
Please note: Some of the questions in this former practice exam may no longer perfectly align with the AP exam. Even though these questions do not fully represent the 2020 exam, teachers indicate that imperfectly aligned questions still provide instructional value. Teachers can consult the Question Bank to determine the degree to which these questions align to the 2020 Exam.

This exam may not be posted on school or personal websites, nor electronically redistributed for any reason. This exam is provided by the College Board for AP Exam preparation. Teachers are permitted to download the materials and make copies to use with their students in a classroom setting only. To maintain the security of this exam, teachers should collect all materials after their administration and keep them in a secure location.

Further distribution of these materials outside of the secure College Board site disadvantages teachers who rely on uncirculated questions for classroom testing. Any additional distribution is in violation of the College Board's copyright policies and may result in the termination of Practice Exam access for your school as well as the removal of access to other online services such as the AP Teacher Community and Online Score Reports.

Students are expected to bring graphing calculators with statistical capabilities to the AP Statistics Exam. Nongraphing scientific calculators are permitted as long as they have the required computational capabilities. Before starting the exam administration, make sure each student has a graphing calculator from the approved list on page 53 of the *2018-19 AP Coordinator's Manual* or a scientific calculator. It is up to the student to determine if a nongraphing scientific calculator has the required computational capabilities. If a student does not have a graphing calculator from the approved list or an appropriate scientific calculator, you may provide one from your supply. See pages 50–53 of the *AP Coordinator's Manual* for more information. If the student does not want to use the calculator you provide, or does not want to use a calculator at all, he or she must hand copy, date, and sign the release statement on page 52 of the *AP Coordinator's Manual*.

Students may have no more than two calculators on their desks. Calculators may not be shared. Calculator memories do not need to be cleared before or after the exam. Students with Hewlett-Packard 48–50 Series and Casio FX-9860 graphing calculators may use cards designed for use with these calculators. Proctors should make sure infrared ports (Hewlett-Packard) are not facing each other. **Since graphing calculators can be used to store data, including text, proctors should monitor that students are using their calculators appropriately. Attempts by students to use the calculator to remove exam questions and/or answers from the room may result in the cancellation of AP Exam scores.**

SECTION I: Multiple Choice

► **Do not begin the exam instructions below until you have completed the appropriate General Instructions for your group.**

Make sure you begin the exam at the designated time. Remember, you must complete a seating chart for this exam. See pages 295–296 for a seating chart template and instructions. See the *2018-19 AP Coordinator's Manual* for exam seating requirements (pages 56–59).

If you are giving the regularly scheduled exam, say:

It is Thursday afternoon, May 16, and you will be taking the AP Statistics Exam.

If you are giving the alternate exam for late testing, say:

It is Wednesday morning, May 22, and you will be taking the AP Statistics Exam.

Look at your exam packet and confirm that the exam title is "AP Statistics."

Raise your hand if your exam packet contains any title other than "AP Statistics," and I will help you.

Once you confirm that all students have the correct exams, say:

In a moment, you will open the exam packet. By opening this packet, you agree to all of the AP Program's policies and procedures outlined in the *2018-19 Bulletin for AP Students and Parents*.

You may now remove the shrinkwrap from the outside only of your exam packet. Do not open the Section I booklet; do not remove the shrinkwrap from the Section II materials. Put the white seals and the shrinkwrapped Section II booklet aside. . . .

Carefully remove the AP Exam label found near the top left of your exam booklet cover. Place it on page 1 of your answer sheet on the light blue box near the top right corner that reads "AP Exam Label." . . .

If students accidentally place the exam label in the space for the number label or vice versa, advise them to leave the labels in place. They should not try to remove the label; their exam can still be processed correctly.

Listen carefully to all my instructions. I will give you time to complete each step. Please look up after completing each step. Raise your hand if you have any questions.

Give students enough time to complete each step. Don't move on until all students are ready.

Read the statements on the front cover of the Section I booklet. . . .

Sign your name, and write today's date. . . .

Now print your full legal name where indicated. . . .

Turn to the back cover of your exam booklet and read it completely. . . .

Give students a few minutes to read the entire cover.

Are there any questions? . . .

You will now take the multiple-choice portion of the exam. You should have in front of you the multiple-choice booklet and your answer sheet. You may never discuss the multiple-choice exam content at any time in any form with anyone, including your teacher and other students. If you disclose the multiple-choice exam content through any means, your AP Exam score will be canceled.

Open your answer sheet to page 2. You must complete the answer sheet using a No. 2 pencil only. Mark all of your responses beginning on page 2 of your answer sheet, one response per question. Completely fill in the circles. If you need to erase, do so carefully and completely. No credit will be given for anything written in the exam booklet. Scratch paper is not allowed, but you may use the margins or any blank space in the exam booklet for scratch work. Calculators may be used for both sections of this exam. You may place your calculators on your desk. Are there any questions? . . .

You have 1 hour and 30 minutes for this section. Open your Section I booklet and begin.



Note Start Time _____ . Note Stop Time _____ .

Check that students are marking their answers in pencil on their answer sheets and that they have not opened their shrinkwrapped Section II booklets. Proctors should walk around and make sure Hewlett-Packard calculators' infrared ports are not facing each other and that students are not sharing calculators.

After 1 hour and 20 minutes, say:

There are 10 minutes remaining.

After 10 minutes, say:

Stop working. Close your booklet and put your answer sheet on your desk, faceup. Make sure you have your AP number label and an AP Exam label on page 1 of your answer sheet. Sit quietly while I collect your answer sheets.

Collect an answer sheet from each student. Check that each answer sheet has an AP number label and an AP Exam label.

After all answer sheets have been collected, say:

Now you must seal your exam booklet using the white seals you set aside earlier. Remove the white seals from the backing and press one on each area of your exam booklet cover marked "PLACE SEAL HERE." Fold each seal over the

back cover. When you have finished, place the booklet on your desk, faceup. I will now collect your Section I booklet. . . .

Collect a Section I booklet from each student. Check that each student has signed the front cover of the sealed Section I booklet.

There is a 10-minute break between Sections I and II.

When all Section I materials have been collected and accounted for and you are ready for the break, say:

Please listen carefully to these instructions before we take a 10-minute break. All items you placed under your chair at the beginning of this exam, including your Student Pack, must stay there, and you are not permitted to open or access them in any way. Leave your shrinkwrapped Section II packet on your desk during the break. You are not allowed to consult teachers, other students, notes, textbooks, or any other resources during the break. You may not make phone calls, send text messages, use your calculators, check email, use a social networking site, or access any electronic or communication device. You may not leave the designated break area. Remember, you may never discuss the multiple-choice exam content with anyone, and if you disclose the content through any means, your AP Exam score will be canceled. Are there any questions? . . .



You may begin your break. Testing will resume at _____ .

SECTION II: Free Response

After the break, say:

May I have everyone's attention? Place your Student Pack on your desk. . . .

You may now remove the shrinkwrap from the Section II packet, but do not open the exam booklet until you are told to do so. . . .

Read the bulleted statements on the front cover of the exam booklet. Look up when you have finished. . . .

Now take an AP number label from your Student Pack and place it on the shaded box. If you don't have any AP number labels, write your AP number in the box. Look up when you have finished. . . .

Read the last statement. . . .

Using your pen, print the first, middle, and last initials of your legal name in the boxes and print today's date where indicated. This constitutes your signature and your agreement to the statements on the front cover. . . .

Now turn to the back cover. Using your pen, complete Items 1 through 3 under "Important Identification Information." . . .

Read Item 4. . . .

Are there any questions? . . .

If this is your last AP Exam, you may keep your Student Pack. Place it under your chair for now. Otherwise if you are taking any other AP Exams this year, leave your Student Pack on your desk and I will collect it now. . . .

Read the information on the back cover of the exam booklet. Do not open the booklet until you are told to do so. Look up when you have finished. . . .

Name: _____

Answer Sheet for AP Statistics
Practice Exam, Section I

No.	Answer
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

No.	Answer
21	
22	
23	
24	
25	
26	
27	
28	
29	
30	
31	
32	
33	
34	
35	
36	
37	
38	
39	
40	

AP[®] Statistics Exam

SECTION I: Multiple Choice

2019

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.

At a Glance

Total Time

1 hour and 30 minutes

Number of Questions

40

Percent of Total Score

50%

Writing Instrument

Pencil required

Electronic Device

Graphing calculator
expected

Instructions

Section I of this exam contains 40 multiple-choice questions. Fill in only the circles for numbers 1 through 40 on your answer sheet.

Indicate all of your answers to the multiple-choice questions on the answer sheet. No credit will be given for anything written in this exam booklet, but you may use the booklet for notes or scratch work. After you have decided which of the suggested answers is best, completely fill in the corresponding circle on the answer sheet. Give only one answer to each question. If you change an answer, be sure that the previous mark is erased completely. Here is a sample question and answer.

Sample Question Sample Answer

Chicago is a (A) ● (C) (D) (E)
(A) state
(B) city
(C) country
(D) continent
(E) village

Use your time effectively, working as quickly as you can without losing accuracy. Do not spend too much time on any one question. Go on to other questions and come back to the ones you have not answered if you have time. It is not expected that everyone will know the answers to all of the multiple-choice questions.

Your total score on the multiple-choice section is based only on the number of questions answered correctly. Points are not deducted for incorrect answers or unanswered questions.

Form I
Form Code 4PBP4-S

90

Formulas begin on page 3.
Questions begin on page 6.
Tables begin on page 42.

Formulas

(I) Descriptive Statistics

$$\bar{x} = \frac{\sum x_i}{n}$$

$$s_x = \sqrt{\frac{1}{n-1} \sum (x_i - \bar{x})^2}$$

$$s_p = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{(n_1 - 1) + (n_2 - 1)}}$$

$$\hat{y} = b_0 + b_1 x$$

$$b_1 = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sum (x_i - \bar{x})^2}$$

$$b_0 = \bar{y} - b_1 \bar{x}$$

$$r = \frac{1}{n-1} \sum \left(\frac{x_i - \bar{x}}{s_x} \right) \left(\frac{y_i - \bar{y}}{s_y} \right)$$

$$b_1 = r \frac{s_y}{s_x}$$

$$s_{b_1} = \frac{\sqrt{\frac{\sum (y_i - \hat{y}_i)^2}{n-2}}}{\sqrt{\sum (x_i - \bar{x})^2}}$$

(II) Probability

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

$$P(A|B) = \frac{P(A \cap B)}{P(B)}$$

$$E(X) = \mu_x = \sum x_i p_i$$

$$\text{Var}(X) = \sigma_x^2 = \sum (x_i - \mu_x)^2 p_i$$

If X has a binomial distribution with parameters n and p , then:

$$P(X = k) = \binom{n}{k} p^k (1 - p)^{n-k}$$

$$\mu_x = np$$

$$\sigma_x = \sqrt{np(1 - p)}$$

$$\mu_{\hat{p}} = p$$

$$\sigma_{\hat{p}} = \sqrt{\frac{p(1 - p)}{n}}$$

If \bar{x} is the mean of a random sample of size n from an infinite population with mean μ and standard deviation σ , then:

$$\mu_{\bar{x}} = \mu$$

$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}$$

(III) Inferential Statistics

Standardized test statistic: $\frac{\text{statistic} - \text{parameter}}{\text{standard deviation of statistic}}$

Confidence interval: statistic \pm (critical value) • (standard deviation of statistic)

Single-Sample

Statistic	Standard Deviation of Statistic
Sample Mean	$\frac{\sigma}{\sqrt{n}}$
Sample Proportion	$\sqrt{\frac{p(1-p)}{n}}$

Two-Sample

Statistic	Standard Deviation
Difference of sample means	$\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$ Special case when $\sigma_1 = \sigma_2$ $\sigma \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}$
Difference of sample proportions	$\sqrt{\frac{p_1(1-p_1)}{n_1} + \frac{p_2(1-p_2)}{n_2}}$ Special case when $p_1 = p_2$ $\sqrt{p(1-p)} \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}$

$$\text{Chi-square test statistic} = \sum \frac{(\text{observed} - \text{expected})^2}{\text{expected}}$$

STATISTICS

SECTION I

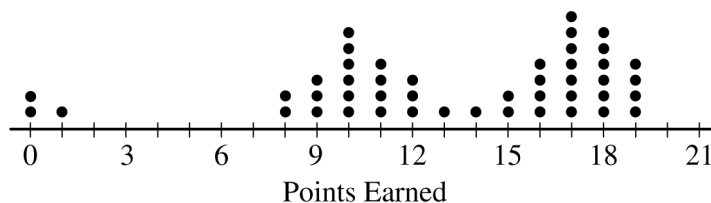
Time—1 hour and 30 minutes

Number of questions—40

Percent of total score—50

Directions: Solve each of the following problems, using the available space for scratch work. Decide which is the best of the choices given and fill in the corresponding circle on the answer sheet. No credit will be given for anything written in the test book. Do not spend too much time on any one problem.

1. A group of students played a game in which they earned points for answering questions correctly. The following dotplot shows the total number of points earned by each student.



Which of the following is the best description of the distribution of points earned?

- (A) Approximately normal
- (B) Bimodal without a gap
- (C) Bimodal with a gap
- (D) Skewed to the right without a gap
- (E) Skewed to the right with a gap

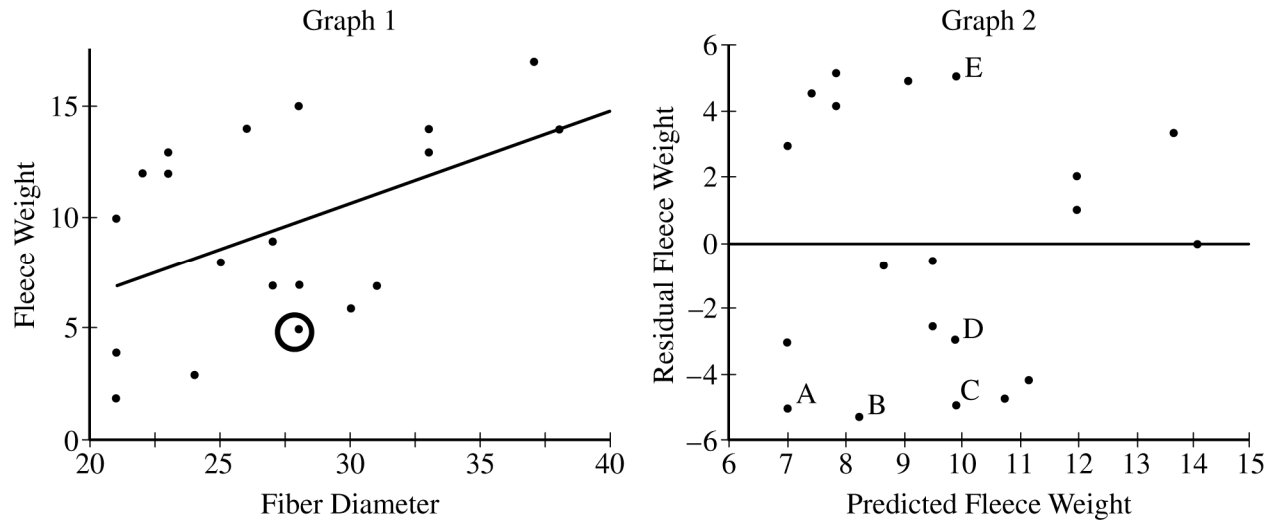
2. The table shows the responses from 103 people when asked if they support a proposal to expand the public library.

	Under the Age of 55	Age 55 or Older	Total
Yes	17	8	25
No	42	36	78
Total	59	44	103

One person from those who responded will be selected at random. Which of the following is closest to the probability that the person selected will be someone who responded no, given that the person selected is age 55 or older?

- (A) 0.350
- (B) 0.427
- (C) 0.462
- (D) 0.757
- (E) 0.818

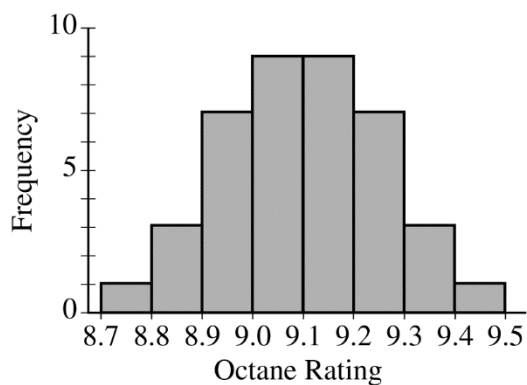
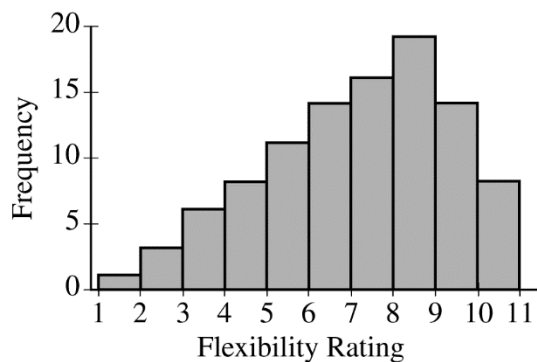
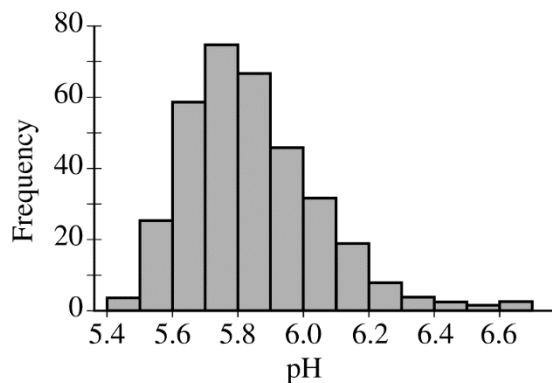
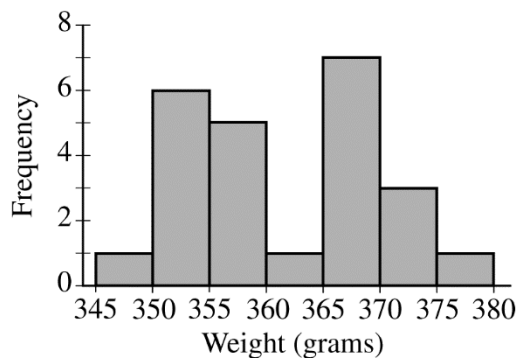
3. Data were collected on the fiber diameter and the fleece weight of wool taken from a sample of 20 sheep. The data are shown in the following graphs. Graph 1 is a scatterplot of fleece weight versus fiber diameter with the respective least-squares regression line shown. Graph 2 is the associated plot of the residuals versus the predicted values.



One point is circled on graph 1. Five points labeled A, B, C, D, and E are identified on graph 2. Which point on graph 2 represents the residual for the circled point on graph 1 ?

- (A) A
- (B) B
- (C) C
- (D) D
- (E) E

4. The distributions of four variables are shown in the following histograms.



Which of the following shapes is NOT represented by one of the four distributions?

- (A) Uniform
- (B) Bimodal
- (C) Skewed to the left
- (D) Skewed to the right
- (E) Symmetric and unimodal

5. A random sample of 1,092 people were asked whether color was a consideration in buying a new car. They were also asked to identify one additional feature that was important. The responses are shown in the table.

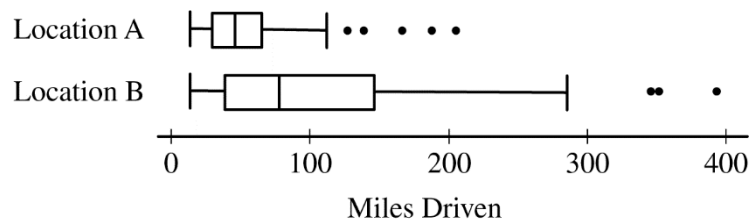
	Color Consideration			Total
	Yes	No	Maybe	
Comfort	40	96	12	148
Cost	108	68	8	184
Performance	62	62	12	136
Reliability	128	116	4	248
Safety	152	192	32	376
Total	490	534	68	1,092

Which of the following is closest to the proportion of people who responded no to color consideration and who identified safety as the additional feature that was important?

- (A) 0.18
- (B) 0.34
- (C) 0.36
- (D) 0.49
- (E) 0.51

6. Scientists estimate that the distribution of the life span of the Galápagos Islands giant tortoise is approximately normal with mean 100 years and standard deviation 15 years. Based on the estimate, which of the following is closest to the age of a Galápagos Islands giant tortoise at the 90th percentile of the distribution?
- (A) 80 years
 - (B) 115 years
 - (C) 120 years
 - (D) 125 years
 - (E) 130 years

7. A car rental agency has two locations in a city. The boxplots below summarize the miles driven for one day of single-day car rentals at each location.



Based on the boxplots, which statement provides the best comparison of the two locations?

- (A) The number of single-day rentals is greater for location A than for location B.
- (B) The number of single-day rentals is less for location A than for location B.
- (C) Compared with location A, the miles driven for location B display more variability, and the median is greater.
- (D) Compared with location A, the miles driven for location B display less variability, and the median is greater.
- (E) Compared with location A, the miles driven for location B display less variability, and the median is about the same.

8. For the purpose of determining the value of its end-of-year inventory, a clothing store creates a list at the end of the year of every item currently in stock along with each item's wholesale price. Which of the following is the best description of the end-of-the-year activity?
- (A) An experiment, because the items are treatments and wholesale prices are responses.
 - (B) An experiment, because the store does not know the total wholesale price of all the items.
 - (C) A sample survey, because the store wants to estimate the value of all items for the entire year.
 - (D) A sample survey, because the items currently in the store at the end of the year are a random sample of all items in the store for the entire year.
 - (E) A census, because the wholesale prices of all items are listed.

9. A grocery store receives deliveries of corn from two farms, one in Iowa and the other in Ohio. Both farms produce ears of corn with mean weight 1.26 pounds. The standard deviation of the weights of the ears of corn from the farm in Ohio is 0.01 pound greater than that from the farm in Iowa. A randomly selected ear of corn from the farm in Iowa weighed 1.39 pounds, which has a standardized score of 1.645 for the distribution of weights for the Iowa corn. If an ear of corn from the farm in Ohio weighs 1.39 pounds, how many standard deviations from the mean is the weight with respect to the Ohio distribution?
- (A) 1.46 standard deviations below the mean
 - (B) 1.46 standard deviations above the mean
 - (C) 1.65 standard deviations above the mean
 - (D) 1.88 standard deviations below the mean
 - (E) 1.88 standard deviations above the mean

-
10. The distribution of number of hours worked by volunteers last year at a large hospital is approximately normal with mean 80 and standard deviation 7. Volunteers in the top 20 percent of hours worked will receive a certificate of merit. If a volunteer from last year is selected at random, which of the following is closest to the probability that the volunteer selected will receive a certificate of merit given that the number of hours the volunteer worked is less than 90 ?
- (A) 0.077
 - (B) 0.123
 - (C) 0.134
 - (D) 0.618
 - (E) 0.923

11. Resting heart rates, in beats per minute, were recorded for two samples of people. One sample was from people in the age-group of 20 years to 30 years, and the other sample was from people in the age-group of 40 years to 50 years. The five-number summaries are shown in the table.

Age-Group (years)	Minimum	Q1	Median	Q3	Maximum
20 to 30	60	71	72	75	84
40 to 50	60	70	73	76	85

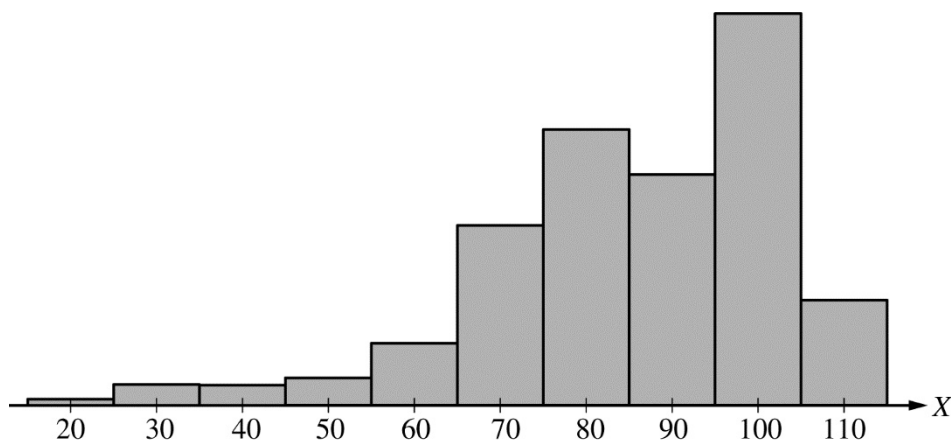
The values of 60, 62, and 84 were common to both samples. The three values are identified as outliers with respect to the age-group 20 years to 30 years because they are either 1.5 times the interquartile range (IQR) greater than the upper quartile or 1.5 times the IQR less than the lower quartile.

Using the same method for identifying outliers, which of the three values are identified as outliers for the age-group 40 years to 50 years?

- (A) None of the three values is identified as an outlier.
- (B) Only 60 is identified as an outlier.
- (C) Only 60 and 62 are identified as outliers.
- (D) Only 60 and 84 are identified as outliers.
- (E) The three values are all identified as outliers.

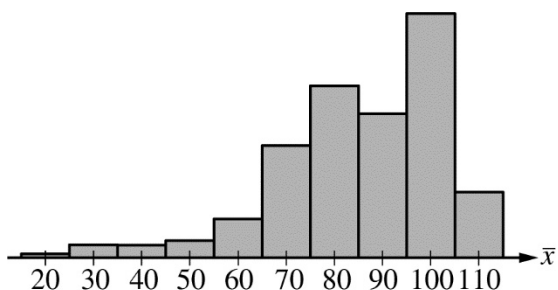
12. As part of a demographic study, a college administrator needed to survey a sample of students from the college. From each major offered at the college, the administrator randomly selected 5 percent of the students with that major to participate in the survey. Which of the following is the best description of the type of sample selected by the administrator?
- (A) Cluster sample
 - (B) Convenience sample
 - (C) Simple random sample
 - (D) Stratified random sample
 - (E) Systematic random sample

13. The graph shows the population distribution of random variable X with mean 85 and standard deviation 18.

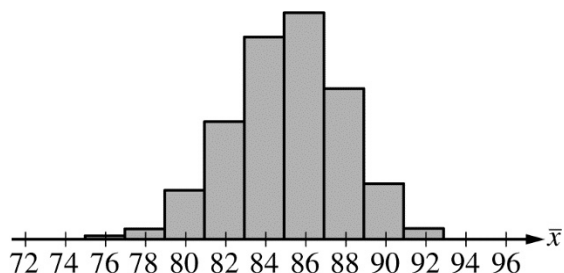


Which of the following graphs is a sampling distribution of the sample mean \bar{x} for samples of size 40 taken from the population?

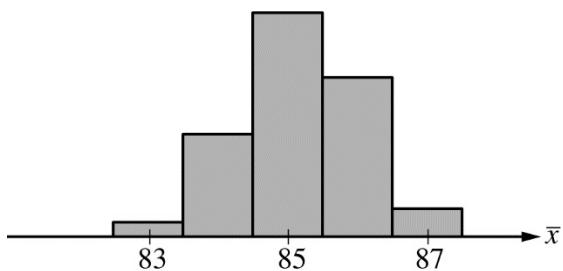
(A)



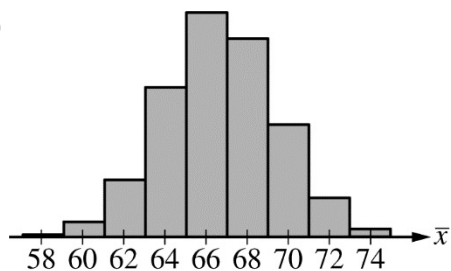
(B)



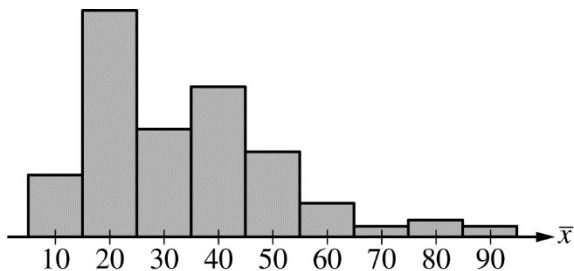
(C)



(D)



(E)



14. A biologist studying trees constructed the confidence interval $(0.14, 0.20)$ to estimate the proportion of trees in a large forest that are dead but still standing. Using the same confidence level, the interval was later revised because the sample proportion had been miscalculated. The correct sample proportion was 0.27. Which of the following statements about the revised interval based on the correct sample proportion is true?
- (A) The revised interval is narrower than the original interval because the correct sample proportion is farther from 0.5 than the miscalculated proportion is.
 - (B) The revised interval is narrower than the original interval because the correct sample proportion is closer to 0.5 than the miscalculated proportion is.
 - (C) The revised interval is wider than the original interval because the correct sample proportion is farther from 0.5 than the miscalculated proportion is.
 - (D) The revised interval is wider than the original interval because the correct sample proportion is closer to 0.5 than the miscalculated proportion is.
 - (E) The revised interval has the same width as the original interval.

15. A research organization reported that 41 percent of adults who were asked to describe their day responded that they were having a good day rather than a typical day or a bad day. To investigate whether the percent would be different for high school students, 600 high school students were randomly selected. When asked to describe their day, 245 students reported that they were having a good day rather than a typical day or a bad day. Do the data provide convincing statistical evidence that the proportion of all high school students who would respond that they were having a good day is different from 0.41 ?
- (A) No, because the p -value is less than any reasonable significance level.
 - (B) No, because the p -value is greater than any reasonable significance level.
 - (C) Yes, because the p -value is less than any reasonable significance level.
 - (D) Yes, because the p -value is greater than any reasonable significance level.
 - (E) Yes, because the expected value of the number of students who will report having a good day is 246, not 245.

16. The director of a community recreation center conducted a six-week study to examine the effects of four types of exercise—strength training, flexibility training, aerobics, and jogging—on maximal oxygen consumption. From the 40 members who participated, the director randomly assigned 10 members to each exercise type. Maximal oxygen consumption was measured for each member at the beginning of the study and again at the end of the six weeks. The director examined the change in maximal oxygen consumption for each member. Which of the following statements is a correct description of a feature of the study?
- (A) The study has replication because there are four types of exercise.
 - (B) The study has replication because it was conducted over a six-week period.
 - (C) The response variable is the type of exercise with the greatest change in maximal oxygen consumption.
 - (D) The treatments in the study are strength training, flexibility training, aerobics, and jogging.
 - (E) The experimental units are the four different types of exercise.

17. Sean and Evan are college roommates who have part-time jobs as servers in restaurants. The distribution of Sean's weekly income is approximately normal with mean \$225 and standard deviation \$25. The distribution of Evan's weekly income is approximately normal with mean \$240 and standard deviation \$15. Assuming their weekly incomes are independent of each other, which of the following is closest to the probability that Sean will have a greater income than Evan in a randomly selected week?
- (A) 0.067
 - (B) 0.159
 - (C) 0.227
 - (D) 0.303
 - (E) 0.354

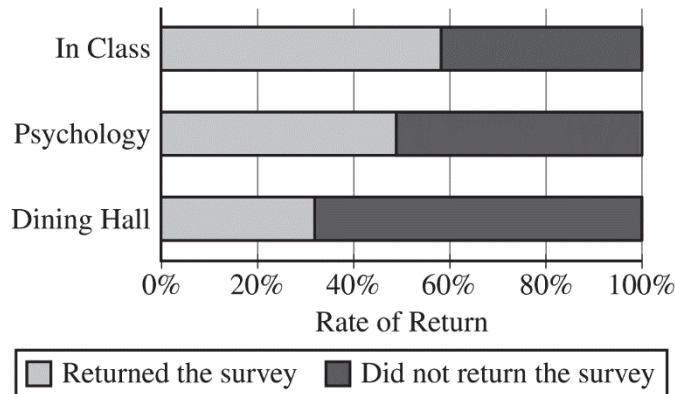
-
18. According to data from the United States Elections Project, only 36 percent of eligible voters voted in the 2014 elections. For random samples of size 40, which of the following best describes the sampling distribution of \hat{p} , the sample proportion of people who voted in the 2014 elections?
- (A) The sampling distribution is skewed to the left, with mean 0.36 and standard deviation 0.076.
 - (B) The sampling distribution is skewed to the right, with mean 0.64 and standard deviation 0.006.
 - (C) The sampling distribution is approximately normal, with mean 0.36 and standard deviation 0.076.
 - (D) The sampling distribution is approximately normal, with mean 0.36 and standard deviation 0.006.
 - (E) The sampling distribution is approximately normal, with mean 0.64 and standard deviation 0.076.

19. To investigate whether the consumption of beetroot juice enhances exercise performance, a researcher selected a random sample of 50 student athletes from all the student athletes at a college. The athletes in the sample were randomly assigned to one of two groups. In one group, 25 athletes were given a daily dose of beetroot juice, and in the other group, the remaining athletes were given a daily dose of a placebo. At the end of six weeks of exercise training, the researcher compared the performances of the two groups. Based on the design of the investigation, which of the following is the largest population to which the results can be generalized?
- (A) The 25 student athletes assigned to the beetroot juice group
 - (B) The 50 student athletes in the sample
 - (C) All student athletes at the college
 - (D) All students at the college
 - (E) All people who exercise

20. College researchers wanted to know under what conditions people are more likely to complete and return a survey. As part of a study, the researchers prepared three sets of identical surveys and used three methods of delivering and returning the surveys. The methods are described as follows.

- In Class: The surveys were given to students in a class, and students were asked to return completed surveys to their instructor.
- Psychology: The surveys were given to students participating in a psychology experiment, and students were asked to return completed surveys to a collection box in the hallway of the psychology building.
- Dining Hall: The surveys were given to students in the dining hall, and students were asked to return completed surveys to a collection box outside the dining hall.

The graph shows the percent of surveys returned and not returned for each delivery method.



Which statement about delivery method and rate of survey return is supported by the graph?

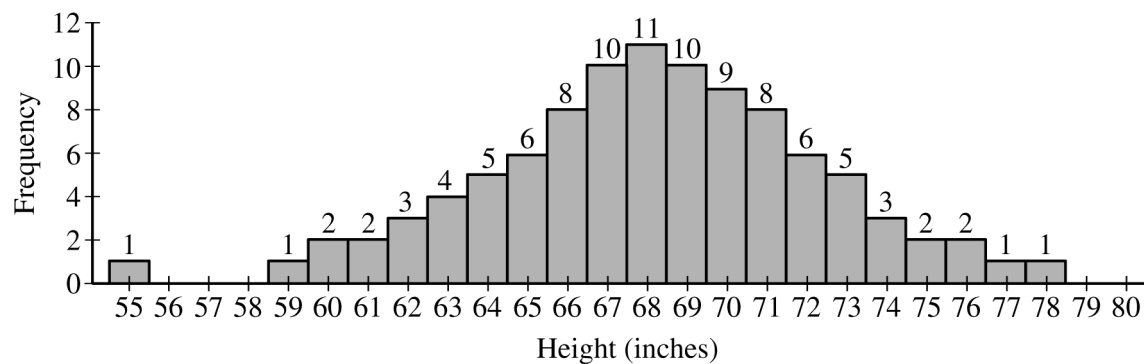
- (A) There is a positive association between delivery method and rate of return.
- (B) There is a negative association between delivery method and rate of return.
- (C) The number of surveys given using the Dining Hall delivery method was less than the number given using either of the other delivery methods.
- (D) The Psychology delivery method displays the most symmetric results; the other delivery methods display skewed results.
- (E) The In Class delivery method had the greatest rate of return, and the Dining Hall delivery method had the least rate of return.

21. The height and age of each child in a random sample of children was recorded. The value of the correlation coefficient between height and age for the children in the sample was 0.8. Based on the least-squares regression line created from the data to predict the height of a child based on age, which of the following is a correct statement?
- (A) On average, the height of a child is 80% of the age of the child.
 - (B) The least-squares regression line of height versus age will have a slope of 0.8.
 - (C) The proportion of the variation in height that is explained by a regression on age is 0.64.
 - (D) The least-squares regression line will correctly predict height based on age 80% of the time.
 - (E) The least-squares regression line will correctly predict height based on age 64% of the time.

-
22. At a certain restaurant, the distribution of wait times between ordering a meal and receiving the meal has mean 11.4 minutes and standard deviation 2.6 minutes. The restaurant manager wants to find the probability that the mean wait time will be greater than 12.0 minutes for a random sample of 84 customers. Assuming the wait times among customers are independent, which of the following describes the sampling distribution of the sample mean wait time for random samples of size 84 ?
- (A) Approximately normal with mean 11.4 minutes and standard deviation 2.6 minutes
 - (B) Approximately normal with mean 11.4 minutes and standard deviation $\frac{2.6}{\sqrt{84}}$ minute
 - (C) Approximately normal with mean 12.0 minutes and standard deviation 2.6 minutes
 - (D) Binomial with mean $84(0.41)$ minutes and standard deviation $\sqrt{84(0.41)(0.59)}$ minutes
 - (E) Binomial with mean $84(0.5)$ minutes and standard deviation $\sqrt{84(0.5)(0.5)}$ minutes

23. Two high schools have a similar number of students and parking lots of similar size. The safety officers at both schools want to investigate whether there is an average difference in the number of cars parked per day in the student parking lots for the school year. A random sample of 15 school days will be selected. For each selected day, the number of cars parked in the student parking lots will be counted at both schools and the difference will be recorded. Assuming all conditions for inference are met, which of the following is the appropriate test for the investigation?
- (A) A two-sample z -test for a difference between proportions
 - (B) A two-sample t -test for a difference between means
 - (C) A matched-pairs t -test for a mean difference
 - (D) A chi-square test of homogeneity
 - (E) A chi-square test of independence

24. The histogram shows the distribution of heights, in inches, of 100 adult men.



Based on the histogram, which of the following is closest to the interquartile range, in inches, of the distribution?

- (A) 2
- (B) 5
- (C) 9
- (D) 12
- (E) 15

25. A state study on labor reported that one-third of full-time teachers in the state also worked part time at another job. For those teachers, the average number of hours worked per week at the part-time job was 13. After an increase in state teacher salaries, a random sample of 400 teachers who worked part time at another job was selected. The average number of hours worked per week at the part-time job for the teachers in the sample was 12.5 with standard deviation 6.5 hours. Is there convincing statistical evidence, at the level of $\alpha = 0.05$, that the average number of hours worked per week at part-time jobs decreased after the salary increase?
- (A) No. The p -value of the appropriate test is greater than 0.05.
 - (B) No. The p -value of the appropriate test is less than 0.05.
 - (C) Yes. The p -value of the appropriate test is greater than 0.05.
 - (D) Yes. The p -value of the appropriate test is less than 0.05.
 - (E) Not enough information is given to determine whether there is convincing statistical evidence.

26. A city department of transportation studied traffic congestion on a certain highway. To encourage carpooling, the department will recommend a carpool lane if the average number of people in passenger cars on the highway is less than 2. The probability distribution of the number of people in passenger cars on the highway is shown in the table.

Number of people	1	2	3	4	5
Probability	0.56	0.28	0.08	0.06	0.02

Based on the probability distribution, what is the mean number of people in passengers cars on the highway?

- (A) 0.28
- (B) 0.56
- (C) 1.7
- (D) 2
- (E) 3

27. To compare the effectiveness of two treatments, researchers conducted a well-designed experiment using a randomized block design in which the subjects were blocked by age-group (under 40 years and 40 years or older). Which of the following must be true about the randomized block design of the experiment?
- (A) The number of subjects in each block is different.
 - (B) Treatments are randomly assigned to subjects within each block.
 - (C) The design cannot have a control group because subjects are blocked by age-group.
 - (D) The experiment uses a matched-pairs design, where subjects from one block are paired with subjects from the other block.
 - (E) The subjects in one block receive one treatment, and the subjects in the other block receive the other treatment.

28. A die used in a certain board game has eight faces, of which 3 are red, 3 are yellow, and 2 are blue. Each face is equally likely to land faceup when the die is tossed. In the game, a player tosses the die until blue lands faceup, and the number of tosses before blue lands faceup is counted. For example, a player who tosses the sequence shown in the following table has tossed the die 3 times before blue lands faceup.

Toss number	1	2	3	4
Face color	yellow	yellow	red	blue

What is the probability that a player will toss the die at least 2 times before blue lands faceup?

- (A) 0.1406
- (B) 0.4219
- (C) 0.4375
- (D) 0.5625
- (E) 0.5781

29. A statistical test involves the following null and alternative hypotheses.

$$H_0: \mu = 64$$

$$H_a: \mu > 64$$

Which of the following describes a Type II error?

- (A) Failing to reject the null hypothesis when the population mean is 64
- (B) Failing to reject the null hypothesis when the population mean is greater than 64
- (C) Rejecting the null hypothesis when the population mean is 64
- (D) Rejecting the null hypothesis when the population mean is greater than 64
- (E) Failing to reject the null hypothesis when the p -value is less than the significance level

30. The marketing director for an ice cream company investigated whether there was a difference in preference for two new ice cream flavors—cotton candy and mango. Each participant from a large group of people was randomly assigned to taste one of the two flavors. After tasting, each person rated the flavor on a numerical scale from 1 to 5, where 1 represented strongly dislike and 5 represented strongly like. A two-sample t -interval for a difference between means (cotton candy minus mango) was constructed. Based on the interval, there was convincing statistical evidence of a difference in population mean flavor ratings, with mango having the greater sample mean rating. Which of the following could be the constructed interval?

- (A) $(-20, -15)$
- (B) $(-2.1, -1.3)$
- (C) $(-1.4, 2.6)$
- (D) $(1.5, 2.7)$
- (E) $(15, 20)$

31. The director of a marketing department wants to estimate the proportion of people who purchase a certain product online. The director originally planned to obtain a random sample of 2,500 people who purchased the product. However, because of budget concerns, the sample size will be reduced to 1,500 people. Which of the following describes the effect of reducing the number of people in the sample?

- (A) The variance of the sample will increase.
- (B) The variance of the population will decrease.
- (C) The variance of the sampling distribution of the estimator will increase.
- (D) The variance of the sampling distribution of the estimator will decrease.
- (E) The variance of the sampling distribution of the estimator will remain the same.

32. From a random sample of 1,005 adults in the United States, it was found that 32 percent own an e-reader. Which of the following is the appropriate 90 percent confidence interval to estimate the proportion of all adults in the United States who own an e-reader?

(A) $0.32 \pm 1.960 \left(\frac{(0.32)(0.68)}{\sqrt{1,005}} \right)$

(B) $0.32 \pm 1.645 \left(\frac{(0.32)(0.68)}{\sqrt{1,005}} \right)$

(C) $0.32 \pm 2.575 \sqrt{\frac{(0.32)(0.68)}{1,005}}$

(D) $0.32 \pm 1.960 \sqrt{\frac{(0.32)(0.68)}{1,005}}$

(E) $0.32 \pm 1.645 \sqrt{\frac{(0.32)(0.68)}{1,005}}$

33. Measuring the height of a tree is usually more difficult than measuring the diameter of the tree. Therefore, many researchers use regression models to predict the height of a tree from its diameter measured at 4 feet 6 inches from the ground. The following computer output shows the results of a linear regression based on the heights, in feet, and the diameters, in inches, recorded from 31 felled trees.

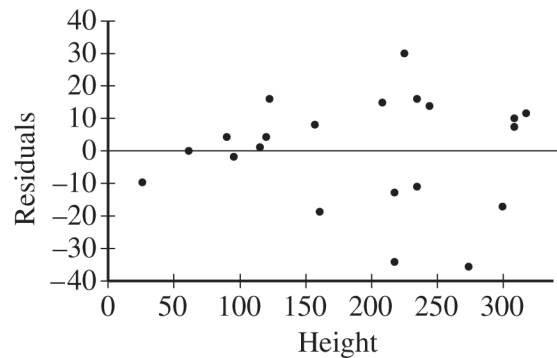
	Estimate	Std Error	t value	Pr(> t)
Intercept	62.031	4.383	14.15	0.0000
Diameter	1.054	0.322	3.27	0.0028

Which of the following is a 95 percent confidence interval for the slope of the population regression line?

- (A) (0.001, 2.107)
- (B) (0.396, 1.712)
- (C) (0.423, 1.685)
- (D) (0.732, 1.376)
- (E) (53.07, 70.99)

34. A group of 80 people who had been diagnosed as prediabetic because of high blood glucose levels volunteered to participate in a study designed to investigate the use of cinnamon to reduce blood glucose to a normal level. Of the 80 people, 40 were randomly assigned to take a cinnamon tablet each day and the other 40 were assigned to take a placebo each day. The people did not know which tablet they were taking. Their blood glucose levels were measured at the end of one month. The results showed that 14 people in the cinnamon group and 10 people in the placebo group had normal blood glucose levels. For people similar to those in the study, do the data provide convincing statistical evidence that the proportion who would be classified as normal after one month of taking cinnamon is greater than the proportion who would be classified as normal after one month of not taking cinnamon?
- (A) No conclusion can be made about the use of cinnamon because the people in the study were volunteers.
- (B) There is convincing statistical evidence at the level of 0.01.
- (C) There is convincing statistical evidence at the level of 0.05 but not at the level of 0.01.
- (D) There is convincing statistical evidence at the level of 0.10 but not at the level of 0.05.
- (E) There is not convincing statistical evidence at any reasonable significance level.

35. A student working on a physics project investigated the relationship between the speed and the height of roller coasters. The student collected data on the maximum speed, in miles per hour, and the maximum height, in feet, for a random sample of 21 roller coasters, with the intent of testing the slope of the linear relationship between maximum speed and maximum height. However, based on the residual plot shown, the conditions for such a test might not be met.



Based on the residual plot, which condition appears to have been violated?

- (A) The errors are independent.
- (B) The sum of the residuals is 0.
- (C) The expected value of the errors is 0.
- (D) There is a linear relationship between the response variable and the explanatory variable.
- (E) The variance of the response variable is constant for all values of the explanatory variable.

36. A researcher conducted a t -test of the hypotheses $H_0 : \mu = 38$ versus $H_a : \mu \neq 38$. The sample mean was 35 and the p -value for the test was 0.0627. What would the p -value have been if the researcher had used $H_a : \mu < 38$ as the alternative hypothesis?

- (A) $1 - 0.0627$
- (B) $1 - 2(0.0627)$
- (C) $1 - \left(\frac{1}{2}\right)(0.0627)$
- (D) $2(0.0627)$
- (E) $\frac{1}{2}(0.0627)$

37. High school students from track teams in the state participated in a training program to improve running times. Before the training, the mean running time for the students to run a mile was 402 seconds with standard deviation 40 seconds. After completing the program, the mean running time for the students to run a mile was 368 seconds with standard deviation 30 seconds. Let X represent the running time of a randomly selected student before training, and let Y represent the running time of the same student after training. Which of the following is true about the distribution of $X - Y$?
- (A) The variables X and Y are independent; therefore, the mean is 34 seconds and the standard deviation is 10 seconds.
 - (B) The variables X and Y are independent; therefore, the mean is 34 seconds and the standard deviation is 50 seconds.
 - (C) The variables X and Y are not independent; therefore, the standard deviation is 50 seconds and the mean cannot be determined with the information given.
 - (D) The variables X and Y are not independent; therefore, the mean is 34 seconds and the standard deviation cannot be determined with the information given.
 - (E) The variables X and Y are not independent; therefore, neither the mean nor the standard deviation can be determined with the information given.

38. A polling organization surveyed 2,002 randomly selected adults who are not scientists and 3,748 randomly selected adults who are scientists. Each adult was asked the question “Do you think that genetically modified foods are safe to eat?” Of those who are not scientists, 37 percent responded yes, and of those who are scientists, 88 percent responded yes. Which of the following is the standard error used to construct a confidence interval for the difference between the proportions of all adults who are not scientists and all adults who are scientists who would answer yes to the question?

(A) $\sqrt{\frac{(0.37)(0.63)}{2,002} + \frac{(0.88)(0.12)}{3,748}}$

(B) $\sqrt{\frac{(0.37)(0.63)}{2,002} - \frac{(0.88)(0.12)}{3,748}}$

(C) $\sqrt{\frac{(0.37)(0.63)}{2,002}} + \sqrt{\frac{(0.88)(0.12)}{3,748}}$

(D) $\sqrt{\frac{(0.70)(0.30)}{2,002}} + \sqrt{\frac{(0.70)(0.30)}{3,748}}$

(E) $\frac{(0.37)(0.63)}{\sqrt{2,002}} + \frac{(0.88)(0.12)}{\sqrt{3,748}}$

39. A polling agency conducted a survey about social media in which each person in random samples of 1,000 men and 1,000 women was asked what factor he or she considers to be the most important when deciding whether to connect on social media with another person. The responses are shown in the table.

	Factor				
	Personal Friend	Stay in Touch	Mutual Friends	Business Networking	Other
Men	600	210	105	45	40
Women	650	224	65	15	46

What is the contribution to the chi-square test statistic for men who selected business networking as the most important factor?

- (A) 0.5
- (B) 5
- (C) 7.5
- (D) 30
- (E) 45

40. A national survey asked 1,501 randomly selected employed adults how many hours they work per week. Based on the collected data, a 95 percent confidence interval for the mean number of hours worked per week for all employed adults was given as (41.18, 42.63). Which of the following statements is a correct interpretation of the interval?
- (A) Ninety-five percent of all employed adults work between 41.18 hours and 42.63 hours per week.
 - (B) The probability is 0.95 that a sample of size 1,501 will produce a mean between 41.18 hours and 42.63 hours.
 - (C) Of all samples of size 1,501 taken from the population, 95% of the samples will have a mean between 41.18 hours and 42.63 hours.
 - (D) We are 95% confident that the mean number of hours worked per week for employed adults in the sample is between 41.18 hours and 42.63 hours.
 - (E) We are 95% confident that the mean number of hours worked per week for all employed adults is between 41.18 hours and 42.63 hours.

END OF SECTION I

**IF YOU FINISH BEFORE TIME IS CALLED, YOU MAY
CHECK YOUR WORK ON THIS SECTION.**

DO NOT GO ON TO SECTION II UNTIL YOU ARE TOLD TO DO SO.

MAKE SURE YOU HAVE DONE THE FOLLOWING.

- **PLACED YOUR AP NUMBER LABEL ON YOUR ANSWER SHEET**
- **WRITTEN AND GRIDDED YOUR AP NUMBER CORRECTLY ON YOUR ANSWER SHEET**
- **TAKEN THE AP EXAM LABEL FROM THE FRONT OF THIS BOOKLET AND PLACED IT ON YOUR ANSWER SHEET**

Table entry for z is the probability lying below z .

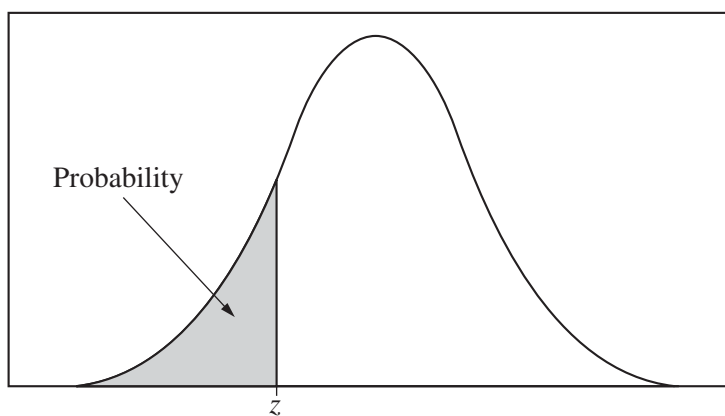


Table A Standard normal probabilities

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
-3.4	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002
-3.3	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0003
-3.2	.0007	.0007	.0006	.0006	.0006	.0006	.0006	.0005	.0005	.0005
-3.1	.0010	.0009	.0009	.0009	.0008	.0008	.0008	.0008	.0007	.0007
-3.0	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010
-2.9	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.0014
-2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
-2.7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
-2.6	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036
-2.5	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.0048
-2.4	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.0064
-2.3	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
-2.2	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.0110
-2.1	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
-2.0	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
-1.9	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.0233
-1.8	.0359	.0351	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
-1.7	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
-1.6	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
-1.5	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
-1.4	.0808	.0793	.0778	.0764	.0749	.0735	.0721	.0708	.0694	.0681
-1.3	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
-1.2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
-1.1	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
-1.0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
-0.9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
-0.8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
-0.7	.2420	.2389	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.2148
-0.6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
-0.5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
-0.4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
-0.3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
-0.2	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
-0.1	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
-0.0	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641

Table entry for z is the probability lying below z .

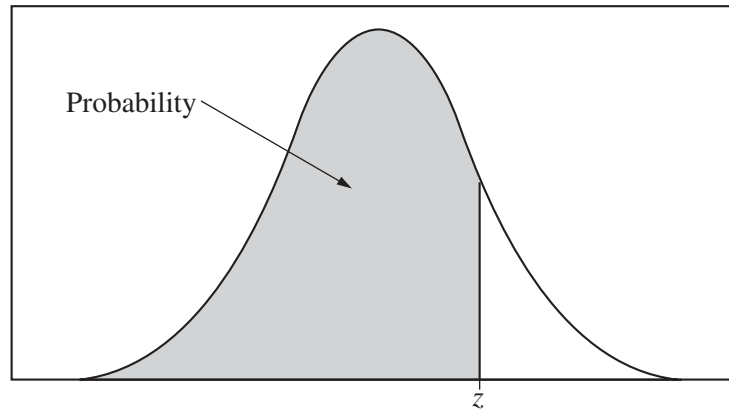


Table A (Continued)

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
0.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
0.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
0.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
0.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
0.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
0.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
0.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
0.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
0.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998

Table entry for p and C is the point t^* with probability p lying above it and probability C lying between $-t^*$ and t^* .

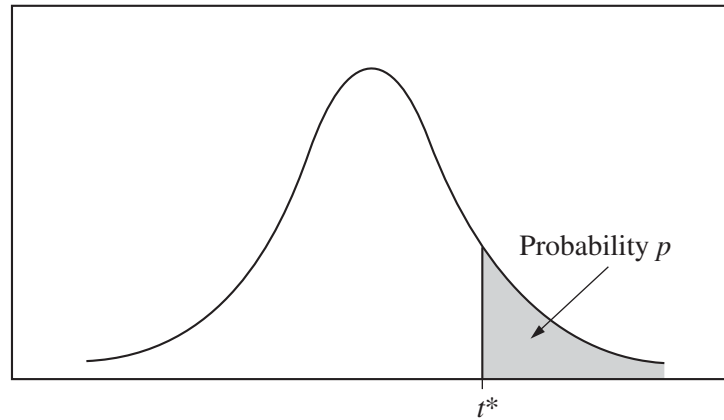


Table B t distribution critical values

df	Tail probability p											
	.25	.20	.15	.10	.05	.025	.02	.01	.005	.0025	.001	.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	.816	1.061	1.386	1.886	2.920	4.303	4.849	6.965	9.925	14.09	22.33	31.60
3	.765	.978	1.250	1.638	2.353	3.182	3.482	4.541	5.841	7.453	10.21	12.92
4	.741	.941	1.190	1.533	2.132	2.776	2.999	3.747	4.604	5.598	7.173	8.610
5	.727	.920	1.156	1.476	2.015	2.571	2.757	3.365	4.032	4.773	5.893	6.869
6	.718	.906	1.134	1.440	1.943	2.447	2.612	3.143	3.707	4.317	5.208	5.959
7	.711	.896	1.119	1.415	1.895	2.365	2.517	2.998	3.499	4.029	4.785	5.408
8	.706	.889	1.108	1.397	1.860	2.306	2.449	2.896	3.355	3.833	4.501	5.041
9	.703	.883	1.100	1.383	1.833	2.262	2.398	2.821	3.250	3.690	4.297	4.781
10	.700	.879	1.093	1.372	1.812	2.228	2.359	2.764	3.169	3.581	4.144	4.587
11	.697	.876	1.088	1.363	1.796	2.201	2.328	2.718	3.106	3.497	4.025	4.437
12	.695	.873	1.083	1.356	1.782	2.179	2.303	2.681	3.055	3.428	3.930	4.318
13	.694	.870	1.079	1.350	1.771	2.160	2.282	2.650	3.012	3.372	3.852	4.221
14	.692	.868	1.076	1.345	1.761	2.145	2.264	2.624	2.977	3.326	3.787	4.140
15	.691	.866	1.074	1.341	1.753	2.131	2.249	2.602	2.947	3.286	3.733	4.073
16	.690	.865	1.071	1.337	1.746	2.120	2.235	2.583	2.921	3.252	3.686	4.015
17	.689	.863	1.069	1.333	1.740	2.110	2.224	2.567	2.898	3.222	3.646	3.965
18	.688	.862	1.067	1.330	1.734	2.101	2.214	2.552	2.878	3.197	3.611	3.922
19	.688	.861	1.066	1.328	1.729	2.093	2.205	2.539	2.861	3.174	3.579	3.883
20	.687	.860	1.064	1.325	1.725	2.086	2.197	2.528	2.845	3.153	3.552	3.850
21	.686	.859	1.063	1.323	1.721	2.080	2.189	2.518	2.831	3.135	3.527	3.819
22	.686	.858	1.061	1.321	1.717	2.074	2.183	2.508	2.819	3.119	3.505	3.792
23	.685	.858	1.060	1.319	1.714	2.069	2.177	2.500	2.807	3.104	3.485	3.768
24	.685	.857	1.059	1.318	1.711	2.064	2.172	2.492	2.797	3.091	3.467	3.745
25	.684	.856	1.058	1.316	1.708	2.060	2.167	2.485	2.787	3.078	3.450	3.725
26	.684	.856	1.058	1.315	1.706	2.056	2.162	2.479	2.779	3.067	3.435	3.707
27	.684	.855	1.057	1.314	1.703	2.052	2.158	2.473	2.771	3.057	3.421	3.690
28	.683	.855	1.056	1.313	1.701	2.048	2.154	2.467	2.763	3.047	3.408	3.674
29	.683	.854	1.055	1.311	1.699	2.045	2.150	2.462	2.756	3.038	3.396	3.659
30	.683	.854	1.055	1.310	1.697	2.042	2.147	2.457	2.750	3.030	3.385	3.646
40	.681	.851	1.050	1.303	1.684	2.021	2.123	2.423	2.704	2.971	3.307	3.551
50	.679	.849	1.047	1.299	1.676	2.009	2.109	2.403	2.678	2.937	3.261	3.496
60	.679	.848	1.045	1.296	1.671	2.000	2.099	2.390	2.660	2.915	3.232	3.460
80	.678	.846	1.043	1.292	1.664	1.990	2.088	2.374	2.639	2.887	3.195	3.416
100	.677	.845	1.042	1.290	1.660	1.984	2.081	2.364	2.626	2.871	3.174	3.390
1000	.675	.842	1.037	1.282	1.646	1.962	2.056	2.330	2.581	2.813	3.098	3.300
∞	.674	.841	1.036	1.282	1.645	1.960	2.054	2.326	2.576	2.807	3.091	3.291
	50%	60%	70%	80%	90%	95%	96%	98%	99%	99.5%	99.8%	99.9%
Confidence level C												

Table entry for p is the point (χ^2) with probability p lying above it.

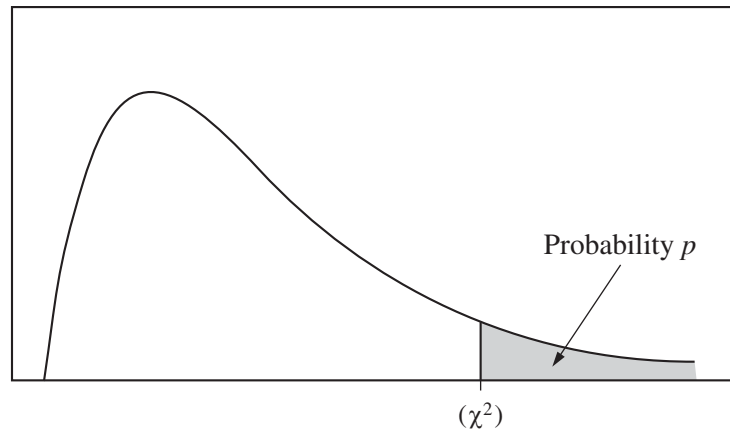


Table C χ^2 critical values

df	Tail probability p											
	.25	.20	.15	.10	.05	.025	.02	.01	.005	.0025	.001	.0005
1	1.32	1.64	2.07	2.71	3.84	5.02	5.41	6.63	7.88	9.14	10.83	12.12
2	2.77	3.22	3.79	4.61	5.99	7.38	7.82	9.21	10.60	11.98	13.82	15.20
3	4.11	4.64	5.32	6.25	7.81	9.35	9.84	11.34	12.84	14.32	16.27	17.73
4	5.39	5.99	6.74	7.78	9.49	11.14	11.67	13.28	14.86	16.42	18.47	20.00
5	6.63	7.29	8.12	9.24	11.07	12.83	13.39	15.09	16.75	18.39	20.51	22.11
6	7.84	8.56	9.45	10.64	12.59	14.45	15.03	16.81	18.55	20.25	22.46	24.10
7	9.04	9.80	10.75	12.02	14.07	16.01	16.62	18.48	20.28	22.04	24.32	26.02
8	10.22	11.03	12.03	13.36	15.51	17.53	18.17	20.09	21.95	23.77	26.12	27.87
9	11.39	12.24	13.29	14.68	16.92	19.02	19.68	21.67	23.59	25.46	27.88	29.67
10	12.55	13.44	14.53	15.99	18.31	20.48	21.16	23.21	25.19	27.11	29.59	31.42
11	13.70	14.63	15.77	17.28	19.68	21.92	22.62	24.72	26.76	28.73	31.26	33.14
12	14.85	15.81	16.99	18.55	21.03	23.34	24.05	26.22	28.30	30.32	32.91	34.82
13	15.98	16.98	18.20	19.81	22.36	24.74	25.47	27.69	29.82	31.88	34.53	36.48
14	17.12	18.15	19.41	21.06	23.68	26.12	26.87	29.14	31.32	33.43	36.12	38.11
15	18.25	19.31	20.60	22.31	25.00	27.49	28.26	30.58	32.80	34.95	37.70	39.72
16	19.37	20.47	21.79	23.54	26.30	28.85	29.63	32.00	34.27	36.46	39.25	41.31
17	20.49	21.61	22.98	24.77	27.59	30.19	31.00	33.41	35.72	37.95	40.79	42.88
18	21.60	22.76	24.16	25.99	28.87	31.53	32.35	34.81	37.16	39.42	42.31	44.43
19	22.72	23.90	25.33	27.20	30.14	32.85	33.69	36.19	38.58	40.88	43.82	45.97
20	23.83	25.04	26.50	28.41	31.41	34.17	35.02	37.57	40.00	42.34	45.31	47.50
21	24.93	26.17	27.66	29.62	32.67	35.48	36.34	38.93	41.40	43.78	46.80	49.01
22	26.04	27.30	28.82	30.81	33.92	36.78	37.66	40.29	42.80	45.20	48.27	50.51
23	27.14	28.43	29.98	32.01	35.17	38.08	38.97	41.64	44.18	46.62	49.73	52.00
24	28.24	29.55	31.13	33.20	36.42	39.36	40.27	42.98	45.56	48.03	51.18	53.48
25	29.34	30.68	32.28	34.38	37.65	40.65	41.57	44.31	46.93	49.44	52.62	54.95
26	30.43	31.79	33.43	35.56	38.89	41.92	42.86	45.64	48.29	50.83	54.05	56.41
27	31.53	32.91	34.57	36.74	40.11	43.19	44.14	46.96	49.64	52.22	55.48	57.86
28	32.62	34.03	35.71	37.92	41.34	44.46	45.42	48.28	50.99	53.59	56.89	59.30
29	33.71	35.14	36.85	39.09	42.56	45.72	46.69	49.59	52.34	54.97	58.30	60.73
30	34.80	36.25	37.99	40.26	43.77	46.98	47.96	50.89	53.67	56.33	59.70	62.16
40	45.62	47.27	49.24	51.81	55.76	59.34	60.44	63.69	66.77	69.70	73.40	76.09
50	56.33	58.16	60.35	63.17	67.50	71.42	72.61	76.15	79.49	82.66	86.66	89.56
60	66.98	68.97	71.34	74.40	79.08	83.30	84.58	88.38	91.95	95.34	99.61	102.7
80	88.13	90.41	93.11	96.58	101.9	106.6	108.1	112.3	116.3	120.1	124.8	128.3
100	109.1	111.7	114.7	118.5	124.3	129.6	131.1	135.8	140.2	144.3	149.4	153.2