difference was determined. Let $m_1$ denote the margin of error for this confidence interval. In the second experiment a 99% confidence interval was used. Let $m_2$ denote the margin of error for this confidence interval. The percentage difference between the two margins of error, i.e. $100(m_1 - m_2)/m_1$, is about
(A) -16 % (B) 30 % (C) 8 % (D) -8 %

**6)** A medical researcher wishes to investigate the effectiveness of exercise versus diet in losing weight. Two groups of 25 overweight adult subjects are used, with a subject in each group matched to a similar subject in the other group on the basis of a number of physiological variables. One group is placed on a regular program of vigorous exercise, but with no restriction on diet, and the other group on a strict diet, but with no requirement to exercise. The weight losses after 20 weeks are determined for each subject, and the difference between matched pairs of subjects (weight loss of subject in exercise group) − (weight loss of matched subject in diet group) is computed. The mean of these differences in weight loss is found to be −2 lbs. with standard deviation $s = 6$ lbs. Is this evidence of a difference in mean weight loss between the two methods? To test this, consider the population of differences (weight loss overweight adult would experience after 20 weeks on the exercise program) - (weight loss the same adult would experience after 20 weeks on the strict diet). Let $\mu$ be the mean of this population of differences and assume their distribution is approximately Normal. We test the hypotheses $H_0 : \mu = 0$ versus $H_a : \mu \neq 0$, using the matched pairs $t$ test. The $P$-value for this test is

(A) below .01.

(B) larger than .10.

(C) between .10 and .05.

(D) between .05 and .01.

**7)** A university administrator obtains a sample of the academic records of past and present scholarship athletes at the university. The administrator reports that no significant difference was found in the mean GPA (grade point average) for male and female scholarship athletes ($P$-value = 0.287). This means

(A) the GPAs for male and female scholarship athletes are identical, except for 28.7% of the athletes.

(B) the maximum difference in GPAs between male and female scholarship athletes is 0.287.

(C) if there really is no difference in mean GPA for male and female scholarship athletes, the probability of observing a difference in GPAs between male and female scholarship athletes as large as that observed in the sample is 0.287.

(D) none of the above.

**8)** You are given 15 observations from a simple random sample taken from a normally distributed population with unknown standard deviation. What critical value would you use to obtain a 98% confidence interval for the mean $\mu$ of the population?
(A) 2.249 (B) 2.602 (C) 2.624 (D) 2.264

**9)** A pharmaceutical company claims that their particular medication does not affect the pulse rate of the patients who are on this medication. Studies showed that average pulse rate of all such patients is about 80 beats per minute (BPM) with standard deviation of 8 BPM. A sample of 30 users of this medication resulted in an average pulse rate of 86 BPM. Based on this information, a 99% confidence interval for the true average pulse rate is estimated as $(82, 90)$ BPM.

Based on the reasoning of hypothesis tests, using $\alpha = 0.01$ and a two-sided test, which of the following statements is TRUE?

(A) There is a 99% probability that the true average pulse rate BPM is 86.
(B) There is not enough evidence to conclude that the true average pulse rate differs from 80 BPM.
(C) We would conclude that the sample average pulse rate differs from 80 BPM.
(D) There is enough evidence to conclude that the true average pulse rate differs from 80 BPM.

**10)** A study of high school students in 1998 showed that 35% of them smoked cigarettes. The federal government implemented an advertising program designed to decrease the smoking rate of high school children. They wish to know if the program has been successful. In 2000, they surveyed 1000 high school students and found that 370 of them smoked. Which of the following statements is correct? Use $\alpha = 0.05$.

(A) $H_0 : p = 35\%$, $H_a : p \neq 35\%$ and we fail to reject $H_0$
(B) $H_0 : p = 37\%$, $H_a : p < 37\%$ and we fail to reject $H_0$
(C) $H_0 : p = 37\%$, $H_a : p < 37\%$ and we reject $H_0$
(D) $H_0 : p = 35\%$, $H_a : p < 35\%$ and we reject $H_0$
(E) $H_0 : p = 35\%$, $H_a : p < 35\%$ and we fail to reject $H_0$

**Questions 11 and 12 refer to the following information:**

Babies typically learn to crawl approximately six months after birth. It may take longer for babies to learn to crawl in the winter when they are often bundled in clothes that restrict their movement. Thus, there may be an association between a baby's crawling age and the average temperature during the month they first try to crawl.

In a study, for each month of the year, researchers sampled babies born during that month and measured the average age (in weeks) of first crawl. They also recorded the average temperature 6 months later (when babies usually start crawling). For example, the babies born in January (on average) had their first crawl at age 29.84 weeks, and the average temperature 6 months after January (that's July) was 19 C. We would record this data point as (19 C, 29.84 weeks). This was done for all 12 months, so there are 12 data points.

We want to investigate if the average age $y$ at which infants begin to crawl can be predicted from the average outdoor temperature $x$ six months after birth when they are likely to begin crawling. We decide to fit a least-squares regression line to the data with $x$ as the explanatory variable and $y$ as the response variable. We compute the following quantities.

$$\begin{aligned} r &= -0.70 \\ \bar{x} &= 10.1 \\ \bar{y} &= 31.77 \\ s_x &= 8.80 \\ s_y &= 1.76 \end{aligned}$$

**11)** The slope of the least-squares regression line is
(A) -3.5 (B) 2.2 (C) 0.88 (D) -0.14 (E) None of these.

**12)** The intercept of the least-squares regression line is
(A) 30.36 (B) 0. (C) 33.18 (D) 14.55 (E) None of these.

**The following description is used in questions 13–15:**

Is there a difference in the amount of airborne bacteria between carpeted and uncarpeted rooms? In an experiment, 5 rooms were carpeted and 5 were left uncarpeted. The rooms are similar in size and function. After a suitable period of time, the concentration of bacteria in the air was measured (in units of bacteria per cubic foot) in all of these rooms. The data and summaries are provided:

| | $\bar{x}$ | $s$ |
|---|---|---|
| Carpeted Rooms | 184 | 27.0 |
| Uncarpeted Rooms | 172 | 17.9 |

**13)** The researcher wants to investigate whether carpet makes a difference (either increases or decreases) in the mean bacterial concentration in air. The numerical value of the two-sample $t$ statistic for this test is

(A) 0.414 (B) 0.828 (C) 1.312 (D) 2.116

**14)** If we had used the conservative approximation to the degrees of freedom (what the text calls "Option 2"), which of the following would be the number of degrees of freedom for the $t$-procedure?

(A) 10 (B) 13 (C) 7 (D) 4

**15)** If we had used the computer method ("Option 1") to approximate the degrees of freedom, the degrees of freedom for the $t$-statistic would be

(A) 8.95 (B) 6.95 (C) 5.95 (D) 4.95 (E) 7.95

**16)** A sports writer wished to see if a football filled with helium travels farther, on average, than a football filled with air. To test this, the writer used 18 adult male volunteers. These volunteers were randomly divided into two groups of 9 subjects each. Group 1 kicked a football filled with helium to the recommended pressure. Group 2 kicked a football filled with air to the recommended pressure. The mean yardage for group 1 was $\bar{x}_1 = 30$ yards, with a standard deviation $s_1 = 8$ yards. The mean yardage for group 2 was $\bar{x}_2 = 26$ yards, with a standard deviation $s_2 = 6$ yards. Assume the two groups of kicks are independent. Let $\mu_1$ and $\mu_2$ represent the mean yardage we would observe for the entire population represented by the volunteers if all members of this population kicked, respectively, a helium and an air-filled football. Assume that two-sample $t$-procedures are safe to use.

A 99% confidence interval for $\mu_1 - \mu_2$ is (use the conservative value for the degrees of freedom)

(A) -0.7 to 8.7 yards.

(B) -8.7 to 16.7 yards.

(C) -2.2 to 10.2 yards.

(D) -7.2 to 15.2 yards.

**17)** Four golfers are asked to play a round of golf each of two consecutive Saturday afternoons. During the first round, one of two club types is to be used. During the second round, another club type is to be used. The order in which a golfer uses each brand is determined randomly. Scores are recorded. The results are given below.

| Golfer | Brand 1 | Brand 2 |
|---|---|---|
| 1 | 93 | 95 |
| 2 | 88 | 86 |
| 3 | 112 | 111 |
| 4 | 79 | 77 |

To determine if the mean scores differ by brand of club, we would use

(A) the two-sample $t$ test.

(B) the matched pairs $t$ test.

(C) the one-sample $t$ test.

(D) Any of the above are valid. It is at the experimenter's discretion.

**18)** Much information about health care comes from patient records, but that source doesn't allow us to compare people who use health services with those who don't. The Ministry of Health in Ontario wants to know whether the provincial health care system is achieving its goals in the province. They conducted the Ontario Health Survey, which interviewed a random sample of 61,239 people who live in Ontario. The population for this study is

(A) the 61,239 people interviewed.

(B) people who don't use health services.

(C) Ontario residents.

(D) none of the above.

**19)** A stratified random sample is most similar to which of the following experimental designs?

(A) a block design.

(B) a double-blind experiment.

(C) an experiment with a placebo.

(D) a confounded, nonrandomized study.

**20)** Sam is good at math, and is taking courses in statistics and in calculus. She has a 70% chance of getting an A in statistics and an 80% chance of getting an A in calculus. Her chance of getting an A in both courses is

(A) 56%

(B) 94%

(C) impossible to determine without further information or assumptions.

(D) 150%

**21)** Do students tend to improve their math SAT scores the second time they take the test? A random sample of four students who took the test twice received the following scores.

| Student | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| First score | 450 | 520 | 720 | 600 |
| Second score | 440 | 600 | 720 | 630 |

Assume that the change in math SAT score (second score) - (first score) for the population of all students taking the test twice is Normally distributed, with mean $\mu$. A 90% confidence interval for $\mu$ is
(A) $25.0 \pm 47.54$. (B) $25.0 \pm 33.24$. (C) $25.0 \pm 64.29$. (D) $25.0 \pm 43.08$.

**22)** Which of the following does not show or display the shape of a distribution?

(A) a steam and leaf plot.
(B) a boxplot.
(C) the mean and standard deviation.
(D) a histogram.

**23)** Which of the following is FALSE about sample size calculations for a desired margin of error in estimating a population proportion $p$?

(A) The required sample size decreases as the confidence level decreases, and as the guess at $p$ moves away from 1/2.
(B) The required sample size increases as the margin of error decreases, and as the guess at $p$ moves away from 1/2.
(C) The required sample size decreases as the margin of error increases, and as the confidence level decreases.
(D) The required sample size increases as the margin of error decreases, and as the guess at $p$ moves towards 1/2.

**24)** Which of the following methods is used to describe the relationship between two variables?

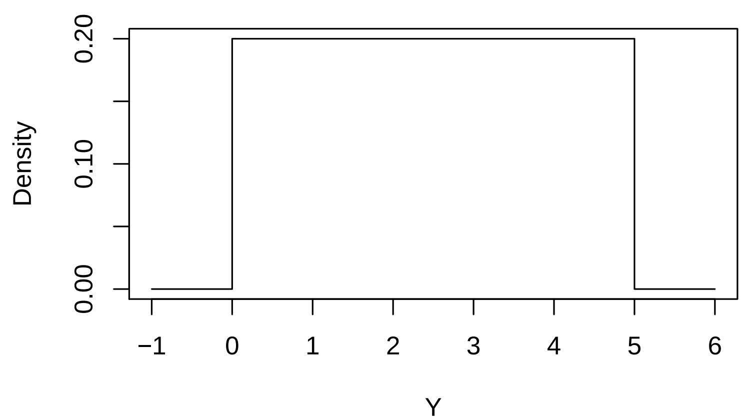
(A) a histogram.

(B) a pie chart.

(C) a scatterplot.

(D) all of the above.

**25)** The graph below shows the density curve for a random number $Y$ that can take any value from 0 to 5.




What is the probability that $Y$ is equal to 5 or more?

(A) 1 (B) 0.2 (C) 0 (D) Cannot be determined.

**26)** We'd like to conduct a survey to determine the proportion $p$ of students at UWO who live at home. If we assume nothing at all about $p$, what is the smallest possible sample size so that in a 95% large sample confidence interval we can be sure the margin of error will be less than 10%?

(A) 96 (B) 97 (C) 385 (D) 95 (E) None of these.

**27)** If $X$ and $Y$ are categorical variables, the best way to determine if there is a relationship between them is to

(A) calculate the correlation between $X$ and $Y$.

(B) draw a scatterplot of the $X$ and $Y$ values.

(C) draw two box plots to compare the distributions of the $X$ and $Y$.

(D) none of the above.

**28)** The Ledd Pipe Company has received a large shipment of pipes, and a quality control inspector wants to estimate the average diameter of the pipes to see if they meet minimum standards. She takes a random sample of 15 pipes, and the sample produces an average diameter of 2.55 mm. Assume that the diameters of the pipes are normally distributed, with a population standard deviation of 0.07 mm. An interval estimate for the population mean at a 99 percent level of confidence is:

(A) (2.520 mm, 2.580 mm)

(B) (2.515 mm, 2.585 mm)

(C) (2.503 mm, 2.597 mm)

(D) (2.514 mm, 2.597 mm)

**29)** In order to study the amounts owed to the city, a city clerk takes a random sample of 16 files from a cabinet containing a large number of delinquent accounts and finds the average amount owed to the city to be $230. It has been claimed that the true mean amount owed on accounts of this type is greater than $250. If it is appropriate to assume that the amount owed is normally distributed with a standard deviation of $36, the value of the test statistic appropriate for testing the claim is

(A) -0.55

(B) not possible to determine without more information.

(C) 2.22

(D) -2.22

(E) 0.55

**30)** A researcher plans to conduct a test of hypotheses at the $\alpha = 0.01$ significance level. She designs her study so that the Type II error probability is 0.10 at a particular alternative value of the parameter of interest. What is the probability that the researcher will incorrectly accept the alternative value?

(A) 0.10

(B) 0.01

(C) 0.90

(D) equal to the $P$-value and cannot be determined until the data have been collected.

**31)** An economist wants to estimate the mean annual income earned (in their first year of work after graduation) by students graduating from his college. What sample size would be required if the economist wants to be 95% confident that the sample mean is within \$500 of the true population mean? Assume the population standard deviation of income earned (in their first year of work after graduation) by college graduates is \$6,250.

(A) 600 (B) 601 (C) 599 (D) 25

**32)** A special diet is intended to reduce the cholesterol of patients at risk of heart disease. If the diet is effective, the target is to have the average cholesterol of this group be below 200. After six months on the diet, a simple random sample of 50 patients at risk for heart disease had an average cholesterol of $\bar{x} = 192$, with standard deviation $s = 21$. Is this sufficient evidence that the diet is effective in meeting the target? Assume the distribution of the cholesterol for patients in this group is approximately Normal with mean $\mu$. The $P$-value for the one-sample $t$ test is

(A) between 0.05 and 0.01.

(B) larger than 0.10.

(C) below 0.01.

(D) between 0.10 and 0.05.

**33)** Suppose we were not sure if a distribution of net weights was Normal. In which of the following circumstances would we **not** be safe using a $t$ procedure in this problem?

(A) A histogram of the data shows moderate skewness.

(B) The mean and median of the data are nearly equal.

(C) A stemplot of the data has a large outlier.

(D) The sample standard deviation is large.

**34)** Which of the following is an example of a matched pairs design?

(A) A teacher compares the scores of some students using a computer-based method of instruction, with the scores of other students using a traditional method of instruction.

(B) A teacher calculates the average of scores of students on a pair of tests and wishes to see if this average is larger than 80%.

(C) A teacher compares the scores of students in her class on a standardized test with the national average score.

(D) A teacher compares the pretest and posttest scores of students.

**35)** A research biologist has carried out an experiment on a random sample of 15 experimental plots in a field. Following the collection of data, a test of significance was conducted under appropriate null and alternative hypotheses and the $P$-value was determined to be approximately 0.03. This indicates that:

(A) It indicates nothing; a sample of 15 is never large enough to draw a useful conclusion.

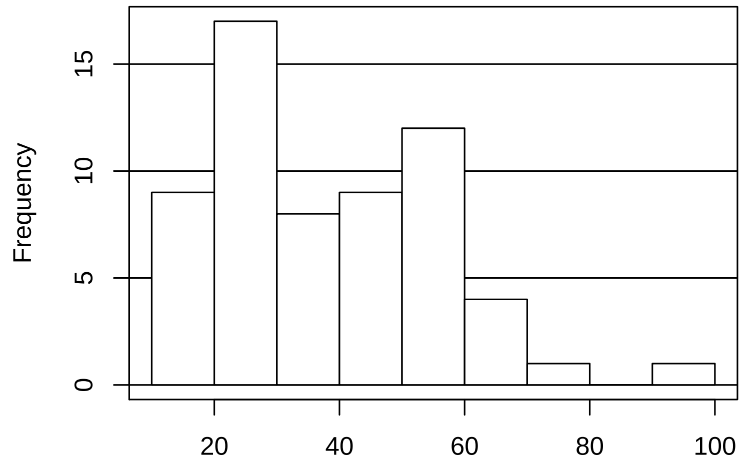
(B) if this experiment was repeated 3 per cent of the time we would get this same result.

(C) the probability of being wrong in this situation is only 0.03.

(D) this result is statistically significant at the 0.05 level.

(E) this result is statistically significant at the 0.01 level.

**36)** The following histogram is constructed from a data set with 61 observations.




Among the following values, which is the best estimate of the median?
(A) 35 (B) 15 (C) 45 (D) 25 (E) 50

**37)** The nicotine content in cigarettes of a certain brand is normally distributed with an unknown mean (in milligrams) $\mu$ and standard deviation 0.2. The brand advertises that the mean nicotine content of their cigarettes is 1.5, but you believed that the mean nicotine content is actually higher than advertised. To explore this, you took a random sample of 36 cigarettes and tested the hypothesis and obtained a $P$-value of 0.003. What was the value of the sample mean $\bar{x}$?

(A) 1.50

(B) 1.59

(C) 1.41

(D) 2.05

(E) It cannot be determined without more information.

**38)** The average time it takes for a person to experience pain relief from aspirin is about 25 minutes. It is reasonable to believe that true standard deviation of relief time for all patients is around 4 minutes and relief time follows a Normal distribution. A new ingredient is added to help speed up relief. A random sample of 25 patients who took the new aspirin pill showed an average relief time of 23 minutes. Which of the following statements are true, keeping in view the information provided?

(I) The appropriate null and alternate hypotheses are $H_0 : \mu = 25$ min and $H_a : \mu > 25$ min.

(II) We fail to reject $H_0$ at $\alpha = 0.05$.

(III) The appropriate null and alternate Hypotheses are $H_0 : \mu = 25$ min and $H_a : \mu < 25$ min.

(IV) If a 95% confidence interval is constructed for the true average relief time, this interval would not contain the value of 25 min.

(A) all but (IV)

(B) (III) and (IV)

(C) all but (I)

(D) (II) and (III)

(E) (I) and (II)

**39)** A four sided-die is used in some games. It is shaped like a pyramid, with four triangular sides marked with the numbers 1 to 4. If one of these dies is rolled twice, the sample space is

(A) $\{(1,1),(1,2),(1,3),(1,4),(2,2),(2,3),(2,4),(3,3),(3,4),(4,4)\}$

(B) $\{(1,1),(1,2),(1,3),(1,4),(2,1),(2,2),(2,3),(2,4),$
$(3,1),(3,2),(3,3),(3,4),(4,1),(4,2),(4,3),(4,4)\}$

(C) $\{2,3,4,5,6,7,8\}$

(D) unknown without specifying which values were sampled.

**40)** The mean annual return on the Toronto Stock Exchange from 1970 to 2009 was 11.1% per year. The standard deviation of the annual returns was 17.5%. Annual returns follow a reasonable approximation to a Normal distribution. You are planning to take early retirement in 20 years, and you assume that the stock market will perform in the future as it did over this period, ignoring any uncertainty in the mean or standard deviation. What is the probability that you will have a 10% or better mean annual return over the next 20 years?

(A) 0.525 (B) 0.611 (C) 0.389 (D) 0.475

**41)** Statistics Canada collects records of the underlying cause of death for each death in Canada, classified according to the "World Health Organization International Statistical Classification of Disease and Related Health Problems". Each death is assigned just one underlying cause. According to their publications, the leading cause of death is some form of cancer (27.2%), followed by diseases of the heart (26.6%). If a death is chosen at random, what is the probability that its underlying cause will be something other than cancer or a disease of the heart?

(A) 0.728 (B) 0.462 (C) 0.734 (D) 0.538

**42)** The appraised values of three recently sold houses in the London area are (in thousands of dollars) 160, 215, and 195. The standard error of the mean of these three appraised values is

(A) 16.07. (B) 290.00. (C) 22.73. (D) 27.84.

**Use the following to answer questions 43–44:**

A university researcher studying the effect of price cuts on consumers' expectations makes up two different histories of the store price of a hypothetical brand of laundry detergent for the past year. Eight students in a class view one or the other price history on a computer. Some students see a steady price, while others see regular sales that temporarily cut the price. Students are asked the price they would expect to pay.

The names of the eight subjects were:

1. Franklin
2. James
3. Wright
4. Edwards
5. Rust
6. Walsh
7. Gofberg
8. Williams

**43)** Using the list of random digits:

41842 81868 71035 09001 43367 49497

start at the beginning and use single-digit labels to assign the first four subjects selected to have the steady price group, and the remaining four to the fluctuating price group. The subjects assigned to the fluctuating price group are

(A) Edwards, Franklin, Williams, and James.

(B) Franklin, James, Wright, and Edwards.

(C) Rust, Walsh, Gofberg, and Williams.

(D) Wright, Rust, Walsh, and Gofberg.

**44)** The experimental units are

(A) the price they would expect to pay.

(B) all students at the university.

(C) the eight students who participated.

(D) the students who were in the fluctuating price group.

**The following description is used in questions 45–47:**

An Ekos poll held in March, 2010 asked voters across Canada the following question: "If a federal election were held tomorrow, which party would you vote for?" The results were reported by region.

**45)** The poll selected 332 voters in British Columbia, and 121 of the respondents chose the Conservative party. What is the large-sample 95% confidence interval for the proportion of British Columbian voters who would respond that way?
(A) $(0.313, 0.416)$ (B) $(0.321, 0.408)$ (C) $(-0.579, 1.308)$ (D) $(0.584, 0.687)$

**46)** The same Ekos poll asked 116 voters in Saskatchewan and Manitoba who they would vote for. In that region, 29 respondents chose the Liberal party. What is the plus four 95% confidence interval for the proportion of voters in the region who would respond that way?
(A) $(0.171, 0.329)$ (B) $(0.180, 0.337)$ (C) $(0.193, 0.324)$ (D) $(0.172, 0.328)$

**47)** The Ekos poll reports that in Ontario the Green Party had the support of 10.6% of those surveyed. In computing a large sample 95% confidence interval, we found a margin of error of 2.2%. This means that

(A) we can be sure that the percent of all adults in Ontario who support the Green Party is between 8.4% and 12.8%.

(B) the method we used together with the Ekos random sampling method generates intervals where the true proportion would be in the interval approximately 95% of the time.

(C) if Ekos takes another poll using the same random sampling method (and the population's opinions haven't changed), the results of the second poll will lie between 8.4% and 12.8%.

(D) none of the above.

**48)** Which of the following statements about simple random sampling is INCORRECT?

(A) Each member of the population has an equal chance of being chosen.

(B) Each possible sample of the given size has an equal chance of being chosen.

(C) The decision to include a subject in the sample depends only on the subject's own characteristics.

(D) None of the above, they are all correct statements.

**49)** In a test of $H_0 : \mu = 100$ against $H_a : \mu \neq 100$ with known $\sigma = 3.4$, a sample of size 80 produces $z = 0.8$ for the value of the test statistic. The $p$-value of the test is thus equal to:
(A) 0.58 (B) 0.79 (C) 0.84 (D) 0.42 (E) 0.21

**50)** Which one of the following statements is true regarding type I and type II error probabilities and power of a test?

(A) Increasing the sample size increases the power of a test and decreases the probability of a type II error when the significance level $\alpha$ is unchanged.

(B) Increasing the sample size decreases the power of a test and increases the probability of a type II error when the significance level $\alpha$ is unchanged.

(C) Increasing the sample size has no effect on the power of a test and it increases the probability of a type II error when the significance level $\alpha$ is unchanged.

(D) Increasing the sample size decreases the power of a test and decreases the probability of a type II error when the significance level $\alpha$ is unchanged.

Use this page for rough work.

Use this page for rough work.

Use this page for rough work.

# FORMULA SHEET

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i \qquad z = \frac{x-\mu}{\sigma} \qquad s = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(x_i-\bar{x})^2}$$

$$b = r\frac{s_y}{s_x} \qquad a = \bar{y} - b\bar{x} \qquad r = \frac{1}{n-1}\sum_{i=1}^{n}\left(\frac{x_i-\bar{x}}{s_x}\right)\left(\frac{y_i-\bar{y}}{s_y}\right)$$

$$\bar{x} \pm z^*\sigma/\sqrt{n} \qquad n = \left(\frac{z^*\sigma}{m}\right)^2 \qquad z = \frac{\bar{x}-\mu_0}{\sigma/\sqrt{n}}$$

$$\bar{x} \pm t^* s/\sqrt{n} \qquad t = \frac{\bar{x}-\mu_0}{s/\sqrt{n}} \qquad t = \frac{\bar{x}_1-\bar{x}_2}{\sqrt{\frac{s_1^2}{n_1}+\frac{s_2^2}{n_2}}}$$

$$(\bar{x}_1-\bar{x}_2) \pm t^*\sqrt{\frac{s_1^2}{n_1}+\frac{s_2^2}{n_2}} \qquad \text{df} = \frac{\left(\frac{s_1^2}{n_1}+\frac{s_2^2}{n_2}\right)^2}{\frac{1}{n_1-1}\left(\frac{s_1^2}{n_1}\right)^2+\frac{1}{n_2-1}\left(\frac{s_2^2}{n_2}\right)^2}$$

$$\hat{p} \pm z^*\sqrt{\frac{\hat{p}(1-\hat{p})}{n}} \qquad z = \frac{\hat{p}-p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}} \qquad n = \left(\frac{z^*}{m}\right)^2 p^*(1-p^*)$$

$$\tilde{p} = \frac{x+2}{n+4}$$

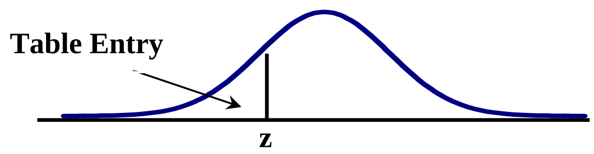



**Table entry for z is the area under the standard normal curve to the left of z.**
**TABLE A Standard normal probabilities**

| z | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 |
|---|---|---|---|---|---|---|---|---|---|---|
| -3.4 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0002 |
| -3.3 | 0.0005 | 0.0005 | 0.0005 | 0.0004 | 0.0004 | 0.0004 | 0.0004 | 0.0004 | 0.0004 | 0.0003 |
| -3.2 | 0.0007 | 0.0007 | 0.0006 | 0.0006 | 0.0006 | 0.0006 | 0.0006 | 0.0005 | 0.0005 | 0.0005 |
| -3.1 | 0.0010 | 0.0009 | 0.0009 | 0.0009 | 0.0008 | 0.0008 | 0.0008 | 0.0008 | 0.0007 | 0.0007 |
| -3.0 | 0.0013 | 0.0013 | 0.0013 | 0.0012 | 0.0012 | 0.0011 | 0.0011 | 0.0011 | 0.0010 | 0.0010 |
| -2.9 | 0.0019 | 0.0018 | 0.0018 | 0.0017 | 0.0016 | 0.0016 | 0.0015 | 0.0015 | 0.0014 | 0.0014 |
| -2.8 | 0.0026 | 0.0025 | 0.0024 | 0.0023 | 0.0023 | 0.0022 | 0.0021 | 0.0021 | 0.0020 | 0.0019 |
| -2.7 | 0.0035 | 0.0034 | 0.0033 | 0.0032 | 0.0031 | 0.0030 | 0.0029 | 0.0028 | 0.0027 | 0.0026 |
| -2.6 | 0.0047 | 0.0045 | 0.0044 | 0.0043 | 0.0041 | 0.0040 | 0.0039 | 0.0038 | 0.0037 | 0.0036 |
| -2.5 | 0.0062 | 0.0060 | 0.0059 | 0.0057 | 0.0055 | 0.0054 | 0.0052 | 0.0051 | 0.0049 | 0.0048 |
| -2.4 | 0.0082 | 0.0080 | 0.0078 | 0.0075 | 0.0073 | 0.0071 | 0.0069 | 0.0068 | 0.0066 | 0.0064 |
| -2.3 | 0.0107 | 0.0104 | 0.0102 | 0.0099 | 0.0096 | 0.0094 | 0.0091 | 0.0089 | 0.0087 | 0.0084 |
| -2.2 | 0.0139 | 0.0136 | 0.0132 | 0.0129 | 0.0125 | 0.0122 | 0.0119 | 0.0116 | 0.0113 | 0.0110 |
| -2.1 | 0.0179 | 0.0174 | 0.0170 | 0.0166 | 0.0162 | 0.0158 | 0.0154 | 0.0150 | 0.0146 | 0.0143 |
| -2.0 | 0.0228 | 0.0222 | 0.0217 | 0.0212 | 0.0207 | 0.0202 | 0.0197 | 0.0192 | 0.0188 | 0.0183 |
| -1.9 | 0.0287 | 0.0281 | 0.0274 | 0.0268 | 0.0262 | 0.0256 | 0.0250 | 0.0244 | 0.0239 | 0.0233 |
| -1.8 | 0.0359 | 0.0351 | 0.0344 | 0.0336 | 0.0329 | 0.0322 | 0.0314 | 0.0307 | 0.0301 | 0.0294 |
| -1.7 | 0.0446 | 0.0436 | 0.0427 | 0.0418 | 0.0409 | 0.0401 | 0.0392 | 0.0384 | 0.0375 | 0.0367 |
| -1.6 | 0.0548 | 0.0537 | 0.0526 | 0.0516 | 0.0505 | 0.0495 | 0.0485 | 0.0475 | 0.0465 | 0.0455 |
| -1.5 | 0.0668 | 0.0655 | 0.0643 | 0.0630 | 0.0618 | 0.0606 | 0.0594 | 0.0582 | 0.0571 | 0.0559 |
| -1.4 | 0.0808 | 0.0793 | 0.0778 | 0.0764 | 0.0749 | 0.0735 | 0.0721 | 0.0708 | 0.0694 | 0.0681 |
| -1.3 | 0.0968 | 0.0951 | 0.0934 | 0.0918 | 0.0901 | 0.0885 | 0.0869 | 0.0853 | 0.0838 | 0.0823 |
| -1.2 | 0.1151 | 0.1131 | 0.1112 | 0.1093 | 0.1075 | 0.1056 | 0.1038 | 0.1020 | 0.1003 | 0.0985 |
| -1.1 | 0.1357 | 0.1335 | 0.1314 | 0.1292 | 0.1271 | 0.1251 | 0.1230 | 0.1210 | 0.1190 | 0.1170 |
| -1.0 | 0.1587 | 0.1562 | 0.1539 | 0.1515 | 0.1492 | 0.1469 | 0.1446 | 0.1423 | 0.1401 | 0.1379 |
| -0.9 | 0.1841 | 0.1814 | 0.1788 | 0.1762 | 0.1736 | 0.1711 | 0.1685 | 0.1660 | 0.1635 | 0.1611 |
| -0.8 | 0.2119 | 0.2090 | 0.2061 | 0.2033 | 0.2005 | 0.1977 | 0.1949 | 0.1922 | 0.1894 | 0.1867 |
| -0.7 | 0.2420 | 0.2389 | 0.2358 | 0.2327 | 0.2296 | 0.2266 | 0.2236 | 0.2206 | 0.2177 | 0.2148 |
| -0.6 | 0.2743 | 0.2709 | 0.2676 | 0.2643 | 0.2611 | 0.2578 | 0.2546 | 0.2514 | 0.2483 | 0.2451 |
| -0.5 | 0.3085 | 0.3050 | 0.3015 | 0.2981 | 0.2946 | 0.2912 | 0.2877 | 0.2843 | 0.2810 | 0.2776 |
| -0.4 | 0.3446 | 0.3409 | 0.3372 | 0.3336 | 0.3300 | 0.3264 | 0.3228 | 0.3192 | 0.3156 | 0.3121 |
| -0.3 | 0.3821 | 0.3783 | 0.3745 | 0.3707 | 0.3669 | 0.3632 | 0.3594 | 0.3557 | 0.3520 | 0.3483 |
| -0.2 | 0.4207 | 0.4168 | 0.4129 | 0.4090 | 0.4052 | 0.4013 | 0.3974 | 0.3936 | 0.3897 | 0.3859 |
| -0.1 | 0.4602 | 0.4562 | 0.4522 | 0.4483 | 0.4443 | 0.4404 | 0.4364 | 0.4325 | 0.4286 | 0.4247 |
| -0.0 | 0.5000 | 0.4960 | 0.4920 | 0.4880 | 0.4840 | 0.4801 | 0.4761 | 0.4721 | 0.4681 | 0.4641 |

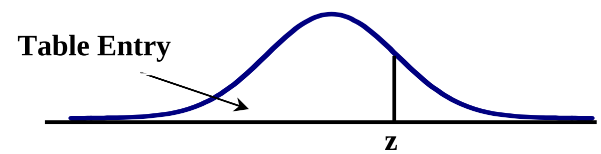



**Table entry for z is the area under the standard normal curve to the left of z.**
**TABLE A Standard normal probabilities (*continued*)**

| z | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 0.5000 | 0.5040 | 0.5080 | 0.5120 | 0.5160 | 0.5199 | 0.5239 | 0.5279 | 0.5319 | 0.5359 |
| 0.1 | 0.5398 | 0.5438 | 0.5478 | 0.5517 | 0.5557 | 0.5596 | 0.5636 | 0.5675 | 0.5714 | 0.5753 |
| 0.2 | 0.5793 | 0.5832 | 0.5871 | 0.5910 | 0.5948 | 0.5987 | 0.6026 | 0.6064 | 0.6103 | 0.6141 |
| 0.3 | 0.6179 | 0.6217 | 0.6255 | 0.6293 | 0.6331 | 0.6368 | 0.6406 | 0.6443 | 0.6480 | 0.6517 |
| 0.4 | 0.6554 | 0.6591 | 0.6628 | 0.6664 | 0.6700 | 0.6736 | 0.6772 | 0.6808 | 0.6844 | 0.6879 |
| 0.5 | 0.6915 | 0.6950 | 0.6985 | 0.7019 | 0.7054 | 0.7088 | 0.7123 | 0.7157 | 0.7190 | 0.7224 |
| 0.6 | 0.7257 | 0.7291 | 0.7324 | 0.7357 | 0.7389 | 0.7422 | 0.7454 | 0.7486 | 0.7517 | 0.7549 |
| 0.7 | 0.7580 | 0.7611 | 0.7642 | 0.7673 | 0.7704 | 0.7734 | 0.7764 | 0.7794 | 0.7823 | 0.7852 |
| 0.8 | 0.7881 | 0.7910 | 0.7939 | 0.7967 | 0.7995 | 0.8023 | 0.8051 | 0.8078 | 0.8106 | 0.8133 |
| 0.9 | 0.8159 | 0.8186 | 0.8212 | 0.8238 | 0.8264 | 0.8289 | 0.8315 | 0.8340 | 0.8365 | 0.8389 |
| 1.0 | 0.8413 | 0.8438 | 0.8461 | 0.8485 | 0.8508 | 0.8531 | 0.8554 | 0.8577 | 0.8599 | 0.8621 |
| 1.1 | 0.8643 | 0.8665 | 0.8686 | 0.8708 | 0.8729 | 0.8749 | 0.8770 | 0.8790 | 0.8810 | 0.8830 |
| 1.2 | 0.8849 | 0.8869 | 0.8888 | 0.8907 | 0.8925 | 0.8944 | 0.8962 | 0.8980 | 0.8997 | 0.9015 |
| 1.3 | 0.9032 | 0.9049 | 0.9066 | 0.9082 | 0.9099 | 0.9115 | 0.9131 | 0.9147 | 0.9162 | 0.9177 |
| 1.4 | 0.9192 | 0.9207 | 0.9222 | 0.9236 | 0.9251 | 0.9265 | 0.9279 | 0.9292 | 0.9306 | 0.9319 |
| 1.5 | 0.9332 | 0.9345 | 0.9357 | 0.9370 | 0.9382 | 0.9394 | 0.9406 | 0.9418 | 0.9429 | 0.9441 |
| 1.6 | 0.9452 | 0.9463 | 0.9474 | 0.9484 | 0.9495 | 0.9505 | 0.9515 | 0.9525 | 0.9535 | 0.9545 |
| 1.7 | 0.9554 | 0.9564 | 0.9573 | 0.9582 | 0.9591 | 0.9599 | 0.9608 | 0.9616 | 0.9625 | 0.9633 |
| 1.8 | 0.9641 | 0.9649 | 0.9656 | 0.9664 | 0.9671 | 0.9678 | 0.9686 | 0.9693 | 0.9699 | 0.9706 |
| 1.9 | 0.9713 | 0.9719 | 0.9726 | 0.9732 | 0.9738 | 0.9744 | 0.9750 | 0.9756 | 0.9761 | 0.9767 |
| 2.0 | 0.9772 | 0.9778 | 0.9783 | 0.9788 | 0.9793 | 0.9798 | 0.9803 | 0.9808 | 0.9812 | 0.9817 |
| 2.1 | 0.9821 | 0.9826 | 0.9830 | 0.9834 | 0.9838 | 0.9842 | 0.9846 | 0.9850 | 0.9854 | 0.9857 |
| 2.2 | 0.9861 | 0.9864 | 0.9868 | 0.9871 | 0.9875 | 0.9878 | 0.9881 | 0.9884 | 0.9887 | 0.9890 |
| 2.3 | 0.9893 | 0.9896 | 0.9898 | 0.9901 | 0.9904 | 0.9906 | 0.9909 | 0.9911 | 0.9913 | 0.9916 |
| 2.4 | 0.9918 | 0.9920 | 0.9922 | 0.9925 | 0.9927 | 0.9929 | 0.9931 | 0.9932 | 0.9934 | 0.9936 |
| 2.5 | 0.9938 | 0.9940 | 0.9941 | 0.9943 | 0.9945 | 0.9946 | 0.9948 | 0.9949 | 0.9951 | 0.9952 |
| 2.6 | 0.9953 | 0.9955 | 0.9956 | 0.9957 | 0.9959 | 0.9960 | 0.9961 | 0.9962 | 0.9963 | 0.9964 |
| 2.7 | 0.9965 | 0.9966 | 0.9967 | 0.9968 | 0.9969 | 0.9970 | 0.9971 | 0.9972 | 0.9973 | 0.9974 |
| 2.8 | 0.9974 | 0.9975 | 0.9976 | 0.9977 | 0.9977 | 0.9978 | 0.9979 | 0.9979 | 0.9980 | 0.9981 |
| 2.9 | 0.9981 | 0.9982 | 0.9982 | 0.9983 | 0.9984 | 0.9984 | 0.9985 | 0.9985 | 0.9986 | 0.9986 |
| 3.0 | 0.9987 | 0.9987 | 0.9987 | 0.9988 | 0.9988 | 0.9989 | 0.9989 | 0.9989 | 0.9990 | 0.9990 |
| 3.1 | 0.9990 | 0.9991 | 0.9991 | 0.9991 | 0.9992 | 0.9992 | 0.9992 | 0.9992 | 0.9993 | 0.9993 |
| 3.2 | 0.9993 | 0.9993 | 0.9994 | 0.9994 | 0.9994 | 0.9994 | 0.9994 | 0.9995 | 0.9995 | 0.9995 |
| 3.3 | 0.9995 | 0.9995 | 0.9995 | 0.9996 | 0.9996 | 0.9996 | 0.9996 | 0.9996 | 0.9996 | 0.9997 |
| 3.4 | 0.9997 | 0.9997 | 0.9997 | 0.9997 | 0.9997 | 0.9997 | 0.9997 | 0.9997 | 0.9997 | 0.9998 |

Table entry for C is the critical value $t^*$ required for confidence level C. To approximate one- and two-sided $P$-values, compare the value of the $t$ statistic with the critical values of $t^*$ that match the $P$-values given at the bottom of the table.

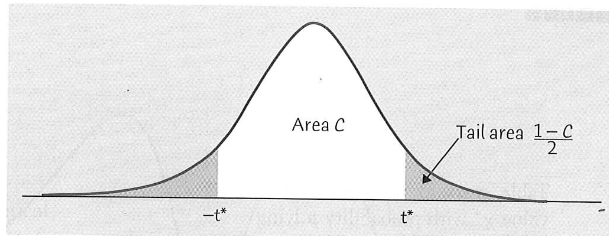



**TABLE C** ***t* distribution critical values**

| DEGREES OF FREEDOM | CONFIDENCE LEVEL C | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 50% | 60% | 70% | 80% | 90% | 95% | 96% | 98% | 99% | 99.5% | 99.8% | 99.9% |
| 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 | 2.920 | 4.303 | 4.849 | 6.965 | 9.925 | 14.09 | 22.33 | 31.60 |
| 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 | 8.610 |
| 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 | 1.440 | 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 | 3.690 | 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 | 0.870 | 1.079 | 1.350 | 1.771 | 2.160 | 2.282 | 2.650 | 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 | 4.140 |
| 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 | 0.860 | 1.064 | 1.325 | 1.725 | 2.086 | 2.197 | 2.528 | 2.845 | 3.153 | 3.552 | 3.850 |
| 21 | 0.686 | 0.859 | 1.063 | 1.323 | 1.721 | 2.080 | 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 | 3.690 |
| 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 | 1.310 | 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 | 2.660 | 2.915 | 3.232 | 3.460 |
| 80 | 0.678 | 0.846 | 1.043 | 1.292 | 1.664 | 1.990 | 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 | 3.390 |
| 1000 | 0.675 | 0.842 | 1.037 | 1.282 | 1.646 | 1.962 | 2.056 | 2.330 | 2.581 | 2.813 | 3.098 | 3.300 |
| $z^*$ | 0.674 | 0.841 | 1.036 | 1.282 | 1.645 | 1.960 | 2.054 | 2.326 | 2.576 | 2.807 | 3.091 | 3.291 |
| One-sided $P$ | .25 | .20 | .15 | .10 | .05 | .025 | .02 | .01 | .005 | .0025 | .001 | .0005 |
| Two-sided $P$ | .50 | .40 | .30 | .20 | .10 | .05 | .04 | .02 | .01 | .005 | .002 | .001 |

Answer key for version 807:

| | | | | | |
|---|---|---|---|---|---|
| 1 | 6 | 11 | 16 | 21 | 26 |
| BBCBC | BCCDE | DCBDB | DBCAC | ACBCC | BDCDB |
| 31 | 36 | 41 | 46 | | |
| BCCDD | ABBBB | BADCA | BBCDA | | |