Contents

Note: This publication shows the page numbers that appeared in the *2016–17 AP Exam Instructions* book and in the actual exam. This publication was not repaginated to begin with page 1.

Exam Instructions

The following contains instructions taken from the *2016–17 AP Exam Instructions* book.

AP® Statistics Exam

Regularly Scheduled Exam Date: Thursday afternoon, May 11, 2017

Late-Testing Exam Date: Wednesday morning, May 17, 2017

Section I

Total Time: 1 hour 30 minutes
Graphing calculator expected
Number of Questions: 40*
Percent of Total Score: 50%
Writing Instrument: Pencil required

**The number of questions may vary slightly depending on the form of the exam.*

Section II

Total Time: 1 hour 30 minutes
Graphing calculator expected
Number of Questions: 6
Percent of Total Score: 50%
Writing Instrument: Either pencil or pen with black or dark blue ink

What Proctors Need to Bring to This Exam

- Exam packets
- Answer sheets
- AP Student Packs
- *2016-17 AP Coordinator's Manual*
- This book — *AP Exam Instructions*
- AP Exam Seating Chart template
- School Code and Home-School/Self-Study Codes
- Extra graphing calculators
- Pencil sharpener
- Container for students' electronic devices (if needed)
- Extra No. 2 pencils with erasers
- Extra pens with black or dark blue ink
- Extra paper
- Stapler
- Watch
- Signs for the door to the testing room
  - "Exam in Progress"
  - "Cell phones are prohibited in the testing room"

Before Distributing Exams: Check that the title on all exam covers is **Statistics**. If there are any exam booklets with a different title, contact the AP coordinator immediately.

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 49 of the *2016-17 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 46–49 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 47 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 325–326 for a seating chart template and instructions. See the *2016-17 AP Coordinator's Manual* for exam seating requirements (pages 51–54).

If you are giving the regularly scheduled exam, say:

It is Thursday afternoon, May 11, 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 17, and you will be taking the AP Statistics Exam.

In a moment, you will open the packet that contains your exam materials. By opening this packet, you agree to all of the AP Program's policies and procedures outlined in the *2016-17 Bulletin for AP Students and Parents*.

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:

You may now remove the shrinkwrap from your exam packet and take out the Section I booklet, but do not open the booklet or the shrinkwrapped Section II materials. Put the white seals aside. . . .

Carefully remove the AP Exam label found near the top left of your exam booklet cover. Now 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.

Read the statements on the front cover of Section I and look up when you have finished. . . .

Sign your name, and write today's date. Look up when you have finished. . . .

Now print your full legal name where indicated. Are there any questions? . . .

Turn to the back cover of your exam booklet and read it completely. Look up when you have finished. . . .

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 here _____. Note Stop Time here _____. Check that students are marking their answers in pencil on their answer sheets and that they are not looking at 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, face up. 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, face up. 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 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, or textbooks 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. Remember, 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. 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 a pen with black or dark blue ink, 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. . . .

Turn to the back cover and, using your pen, complete Item 1 under "Important Identification Information." Print the first two letters of your last name and the first letter of your first name in the boxes. Look up when you have finished. . . .

In Item 2, print your date of birth in the boxes. . . .

In Item 3, write the school code you printed on the front of your Student Pack in the boxes. . . .

Read Item 4. . . .

Are there any questions? . . .

I need to collect the Student Pack from anyone who will be taking another AP Exam. You may keep it only if you are not taking any other AP Exams this year. If you have no other AP Exams to take, place your Student Pack under your chair 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. . . .

Collect the Student Packs. Then say:

Are there any questions? . . .

Section II has two parts. You have 1 hour and 30 minutes to complete all of Section II. You are responsible for pacing yourself and may proceed freely from one part to the next. You must write your answers in the exam booklet using a pen with black or dark blue ink or a No. 2 pencil. If you use a pencil, be sure that your writing is dark enough to be easily read. If you need more paper during the exam, raise your hand. At the top of each extra sheet of paper you use, be sure to write only your AP number and the question number you are working on. Do not write your name. Are there any questions? . . .

You may begin Section II.

Note Start Time here _____. Note Stop Time here _____. You should also make sure that Hewlett-Packard calculators' infrared ports are not facing each other and that students are not sharing calculators. After 1 hour and 5 minutes, say:

There are 25 minutes remaining and you may want to move on to Part B, if you have not already started answering that question.

After 15 minutes, say:

There are 10 minutes remaining.

After 10 minutes, say:

Stop working and close your exam booklet. Place it on your desk, face up. . . .

If any students used extra paper for a question in the free-response section, have those students staple the extra sheet(s) to the first page corresponding to that question in their exam booklets. Complete an Incident Report. A single Incident Report may be completed for multiple students per exam subject per administration (regular or late testing) as long as all of the required information is provided. Include all exam booklets with extra sheets of paper in an Incident Report return envelope (see page 62 of the *2016-17 AP Coordinator's Manual* for complete details). Then say:

Remain in your seat, without talking, while the exam materials are collected. . . .

Collect a Section II booklet from each student. Check for the following:

- Exam booklet front cover: The student placed an AP number label on the shaded box and printed his or her initials and today's date.
- Exam booklet back cover: The student completed the "Important Identification Information" area.

When all exam materials have been collected and accounted for, return to students any electronic devices you may have collected before the start of the exam.

If you are giving the regularly scheduled exam, say:

You may not discuss or share the free-response exam content with anyone unless it is released on the College Board website in about two days. Your AP Exam score results will be available online in July.

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

None of the content in this exam may ever be discussed or shared in any way at any time. Your AP Exam score results will be available online in July.

If any students completed the AP number card at the beginning of this exam, say:

Please remember to take your AP number card with you. You will need the information on this card to view your scores and order AP score reporting services online.

Then say:

You are now dismissed.

Post-Exam Tasks

Be sure to give the completed seating chart to the AP coordinator. Schools must retain seating charts for at least six months (unless the state or district requires that they be retained for a longer period of time). Schools should not return any seating charts in their exam shipments unless they are required as part of an Incident Report.

The exam proctor should complete the following tasks if asked to do so by the AP coordinator. Otherwise, the AP coordinator must complete these tasks.

All exam materials must be placed in secure storage until they are returned to the AP Program after your school's last administration. Before storing materials, check the "School Use Only" section on page 1 of the answer sheet and:

- Fill in the appropriate section number circle in order to access a separate AP Instructional Planning Report (for regularly scheduled exams only) or subject score roster at the class section or teacher level. See "Post-Exam Activities" in the *2016-17 AP Coordinator's Manual*.
- Check your list of students who are eligible for fee reductions and fill in the appropriate circle on their registration answer sheets.

Student Answer Sheet for the Multiple-Choice Section

Use this section to capture student responses. (Note that the following answer sheet is a sample, and may differ from one used in an actual exam.)

AP Answer Sheet 2017

AP Number Label
(from Student Pack)

123456789

AP Exam Label
(from Section I Booklet)

CollegeBoard

COMPLETE THIS AREA AT EVERY EXAM. **USE NO. 2 PENCIL ONLY**

To maintain the security of the exam and the validity of my AP score, I will allow no one else to see the multiple-choice exam content. I will seal the multiple-choice booklet when asked to do so, and I will not discuss the exam content with anyone at any time after completing the section. I am aware of and agree to the AP Program's policies and procedures as outlined in the *2016-17 Bulletin for AP Students and Parents*, including using testing accommodations (e.g., extended time, computer, etc.) only if I have been preapproved by College Board Services for Students with Disabilities.

A. SIGNATURE Sign your legal name as it will appear on your college applications. Date

B. LEGAL NAME Omit apostrophes, Jr., II.

Legal Last Name — First 15 Letters | Legal First Name — First 12 Letters | MI

C. YOUR AP NUMBER

D. EXAM DATE Month Day

E. EXAM START TIME AM PM

F. MULTIPLE-CHOICE BOOKLET SERIAL NUMBER S

G. ONLINE PROVIDER CODE

COMPLETE THIS AREA ONLY ONCE.

I. AREA CODE AND PHONE NUMBER

INTERNATIONAL PHONE

J. SCHOOL YOU ATTEND

SCHOOL CODE | School Name | City | State | Country

K. DATE OF BIRTH

Month (Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec) Day Year

L. SOCIAL SECURITY NUMBER (Optional)

M. COLLEGE TO RECEIVE YOUR AP SCORE REPORT

COLLEGE CODE

Using the college code listed in the AP Student Pack, indicate the **ONE** college that you want to receive your AP score report.

College Name | City | State | Country

N. CURRENT GRADE LEVEL

- Not yet in 9th grade
- 9th
- 10th
- 11th
- 12th
- No longer in high school

O. STUDENT SEARCH SERVICE®

Colleges and scholarship programs may request your information to inform you of educational opportunities and financial aid.

Would you like us to supply your information?

- Yes
- No

If you don't answer and previously chose to participate in this service, we will continue providing your information.

H. AP EXAM I AM TAKING USING THIS ANSWER SHEET Exam Name: Form: Form Code:

792107

SCHOOL USE ONLY

Section Number (1 2 3 4 5 6 7 8 9)

Fee Reduction Granted (1) Option 1 (2) Option 2

113913-00657 • UNLWEB1116

Q4298/1-4

COMPLETE THIS AREA AT EACH EXAM (IF APPLICABLE).

P. SURVEY QUESTIONS — Answer the survey questions in the AP Student Pack. Do not put responses to exam questions in this section.

1	A B C D E F G H I	4	A B C D E F G H I	7	A B C D E F G H I
2	A B C D E F G H I	5	A B C D E F G H I	8	A B C D E F G H I
3	A B C D E F G H I	6	A B C D E F G H I	9	A B C D E F G H I

Q. LANGUAGE — Do not complete this section unless instructed to do so.

If this answer sheet is for the French Language and Culture, German Language and Culture, Italian Language and Culture, Spanish Language and Culture, or Spanish Literature and Culture Exam, please answer the following questions. Your responses will not affect your score.

1. Have you lived or studied for one month or more in a country where the language of the exam you are now taking is spoken?

○ Yes ○ No

2. Do you regularly speak or hear the language at home?

○ Yes ○ No

QUESTIONS 1–75

Indicate your answers to the exam questions in this section (pages 2 and 3). Mark only one response per question for Questions 1 through 120. If a question has only four answer options, do not mark option E. Answers written in the multiple-choice booklet will not be scored.

COMPLETE MARK ● EXAMPLES OF INCOMPLETE MARKS 

You must use a No. 2 pencil and marks must be complete. Do not use a mechanical pencil. It is very important that you fill in the entire circle darkly and completely. If you change your response, erase as completely as possible. Incomplete marks or erasures may affect your score.

1	A B C D E	26	A B C D E	51	A B C D E
2	A B C D E	27	A B C D E	52	A B C D E
3	A B C D E	28	A B C D E	53	A B C D E
4	A B C D E	29	A B C D E	54	A B C D E
5	A B C D E	30	A B C D E	55	A B C D E
6	A B C D E	31	A B C D E	56	A B C D E
7	A B C D E	32	A B C D E	57	A B C D E
8	A B C D E	33	A B C D E	58	A B C D E
9	A B C D E	34	A B C D E	59	A B C D E
10	A B C D E	35	A B C D E	60	A B C D E
11	A B C D E	36	A B C D E	61	A B C D E
12	A B C D E	37	A B C D E	62	A B C D E
13	A B C D E	38	A B C D E	63	A B C D E
14	A B C D E	39	A B C D E	64	A B C D E
15	A B C D E	40	A B C D E	65	A B C D E
16	A B C D E	41	A B C D E	66	A B C D E
17	A B C D E	42	A B C D E	67	A B C D E
18	A B C D E	43	A B C D E	68	A B C D E
19	A B C D E	44	A B C D E	69	A B C D E
20	A B C D E	45	A B C D E	70	A B C D E
21	A B C D E	46	A B C D E	71	A B C D E
22	A B C D E	47	A B C D E	72	A B C D E
23	A B C D E	48	A B C D E	73	A B C D E
24	A B C D E	49	A B C D E	74	A B C D E
25	A B C D E	50	A B C D E	75	A B C D E

ETS USE ONLY

Exam		0 1 2 3 4 5 6 7 8 9
		0 1 2 3 4 5 6 7 8 9
Exam		0 1 2 3 4 5 6 7 8 9
		0 1 2 3 4 5 6 7 8 9

SELECTED MEDIA EXAMS	R	W	O	OTHER EXAMS	R	W	O
PT02				TOTAL			
PT03				Subscore (if applicable)			
PT04				Subscore (if applicable)			

DO NOT WRITE IN THIS AREA

QUESTIONS 76–120

Be sure each mark is dark and completely fills the circle. If a question has only four answer options, do not mark option E.

76	A B C D E	91	A B C D E	106	A B C D E
77	A B C D E	92	A B C D E	107	A B C D E
78	A B C D E	93	A B C D E	108	A B C D E
79	A B C D E	94	A B C D E	109	A B C D E
80	A B C D E	95	A B C D E	110	A B C D E
81	A B C D E	96	A B C D E	111	A B C D E
82	A B C D E	97	A B C D E	112	A B C D E
83	A B C D E	98	A B C D E	113	A B C D E
84	A B C D E	99	A B C D E	114	A B C D E
85	A B C D E	100	A B C D E	115	A B C D E
86	A B C D E	101	A B C D E	116	A B C D E
87	A B C D E	102	A B C D E	117	A B C D E
88	A B C D E	103	A B C D E	118	A B C D E
89	A B C D E	104	A B C D E	119	A B C D E
90	A B C D E	105	A B C D E	120	A B C D E

QUESTIONS 121–126

For Students Taking AP Biology

Write your answer in the boxes at the top of the griddable area and fill in the corresponding circles. Mark only one circle in any column. You will receive credit only if the circles are filled in correctly.

121 122 123 124 125 126

QUESTIONS 131–142

For Students Taking AP Computer Science Principles, AP Physics 1, or AP Physics 2

Mark two responses per question. You will receive credit only if both correct responses are selected.

131	A B C D	135	A B C D	139	A B C D
132	A B C D	136	A B C D	140	A B C D
133	A B C D	137	A B C D	141	A B C D
134	A B C D	138	A B C D	142	A B C D

DO NOT WRITE IN THIS AREA

COMPLETE THIS AREA ONLY ONCE.

R. YOUR MAILING ADDRESS

Use the address abbreviations from your AP Student Pack. Fill in only one circle per column. Indicate a space in your address by leaving a blank box; do not grid that column.

STREET ADDRESS (include street number, street name, apartment number, etc.)

CITY

ZIP OR POSTAL CODE

COUNTRY CODE

STATE

AK	HI	MI	NY	VT
AL	IA	MN	OH	WA
AR	ID	MO	OK	WI
AZ	IL	MS	OR	WV
CA	IN	MT	PA	WY
CO	KS	NC	RI	Puerto Rico
CT	KY	ND	SC	
DC	LA	NE	SD	AA
DE	MA	NH	TN	AE
FL	MD	NJ	TX	AP
GA	ME	NM	UT	Other
		NV	VA	

V. SEX

- Female
- Male

W. WHICH LANGUAGE DO YOU KNOW BEST?

- English
- English and another language about the same
- Another language

X. RACIAL/ETHNIC GROUP

Please answer both questions about Hispanic origin and about race. For the following questions about your identity, Hispanic origins are not races.

(You may mark all that apply.)

a. Are you of Hispanic, Latino, or Spanish origin?

- No, not of Hispanic, Latino, or Spanish origin
- Yes, Cuban
- Yes, Mexican
- Yes, Puerto Rican
- Yes, another Hispanic, Latino, or Spanish origin

b. What is your race?

- American Indian or Alaska Native
- Asian (including Indian subcontinent and Philippines origin)
- Black or African American (including Africa and Afro-Caribbean origin)
- Native Hawaiian or other Pacific Islander
- White (including Middle Eastern origin)

Y. PARENTAL EDUCATION LEVEL

In the first column, indicate the highest level of education of one parent/guardian, and indicate whether this is your mother/female guardian or father/male guardian. Then, if applicable, indicate the highest level of education of your other parent/guardian in the second column, and indicate whether this is your mother/female guardian or father/male guardian.

	Mother or female guardian
	Father or male guardian
Grade school	Grade school
Some high school	Some high school
High school diploma or equivalent	High school diploma or equivalent
Vocational or trade school	Vocational or trade school
Some college	Some college
Associate or two-year degree	Associate or two-year degree
Bachelor's or four-year degree	Bachelor's or four-year degree
Some graduate or professional school	Some graduate or professional school
Graduate or professional degree	Graduate or professional degree

S. FOR STUDENTS OUTSIDE THE UNITED STATES ONLY

If your address does not fit in the spaces provided in Item R, fill in as many circles as you can, then fill in the circle in Item S and print the remainder of your address in the spaces provided.

Address	City	State or Province	Country	ZIP or Postal Code

T. STUDENT IDENTIFIER (Student ID Number)

U. EMAIL ADDRESS

By providing your email address, you are granting the College Board permission to use your email address in accordance with the policies in the *2016-17 Bulletin for AP Students and Parents*.

Section I: Multiple-Choice Questions

This is the multiple-choice section of the 2017 AP exam.
It includes cover material and other administrative instructions
to help familiarize students with the mechanics of the exam.
(Note that future exams may differ in look from the following content.)

AP® Statistics Exam

SECTION I: Multiple Choice

2017

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

At a Glance

Total Time
1 hour, 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) 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 4NBP4-S

90

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. Researchers conducted a telephone survey of 427 adults living in a large city. The adults were asked whether they planned to purchase a smart watch in the next year. The table shows the responses categorized by the region of the city in which the residents live.

	Yes	No
North	24	38
East	32	76
South	38	98
West	23	98

Which of the following graphical displays is most appropriate for comparing the proportions of those surveyed who plan to purchase a smart watch within the four regions?

(A) A scatterplot

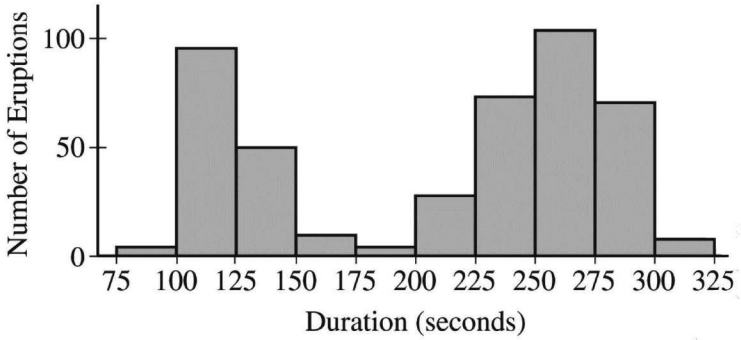
(B) A boxplot

(C) A segmented bar chart

(D) A back-to-back stemplot

(E) A dotplot

2. A scientist recorded the duration of the eruptions of the Old Faithful geyser in Yellowstone National Park that occurred during a one-month time period. The histogram below shows the distribution of the duration, in seconds, of the eruptions.



Based on the histogram, which of the following is the best description of the distribution?

(A) The distribution is uniform, is centered at about 200 seconds, and has a range of at most 250 seconds.

(B) The distribution is skewed to the left, is centered at about 125 seconds, and has a range of at most 250 seconds.

(C) The distribution is skewed to the right, is centered at about 260 seconds, and has a range of at most 250 seconds.

(D) The distribution displays two clusters, has a range of at most 200 seconds, and includes outliers below 75 seconds and above 325 seconds.

(E) The distribution displays two clusters, with one cluster centered at about 125 seconds and the other centered at about 260 seconds, and has a range of at most 250 seconds.

GO ON TO THE NEXT PAGE.

3. Events D and E are independent, with $P(D) = 0.6$ and $P(D \text{ and } E) = 0.18$. Which of the following is true?

(A) $P(E) = 0.12$

(B) $P(E) = 0.4$

(C) $P(D \text{ or } E) = 0.28$

(D) $P(D \text{ or } E) = 0.72$

(E) $P(D \text{ or } E) = 0.9$

---

4. Researchers used two footballs of the same size to examine the effect of helium on kicking distance. One football was filled with air, and the other was filled with helium. Eleven people participated in the study. Each person kicked the football filled with air and the football filled with helium, and the kicking distances, in yards, were recorded. The football that was kicked first was determined by the flip of a fair coin, and the people did not know which football was filled with air and which was filled with helium. What type of study was conducted by the researchers and, of the following, which is the appropriate t-interval for inference?

(A) A completely randomized design and a t-interval for a difference between means for independent samples

(B) A completely randomized design and a t-interval for a mean difference

(C) A matched-pairs design and a t-interval for a difference between means for independent samples

(D) A matched-pairs design and a t-interval for a mean difference

(E) An observational study and a t-interval for a difference between means for independent samples

GO ON TO THE NEXT PAGE.

5. A survey of a random sample of 1,045 young adults found that 60 percent do not have a landline telephone number. A hypothesis test will be used to determine whether the data provide convincing statistical evidence that more than 50 percent of all young adults do not have a landline telephone number. Which of the following is the test statistic for the appropriate test?

(A) $\dfrac{0.50 - 0.60}{\sqrt{\dfrac{(0.50)(0.50)}{1,045}}}$

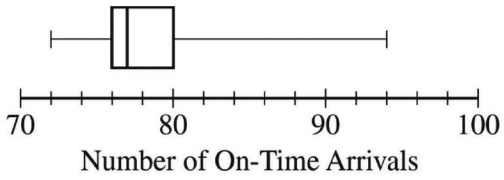
(B) $\dfrac{0.50 - 0.60}{\sqrt{\dfrac{(0.40)(0.60)}{1,045}}}$

(C) $\dfrac{0.60 - 0.50}{\sqrt{\dfrac{(0.50)(0.50)}{1,045}}}$

(D) $\dfrac{0.60 - 0.50}{\sqrt{\dfrac{(0.40)(0.60)}{1,045}}}$

(E) $\dfrac{0.60 - 0.50}{\dfrac{(0.40)(0.60)}{\sqrt{1,045}}}$

6. An airline recorded the number of on-time arrivals for a sample of 100 flights each day. The boxplot below summarizes the recorded data for one year.



Based on the boxplot, which of the following statements must be true?

(A) The range of the number of on-time arrivals is greater than 90.

(B) The interquartile range of the number of on-time arrivals is 22.

(C) The number of days that had at least 80 on-time arrivals is greater than the number of days that had at most 76 on-time arrivals.

(D) The number of days that had from 76 to 80 on-time arrivals is equal to the number of days that had at most 76 on-time arrivals.

(E) The difference between the median and the lower quartile for the number of on-time arrivals is less than 2.

7. A tropical storm is classified as major if it has sustained winds greater than 110 miles per hour. Based on data from the past two decades, a meteorologist estimated the following percentages about future storms.

   - 20% of all tropical storms will originate in the Atlantic Ocean, of which 20% will be classified as major.
   - 30% of all tropical storms will originate in the eastern Pacific Ocean, of which 15% will be classified as major.
   - 50% of all tropical storms will originate in the western Pacific Ocean, of which 25% will be classified as major.

   Based on the meteorologist's estimates, approximately what is the probability that a future tropical storm will originate in the Pacific Ocean and be classified as major?

   (A) 0.045

   (B) 0.125

   (C) 0.170

   (D) 0.400

   (E) 0.960

8. Research indicates that the standard deviation of typical human body temperature is 0.4 degree Celsius (C). Which of the following represents the standard deviation of typical human body temperature in degrees Fahrenheit (F), where $F = \frac{9}{5}C + 32$?

(A) $\frac{9}{5}(0.4) + 32$

(B) $\frac{9}{5}(0.4)$

(C) $\frac{9}{5}(0.4)^2$

(D) $\left(\frac{9}{5}\right)^2(0.4)$

(E) $\left(\frac{9}{5}\right)^2(0.4)^2$

9. The distribution of weights of female college cross-country runners is approximately normal with mean 122 pounds and standard deviation 8 pounds. Which of the following is closest to the percent of the runners who weigh between 114 pounds and 138 pounds?

(A) 18%

(B) 32%

(C) 68%

(D) 82%

(E) 95%

---

10. Measurements of water quality were taken from a river downstream from an abandoned chemical dumpsite. Concentrations of a certain chemical were obtained from 9 measurements taken at the surface of the water, 9 measurements taken at mid-depth of the water, and 9 measurements taken at the bottom of the water. What type of study was conducted, and what is the response variable of the study?

(A) An experiment was conducted, and the response variable is the concentration of the chemical.

(B) An experiment was conducted, and the response variable is the depth of the water.

(C) A census was conducted, and the response variable is the depth of the water.

(D) An observational study was conducted, and the response variable is the concentration of the chemical.

(E) An observational study was conducted, and the response variable is the depth of the water.

GO ON TO THE NEXT PAGE.

11. Ecologists wanted to estimate the mean biomass (amount of vegetation) of a certain forested region. The ecologists divided the region into plots measuring 1 square meter each, and they selected a random sample of 9 plots. The mean biomass of the 9 plots was 4.3 kilograms per square meter (kg/m^2) and the standard deviation was 1.5 kg/m^2. Assuming all conditions for inference are met, which of the following is a 95 percent confidence interval for the population mean biomass, in kg/m^2 ?

(A) $4.3 \pm 1.96\left(\frac{\sqrt{1.5}}{3}\right)$

(B) $4.3 \pm 1.96\left(\frac{1.5}{3}\right)$

(C) $4.3 \pm 2.306\left(\frac{\sqrt{1.5}}{9}\right)$

(D) $4.3 \pm 2.306\left(\frac{1.5}{9}\right)$

(E) $4.3 \pm 2.306\left(\frac{1.5}{3}\right)$

12. Staff members of a high school newspaper want to obtain an estimate of the average number of years teachers in the state have been teaching. At an educational conference attended by many teachers in the state, the staff members randomly selected 50 conference attendees and asked the attendees how long they have been teaching. Which of the following describes the sample and the population to which it would be most reasonable for the staff members to generalize the results?

(A) The sample is the 50 conference attendees, and the population is all teachers in the state.

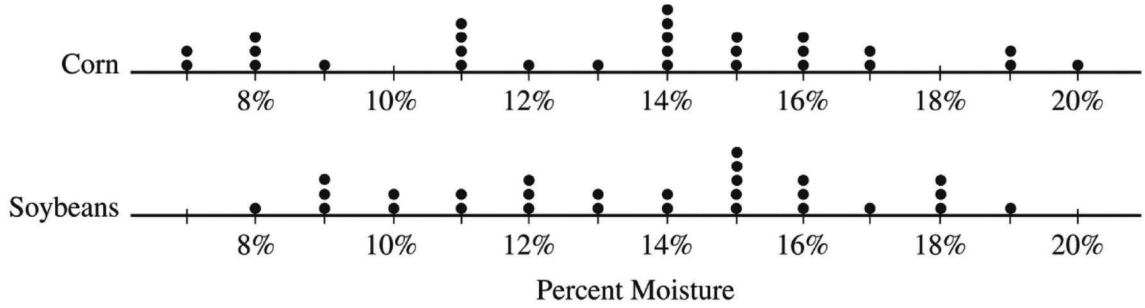
(B) The sample is the 50 conference attendees, and the population is all conference attendees.

(C) The sample is all conference attendees, and the population is all teachers in the state.

(D) The sample is all conference attendees, and the population is the 50 conference attendees.

(E) The sample is the average number of years that all conference attendees have taught, and the population is all conference attendees.

13. Grain moisture is a characteristic of grain that affects the price paid for the grain. A random sample of 28 loads of corn was evaluated for moisture as a percent of the total weight. A different random sample of 28 loads of soybeans was also evaluated for moisture. The data are displayed in the dotplots below.



Based on the dotplots, which of the following is greater for the percent moisture of corn than for the percent moisture of soybeans?

(A) The first quartile

(B) The median

(C) The third quartile

(D) The range

(E) The interquartile range

14. A sleep time of 15.9 hours per day for a newborn baby is at the 10th percentile of the distribution of sleep times for all newborn babies. Assuming the distribution is normal with standard deviation 0.5 hour, approximately what is the mean sleep time, in hours per day, for newborn babies?

(A) 15.1

(B) 15.3

(C) 16.3

(D) 16.5

(E) 16.7

---

15. As part of a science experiment, a student recorded 10 measurements of the temperature of a liquid. One of the measurements was an outlier when compared with the other 9 measurements. Which of the following must be true about the 9 measurements, excluding the outlier, when compared with the 10 measurements? (Note: An outlier is any number that is greater than the upper quartile or less than the lower quartile by at least 1.5 times the interquartile range.)

(A) The median of the 9 measurements is less than the median of the 10 measurements.

(B) The median of the 9 measurements is greater than the median of the 10 measurements.

(C) The maximum of the 9 measurements is less than the maximum of the 10 measurements.

(D) The maximum of the 9 measurements is greater than the maximum of the 10 measurements.

(E) The standard deviation of the 9 measurements is less than the standard deviation of the 10 measurements.

GO ON TO THE NEXT PAGE.

16. At a local ice-cream store, 210 people were surveyed on whether they preferred eating ice cream from a cone or a cup. Of the 210 people surveyed, 70 were adults and 140 were children. Of the responses, 150 indicated the cone as the preferred method of eating ice cream. For those surveyed, there was no association between age and preferred method of eating ice cream. Which of the following tables shows the distribution of responses?

(A)

	Cone	Cup	Total
Adults	35	35	70
Children	115	25	140
Total	150	60	210

(B)

	Cone	Cup	Total
Adults	40	30	70
Children	110	30	140
Total	150	60	210

(C)

	Cone	Cup	Total
Adults	50	20	70
Children	100	40	140
Total	150	60	210

(D)

	Cone	Cup	Total
Adults	60	10	70
Children	90	50	140
Total	150	60	210

(E)

	Cone	Cup	Total
Adults	65	5	70
Children	85	55	140
Total	150	60	210

17. A two-sided t-test for a population mean is conducted of the null hypothesis $H_0 : \mu = 100$. If a 90 percent t-interval constructed from the same sample data contains the value of 100, which of the following can be concluded about the test at a significance level of $\alpha = 0.10$?

(A) The p-value is less than 0.10, and H_0 should be rejected.

(B) The p-value is less than 0.10, and H_0 should not be rejected.

(C) The p-value is greater than 0.10, and H_0 should be rejected.

(D) The p-value is greater than 0.10, and H_0 should not be rejected.

(E) There is not enough information given to make a conclusion about the p-value and H_0.

18. An agriculturalist working with Australian pine trees wanted to investigate the relationship between the age and the height of the Australian pine. A random sample of Australian pine trees was selected, and the age, in years, and the height, in meters, was recorded for each tree in the sample. Based on the recorded data, the agriculturalist created the following regression equation to predict the height, in meters, of the Australian pine based on the age, in years, of the tree.

$$\text{predicted height} = 0.29 + 0.48(\text{age})$$

Which of the following is the best interpretation of the slope of the regression line?

(A) The height increases, on average, by 1 meter each 0.48 year.

(B) The height increases, on average, by 0.48 meter each year.

(C) The height increases, on average, by 0.29 meter each year.

(D) The height increases, on average, by 0.29 meter each 0.48 year.

(E) The difference between the actual height and the predicted height is, on average, 0.48 meter for each year.

19. At a certain store, the distribution of weights of cartons of large eggs is approximately normal with mean 26 ounces (oz). Based on the distribution, which of the following intervals will contain the greatest proportion of cartons of large eggs at the store?

(A) 20 oz to 24 oz

(B) 22 oz to 26 oz

(C) 24 oz to 28 oz

(D) 26 oz to 30 oz

(E) 28 oz to 32 oz

20. In 1960 sociologists studied a random sample of 1,018 families that consisted of a husband, a wife, and at least one child. Of those families, 5.8 percent reported that the wife was the primary wage earner of the family. In 2011 the study was replicated with a random sample of 1,013 families that consisted of a husband, a wife, and at least one child. Of those families, 22.3 percent reported that the wife was the primary wage earner of the family. Which of the following represents a 99 percent confidence interval for the difference between the proportions of families that consisted of a husband, a wife, and at least one child from 1960 to 2011 that would have reported the wife as the primary wage earner?

(A) $(0.223 - 0.058) \pm 1.96\sqrt{\frac{(0.223)(0.777)}{1,013} + \frac{(0.058)(0.942)}{1,018}}$

(B) $(0.223 - 0.058) \pm 2.326\sqrt{\frac{(0.223)(0.777)}{1,013} + \frac{(0.058)(0.942)}{1,018}}$

(C) $(0.223 - 0.058) \pm 2.576\sqrt{\frac{(0.223)(0.777)}{1,013} + \frac{(0.058)(0.942)}{1,018}}$

(D) $(0.223 - 0.058) \pm 2.326\sqrt{\frac{285}{2,031}\left(\frac{1}{1,013} + \frac{1}{1,018}\right)}$

(E) $(0.223 - 0.058) \pm 2.576\sqrt{\frac{285}{2,031}\left(\frac{1}{1,013} + \frac{1}{1,018}\right)}$

21. Researchers working for a certain airline are investigating the weight of carry-on bags. The researchers will use the mean weight of a random sample of 800 carry-on bags to estimate the mean weight of all carry-on bags for the airline. Which of the following best describes the effect on the bias and the variance of the estimator if the researchers increase the sample size to 1,300 ?

(A) The bias will decrease and the variance will remain the same.

(B) The bias will increase and the variance will remain the same.

(C) The bias will remain the same and the variance will decrease.

(D) The bias will remain the same and the variance will increase.

(E) The bias will decrease and the variance will decrease.

---

22. Researchers investigated whether a new process for producing yarn could reduce the mean amount of volatile organic compounds (VOCs) emitted by carpet. From random samples of carpets, the researchers found the mean reduction of VOCs emitted by carpets made with yarn produced by the new process compared with that of carpets made with yarn produced by the traditional process was 13 parts per million (ppm). All conditions for inference were met, and the p-value for the appropriate hypothesis test was 0.095. Which of the following statements is the best interpretation of the p-value?

(A) The probability that the null hypothesis is true is 0.095.

(B) The probability that the alternative hypothesis is true is 0.095.

(C) The probability of observing a mean reduction of 13 ppm is 0.095.

(D) If the null hypothesis is true, the probability of observing a mean reduction of at least 13 ppm is 0.095.

(E) If the null hypothesis is true, the probability of observing a mean reduction of at most 13 ppm is 0.095.

23. A 99 percent one-sample z-interval for a proportion will be created from the point estimate obtained from each of two random samples selected from the same population: sample R and sample S. Let R represent a random sample of size 1,000, and let S represent a random sample of size 4,000. If the point estimate obtained from R is equal to the point estimate obtained from S, which of the following must be true about the respective margins of error constructed from those samples?

(A) The margin of error for S will be 4 times the margin of error for R.

(B) The margin of error for S will be 2 times the margin of error for R.

(C) The margin of error for S will be equal to the margin of error for R.

(D) The margin of error for R will be 4 times the margin of error for S.

(E) The margin of error for R will be 2 times the margin of error for S.

---

24. A study was conducted to evaluate the impact of taking a nutritional supplement on a person's reaction time. One hundred volunteers were placed into one of three groups according to their athletic ability: low, moderate, or high. Participants in each group were randomly assigned to take either the nutritional supplement or a placebo for six weeks. At the end of the six weeks, participants were given a coordination task. The reaction time in completing the task was recorded for each participant. The study compared the reaction times between those taking the supplement and those taking the placebo within each athletic ability level. Which of the following is the best description of the study?

(A) A randomized block design

(B) A completely randomized design

(C) A matched-pairs design

(D) A randomized observational study

(E) A stratified observational study

GO ON TO THE NEXT PAGE.

25. The number of tickets purchased by a customer for a musical performance at a certain concert hall can be considered a random variable. The table below shows the relative frequency distribution for the number of tickets purchased by a customer.

Number of tickets purchased	1	2	3	4	5
Relative frequency	0.20	0.45	0.10	0.20	0.05

Suppose each ticket for a certain musical performance cost $12. Based on the distribution shown, what is the mean cost per customer for the performance?

(A) $2.45

(B) $2.75

(C) $24.50

(D) $29.40

(E) $36.00

26. A survey of a random sample of 210 male teens and 228 female teens, ages 13 years to 17 years, found that 122 of the male teens and 160 of the female teens brush their teeth at least twice a day. If there is no difference between the proportions in the population of all male and female teens ages 13 years to 17 years who brush their teeth at least twice a day, approximately how many males and females in the sample would be expected to brush their teeth at least twice a day?

(A) 105 males and 114 females

(B) 122 males and 160 females

(C) 135 males and 147 females

(D) 141 males and 141 females

(E) 219 males and 219 females

27. Researchers believed that an increase in lean body mass is associated with an increase in maximal oxygen uptake. A scatterplot of the measurements taken from 18 randomly selected college athletes displayed a strong positive linear relationship between the two variables. A significance test for the null hypothesis that the slope of the regression line is 0 versus the alternative that the slope is greater than 0 yielded a p-value of 0.04. Which statement is an appropriate conclusion for the test?

(A) The p-value of 0.04 indicates that 4% of the variation in maximal oxygen uptake for college athletes can be explained by the amount of lean body mass.

(B) The p-value of 0.04 indicates that 16% of the variation in maximal oxygen uptake for college athletes can be explained by the amount of lean body mass.

(C) The strong positive linear relationship displayed in the scatterplot along with a p-value less than 0.05 indicates that college athletes with higher lean body mass tend to have higher maximal oxygen uptake.

(D) The strong positive linear relationship displayed in the scatterplot along with a p-value less than 0.05 indicates that an increase in lean body mass causes an increase in maximal oxygen uptake for college athletes.

(E) A p-value less than 0.05 indicates that the relationship displayed in the scatterplot is likely due to chance, and that there is no statistical evidence of a relationship between lean body mass and maximal oxygen uptake for college athletes.

GO ON TO THE NEXT PAGE.

28. An environmental group wanted to estimate the proportion of fresh produce sales identified as organic in a local grocery store. In the winter, the group obtained a random sample of sales from the store and used the data to construct the 95 percent z-interval for a proportion $(0.087, 0.133)$. Six months later in the summer, the group obtained a second random sample of sales from the store. The second sample was the same size as the first, and the proportion of sales identified as organic was 0.4. How does the 95 percent z-interval for a proportion constructed from the summer sample compare to the winter interval?

(A) The summer interval is wider and has a lesser point estimate.

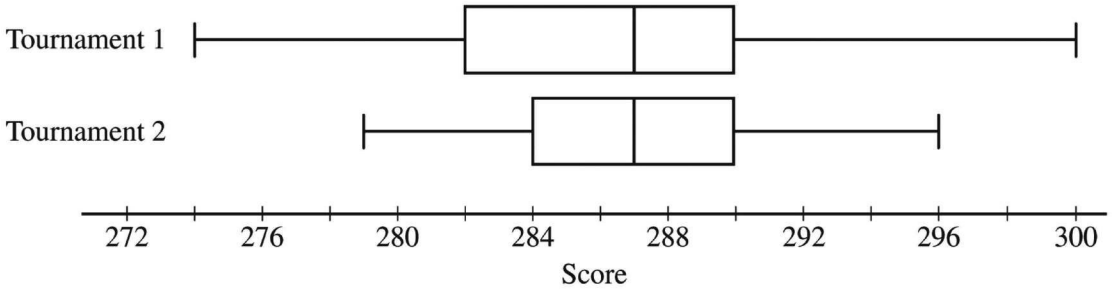
(B) The summer interval is wider and has a greater point estimate.

(C) The summer interval is narrower and has a lesser point estimate.

(D) The summer interval is narrower and has a greater point estimate.

(E) The summer interval is the same width and has a greater point estimate.

29. In a standard golf tournament, golfers play 18 holes of golf on each of 4 consecutive days. For each hole, golfers keep track of the number of times they hit the ball (strokes) before the ball goes into the cup. A golfer's score for the tournament is the total number of strokes needed to complete the tournament. The boxplots below summarize the scores for golfers who competed in tournament 1 and golfers who competed in tournament 2.



Based on the boxplots, which of the following statements must be true?

(A) More golfers played in tournament 1 than in tournament 2.

(B) In both tournaments, at least half the golfers completed the tournament with a score less than 288.

(C) The number of golfers who completed tournament 1 with a score less than 288 was greater than the number of golfers who completed tournament 2 with a score less than 288.

(D) The range of scores for tournament 1 is less than the range of scores for tournament 2.

(E) The score of the golfer with the least score in tournament 1 was greater than the score of the golfer with the least score in tournament 2.

30. Based on records kept at a gas station, the distribution of gallons of gas purchased by customers is skewed to the right with mean 10 gallons and standard deviation 4 gallons. A random sample of 64 customer receipts was selected, and the sample mean number of gallons was recorded. Suppose the process of selecting a random sample of 64 receipts and recording the sample mean number of gallons was repeated for a total of 100 samples. Which of the following is the best description of a dotplot created from the 100 sample means?

(A) The dotplot is skewed to the right with mean 10 gallons and standard deviation 4 gallons.

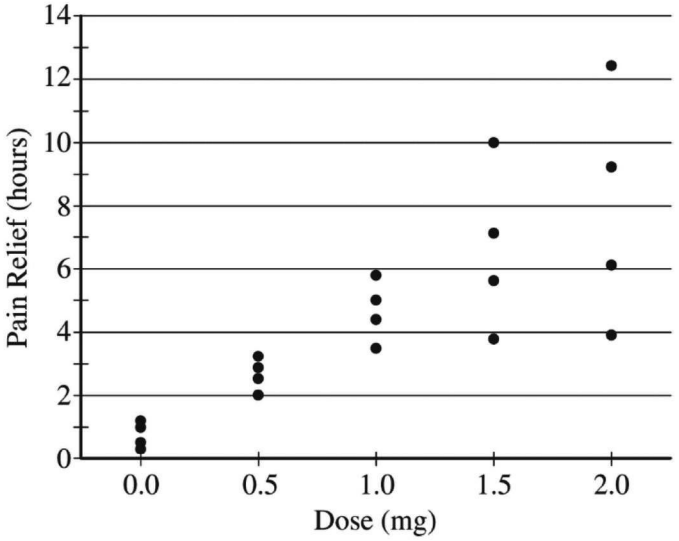
(B) The dotplot is skewed to the right with mean 10 gallons and standard deviation 0.5 gallon.

(C) The dotplot is skewed to the right with mean 10 gallons and standard deviation 0.4 gallon.

(D) The dotplot is approximately normal with mean 10 gallons and standard deviation 0.5 gallon.

(E) The dotplot is approximately normal with mean 10 gallons and standard deviation 0.4 gallon.

31. An experiment was conducted to investigate the relationship between the dose of a pain medication and the number of hours of pain relief. Twenty individuals with chronic pain were randomly assigned to one of five doses—0.0, 0.5, 1.0, 1.5, 2.0—in milligrams (mg) of medication. The results are shown in the scatterplot below.



The data were used to fit a least-squares regression line to predict the number of hours of pain relief for a given dose. Which of the following would be revealed by a plot of the residuals of the regression versus the dose?

(A) The sum of the residuals is less than 0.

(B) The sum of the residuals is greater than 0.

(C) There are outliers associated with the lower doses.

(D) The variation in the hours of pain relief is not the same across the doses.

(E) There is a positive linear relationship between the residuals and the dose.

32. A large store has a customer service department where customers can go to ask for help with store-related issues. According to store records, approximately $\frac{1}{4}$ of all customers who go to the service department ask for help finding an item. Assume the reason each customer goes to the service department is independent from customer to customer. Based on the approximation, what is the probability that at least 1 of the next 4 customers who go to the service department will ask for help finding an item?

(A) $4\left(\frac{1}{4}\right)$

(B) $1-\left(\frac{1}{4}\right)^4$

(C) $1-\left(\frac{3}{4}\right)^4$

(D) $4\left(\frac{1}{4}\right)^1\left(\frac{3}{4}\right)^3$

(E) $\left(\frac{4}{4}\right)\left(\frac{3}{4}\right)\left(\frac{2}{4}\right)\left(\frac{1}{4}\right)$

33. Data were collected from a longitudinal study designed to investigate the relationship between blood sugar levels and brain shrinkage. The results of an analysis of the data for 22 observations are shown in the table below.

Term	Coef	SE Coef
Constant	−15.668	6.154
Blood sugar	0.161	0.073

Which of the following represents a 98 percent confidence interval for the slope of the least-squares regression line for brain shrinkage on blood sugar levels? Assume the conditions for inference are met.

(A) $-15.668 \pm 2.528(6.154)$

(B) $-15.668 \pm 2.518(6.154)$

(C) $0.161 \pm 2.528(0.073)$

(D) $0.161 \pm 2.518(0.073)$

(E) $0.161 \pm 2.197(0.073)$

34. In a certain computer card game, the player is awarded 5 points for each card that is moved to a correct position. The player is penalized 10 points for each minute the game is played. Let the random variable X represent the number of cards moved to a correct position, and let the random variable Y represent the number of minutes the game is played. The means and standard deviations of the random variables for a particular player are shown in the table below.

Variable	Mean	Standard Deviation
X	9.5	12.9
Y	5.4	1.1

Assume that X and Y are independent. What are the expected value and the standard deviation of the points per game for the player?

(A) The expected value is -6.5, and the standard deviation is 63.5.

(B) The expected value is -6.5, and the standard deviation is 65.4.

(C) The expected value is 4.1, and the standard deviation is 63.5.

(D) The expected value is 4.1, and the standard deviation is 65.4.

(E) The expected value is 101.5, and the standard deviation is 63.5.

35. A program that was intended to cure a person's fear of spiders was offered at a local zoo. Volunteers with a fear of spiders participated in the program, which included holding a spider for 15 minutes. One month after they completed the program, the participants were contacted and surveyed about the program. Over 90 percent of the participants claimed they were cured of their fear of spiders. Based on the description of the program, which of the following statements is true?

(A) Because over 90% of the participants claimed to be cured, the results prove that holding a spider will cure a person's fear of spiders.

(B) Because over 90% of the participants claimed to be cured, the results can be generalized to the population of all people who have a fear of spiders.

(C) Because the participants were volunteers, the study is a census of all people in the local area who have a fear of spiders.

(D) Because the participants were self-selected, a person's desire to be cured could be a confounding variable.

(E) Because participants held a spider for 15 minutes, the study is an experiment and the results can be generalized to the population of all people who have a fear of spiders.

36. A police officer uses a motion detector to indicate whether a car is traveling faster than the speed limit (speeding). A speeding ticket will be issued to the driver of the car if the officer believes the driver is speeding, as indicated by the detector. The situation is similar to using a null and an alternative hypothesis to decide whether to issue a ticket. The hypotheses can be stated as follows.

H_0 : The driver is not speeding.

H_a : The driver is speeding.

Which of the following best describes the power of the test?

(A) The probability of issuing a ticket to a driver who is speeding

(B) The probability of issuing a ticket to a driver who is not speeding

(C) The probability of not issuing a ticket to a driver who is speeding

(D) The probability of not issuing a ticket to a driver who is not speeding

(E) The probability that the motion detector is working correctly

37. An agricultural scientist wanted to compare the effect of a new fertilizer to that of three older fertilizers—X, Y, and Z—on the growth of vegetables typically grown in small gardens. Two hundred green bean seedlings were individually planted in identical pots and randomly assigned to one of four groups of 50 each. Seedlings in one group were given the new fertilizer, and the three remaining groups of seedlings were given fertilizers X, Y, or Z, respectively. At the end of four weeks, all seedlings were dried and weighed. The scientist found that the mean weight of the seedlings in the group given the new fertilizer was significantly greater than the mean weights of seedlings in the other three groups. The scientist concluded that the new fertilizer was more effective than the other fertilizers for all vegetables. Why is the scientist's conclusion not appropriate?

(A) The study was observational, so cause and effect cannot be concluded.

(B) The study was observational, so no replication was used in the study.

(C) The experiment only included green beans, so the results cannot be generalized to all vegetables.

(D) The experiment did not group the seedlings into blocks by the variety of beans.

(E) The experiment lacked a control group that did not use any fertilizer.

38. In a physics experiment, two different methods were used to measure the angle of deflection when a subatomic particle collides with a certain material. Ten specimens of the material were used to compare the two methods. For each specimen, the angle of deflection was measured using both methods. For each specimen, the method used first was determined by the flip of a fair coin. The difference between the measured angles was calculated for each specimen. A test of the hypothesis that the population mean difference is zero had a p-value of 0.082.

    The hypothesis test described had three components: the number of specimens, the sample standard deviation of the differences, and the magnitude of the sample mean difference. Compared to the test described, which of the following would have resulted in a smaller p-value?

    (A) The number of specimens and the sample standard deviation of the differences remained the same, but the magnitude of the sample mean difference was smaller.

    (B) The number of specimens and the magnitude of the sample mean difference remained the same, but the sample standard deviation of the differences was larger.

    (C) The number of specimens remained the same, but the magnitude of the sample mean difference was smaller and the sample standard deviation of the difference was larger.

    (D) The number of specimens remained the same, but the magnitude of the sample mean difference was larger and the sample standard deviation of the difference was smaller.

    (E) The magnitude of the sample mean difference and the sample standard deviation of the differences remained the same, but the number of specimens was smaller.

39. A polling agency reported that 66 percent of adults living in the United States were satisfied with their health care plans. The estimate was taken from a random sample of 1,542 adults living in the United States, and the 95 percent confidence interval for the population proportion was calculated as $(0.636, 0.684)$. Which of the following statements is a correct interpretation of the 95 percent confidence level?

(A) The probability is 0.95 that the percent of adults living in the United States who are satisfied with their health care plans is between 63.6% and 68.4%.

(B) Approximately 95% of random samples of the same size from the population will result in a confidence interval that includes the proportion of all adults living in the United States who are satisfied with their health care plans.

(C) Approximately 95% of random samples of the same size from the population will result in a confidence interval that includes the proportion of all adults in the sample who are satisfied with their health care plans.

(D) Approximately 95% of all random samples of adults living in the United States will indicate that between 63.6% and 68.4% of the adults are satisfied with their health care plans.

(E) Approximately 95% of all random samples of adults living in the United States will result in a sample proportion of 0.66 adults living in the United States who are satisfied with their health care plans.

40. A survey was conducted in a large city to investigate public opinion on banning the use of trans fats in restaurant cooking. A random sample of 230 city residents with school-age children was selected, and another random sample of 341 city residents without school-age children was also selected. Of those with school-age children, 94 opposed the banning of trans fats, and of those without school-age children, 147 opposed the banning of trans fats. An appropriate hypothesis test was conducted to investigate whether there was a difference between the two groups of residents in their opposition to the banning of trans fats. Is there convincing statistical evidence of a difference between the two population proportions at the significance level of 0.05 ?

(A) Yes, because the sample proportions are different.

(B) Yes, because the probability of observing a difference at least as large as the sample difference is greater than 0.05.

(C) Yes, because the probability of observing a difference at least as large as the sample difference, if the two population proportions are the same, is less than 0.05.

(D) No, because the probability of observing a difference at least as large as the sample difference, if the two population proportions are the same, is greater than 0.05.

(E) No, because the probability of observing a difference at least as large as the sample difference is less than 0.05.

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**

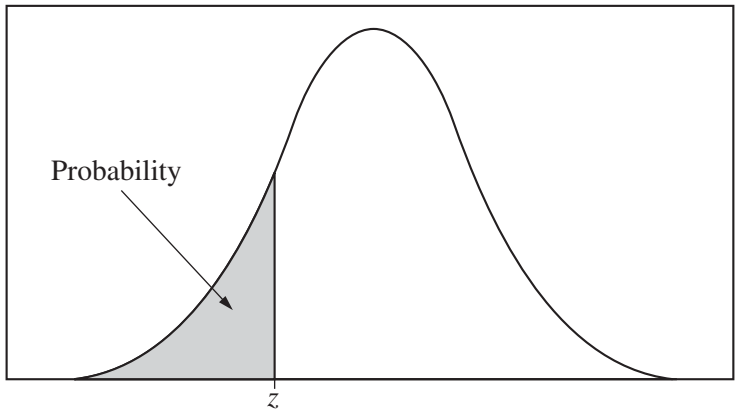


Table entry for z is the probability lying below z.

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.

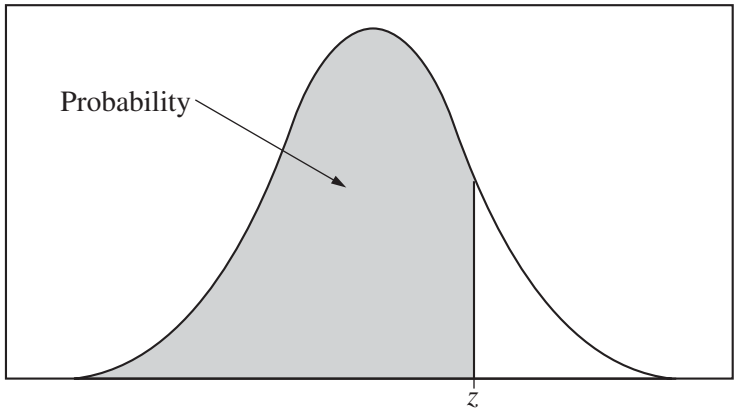


Table A (*Continued*)

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^*.

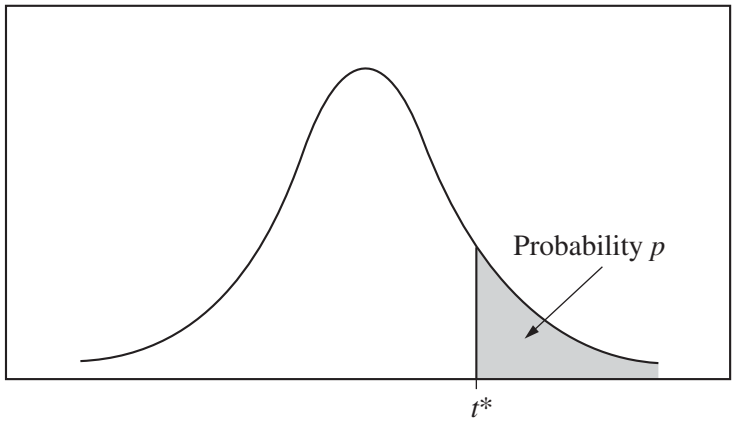


Table B ***t* distribution critical values**

	Tail probability p											
df	.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.

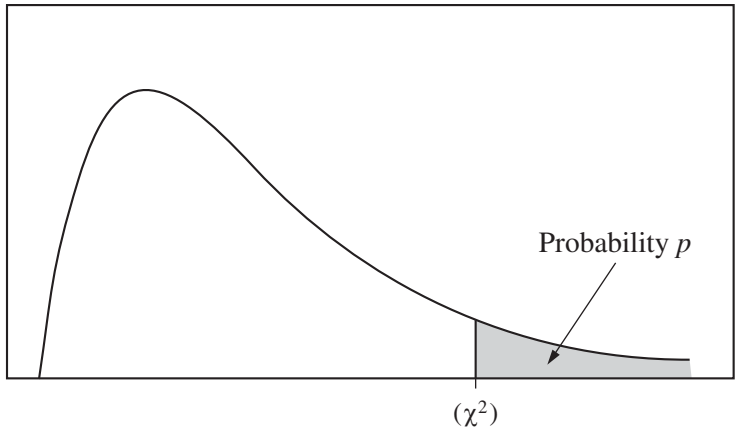


Table C χ^2 critical values

	Tail probability p											
df	.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

Section II: Free-Response Questions

This is the free-response section of the 2017 AP exam.
It includes cover material and other administrative instructions
to help familiarize students with the mechanics of the exam.
(Note that future exams may differ in look from the following content.)

AP® Statistics Exam

SECTION II: Free Response

2017

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

At a Glance

Total Time
1 hour, 30 minutes
Number of Questions
6
Percent of Total Score
50%
Writing Instrument
Either pencil or pen with black or dark blue ink
Electronic Device
Graphing calculator expected

Part A

Number of Questions
5
Suggested Time
1 hour, 5 minutes
Percent of Section II Score
75%

Part B

Number of Questions
1
Suggested Time
25 minutes
Percent of Section II Score
25%

IMPORTANT Identification Information

PLEASE PRINT WITH PEN:

1. First two letters of your last name ☐☐
   First letter of your first name ☐
2. Date of birth
   ☐☐ Month ☐☐ Day ☐☐☐☐ Year
3. Six-digit school code
   ☐☐☐☐☐☐
4. Unless I check the box below, I grant the College Board the unlimited right to use, reproduce, and publish my free-response materials, both written and oral, for educational research and instructional purposes. My name and the name of my school will not be used in any way in connection with my free-response materials. I understand that I am free to mark "No" with no effect on my score or its reporting.

   No, I do not grant the College Board these rights. ☐

Instructions

The questions for both Part A and Part B are printed in this booklet. You may use any blank space in the booklet to organize your answers and for scratch work, but you must write your answers in the spaces provided for each answer. Pages containing statistical tables and useful formulas are printed in this booklet.

You may wish to look over the questions before starting to work on them. It is not expected that everyone will be able to complete all parts of all questions. Show all your work. Indicate clearly the methods you use because you will be scored on the correctness of your methods as well as the accuracy and completeness of your results and explanations. Correct answers without supporting work may not receive credit. Write your solution to each part of each question in the space provided for that part. Write clearly and legibly. Cross out any errors you make; erased or crossed-out work will not be scored.

Manage your time carefully. The proctor will announce the suggested time for Part A and Part B, but you may proceed freely from one question to the next. You may review your responses if you finish before the end of the exam is announced.

Form I
Form Code 4NBP4-S

90

Formulas

(I) Descriptive Statistics

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

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

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

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

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

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

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

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

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

(II) Probability

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

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

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

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

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

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

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

(III) Inferential Statistics

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

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

Single-Sample

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

Two-Sample

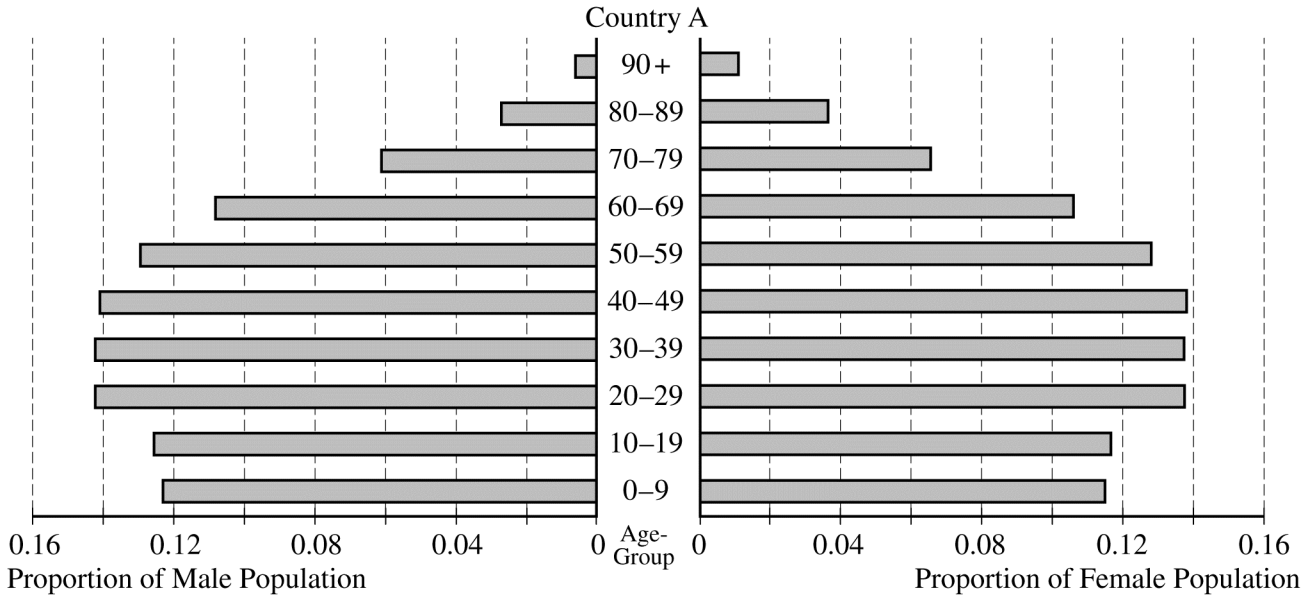
Statistic	Standard Deviation of Statistic
Difference of sample means	$\sqrt{\dfrac{\sigma_1^2}{n_1} + \dfrac{\sigma_2^2}{n_2}}$ Special case when $\sigma_1 = \sigma_2$ $\sigma\sqrt{\dfrac{1}{n_1} + \dfrac{1}{n_2}}$
Difference of sample proportions	$\sqrt{\dfrac{p_1(1-p_1)}{n_1} + \dfrac{p_2(1-p_2)}{n_2}}$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

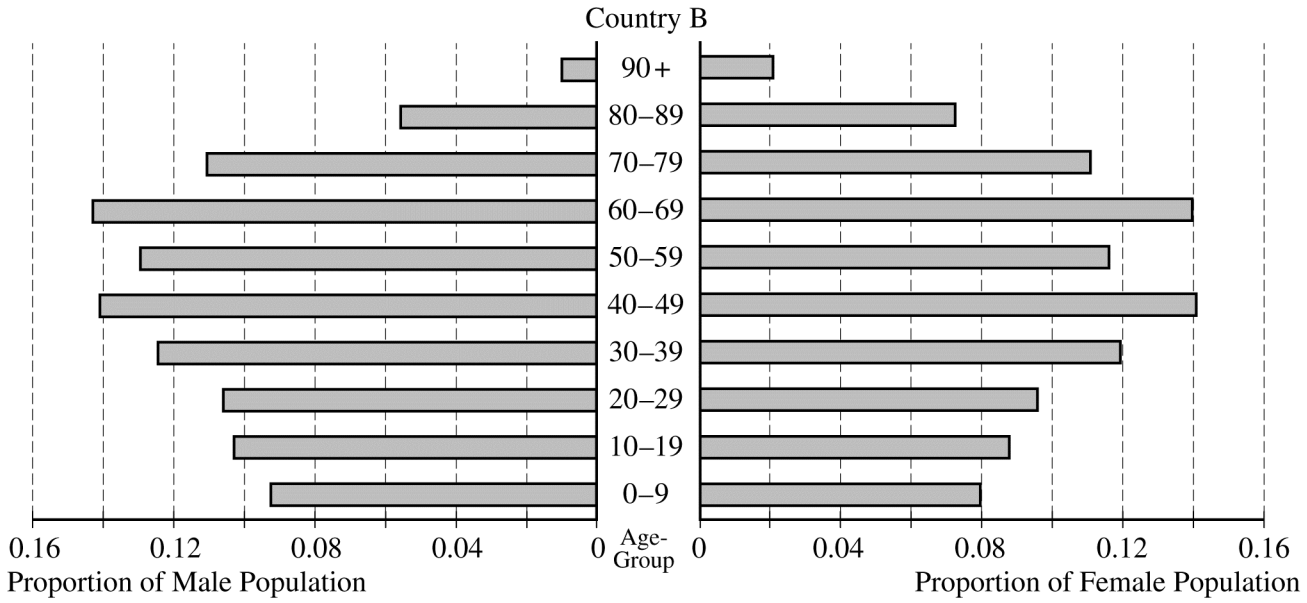
Chi-square test statistic $= \sum \dfrac{(\text{observed} - \text{expected})^2}{\text{expected}}$

STATISTICS
SECTION II
Part A
Questions 1-5
Spend about 65 minutes on this part of the exam.
Percent of Section II score—75

Directions: Show all your work. Indicate clearly the methods you use, because you will be scored on the correctness of your methods as well as on the accuracy and completeness of your results and explanations.

1. Population pyramids are a type of bar chart that show the distribution of ages of a country's population. The distributions of ages of men and women for two countries, A and B, for the year 2015 are shown in the population pyramids below. The age-groups, in years, are listed in the center columns, and the proportions are shown on the horizontal axes. Each bar represents the proportion of the age-group in the population for that sex.





GO ON TO THE NEXT PAGE.

(a) Is the proportion of the female population age 60 or older in Country A greater than the proportion of the female population age 60 or older in Country B? Justify your answer.

(b) One of the two countries experienced an increase in the birth rate in the years 1946 to 1955 and another increase in the birth rate about 20 years later. Based on the graphs, which country experienced the described increases in birth rate? Justify your answer using information from the graphs.

(c) For Country A, in which age-group is the median age of the male population? Justify your answer.

GO ON TO THE NEXT PAGE.

2. The ability to visually search, such as when reading an x-ray or interpreting a satellite image, is an important skill in many jobs. Researchers conducted a study to investigate whether playing video games could improve a person's ability to visually search. Three video games were used in the study: one was a driving game, one was a sports game, and one was a puzzle game. The participants consisted of 60 volunteers who had no experience playing video games before the study. Each participant was randomly assigned to one of the three games so that there were 20 participants per game.

   (a) Describe an appropriate method for randomly assigning 60 participants to three groups so that each group has 20 participants.

   The time to complete a visual search task was recorded for each participant before the assigned game was played. The time to complete a visual search task was again recorded for each participant after the assigned game was played. For each game, the mean improvement time (time before minus time after) was calculated.

   (b) One researcher expressed an interest in investigating whether playing a driving game would lead to a different mean improvement time to complete a visual search task than would playing a sports game. Assuming the appropriate population values are approximately normally distributed, state the name of a test with the appropriate null and alternative hypotheses that could be used to investigate the researcher's interest.

GO ON TO THE NEXT PAGE.

(c) When the appropriate test was performed, no significant difference was found in mean improvement time between the driving game and the sports game. Name one change the researchers could make in a future study to increase the power of the test. Explain why such a change would increase the power.

3. In women's tennis, a player must win 2 out of 3 sets to win a match. If a player wins the first 2 sets, she wins the match and the third set is not played. Player V and Player M will compete in a match.

(a) Let V represent the event that Player V wins a set, and let M represent the event that Player M wins a set.

(i) List all possible sequences of events V and M by set played that will result in Player V winning the match.

(ii) List all possible sequences of events V and M by set played that will result in Player M winning the match.

Player V and Player M have competed against each other many times. Historical data show that each player is equally likely to win the first set. If Player V wins the first set, the probability that she will win the second set is 0.60. If Player V loses the first set, the probability that she will lose the second set is 0.70. If Player V wins exactly one of the first two sets, the probability that she will win the third set is 0.45.

(b) What is the probability that Player V will win a match against Player M?

GO ON TO THE NEXT PAGE.

(c) What is the probability that a match between Player V and Player M will consist of 3 sets given that Player V wins the match?

(d) What is the expected number of sets played when Player V competes in a match with Player M?

4. A sociologist was investigating the ages of grandparents of high school students. From a random sample of 10 high school students, the sociologist collected data on the current ages, in years, of the students' maternal grandparents. The data are shown in the table below.

	Student											
	A	B	C	D	E	F	G	H	I	J	Mean	Standard Deviation
Age of grandmother	75	70	55	75	55	70	80	70	74	74	69.8	8.38
Age of grandfather	74	75	65	67	60	78	83	74	70	70	71.6	6.65
Difference	1	–5	–10	8	–5	–8	–3	–4	4	4	–1.8	5.81

(a) Construct and interpret a 95 percent confidence interval for the population mean difference in age (age of grandmother minus age of grandfather) of the maternal grandparents of high school students.

(b) One of the sociologist's research questions was about the mean difference in age without regard to which grandparent is older. The interval constructed in part (a) does not address such a question. Based on the sample of high school students, give the value of the point estimate for the mean difference in age that could be used to address the sociologist's question.

5. An automobile manufacturer sold 30,000 new cars, one to each of 30,000 customers, in a certain year. The manufacturer was interested in investigating the proportion of the new cars that experienced a mechanical problem within the first 5,000 miles driven.

   (a) A list of the names and addresses of all customers who bought the new cars is available. Describe a sampling plan that could be used to obtain a simple random sample of 1,000 customers from the list.

Each customer from a simple random sample of 1,000 customers who bought one of the new cars was asked whether they experienced any mechanical problems within the first 5,000 miles driven. Forty customers from the sample reported a problem. Of the 40 customers who reported a problem, 13 customers, or 32.5%, reported a problem specifically with the power door locks.

   (b) Explain why 0.325 should not be used to estimate the population proportion of the 30,000 new cars sold that experienced a problem with the power door locks within the first 5,000 miles driven.

GO ON TO THE NEXT PAGE.

(c) Based on the results of the sample, give a point estimate of the number of new cars sold that experienced a problem with the power door locks within the first 5,000 miles driven.

GO ON TO THE NEXT PAGE.

STATISTICS

SECTION II

Part B

Question 6

Spend about 25 minutes on this part of the exam.

Percent of Section II score—25

Directions: Show all your work. Indicate clearly the methods you use, because you will be scored on the correctness of your methods as well as on the accuracy and completeness of your results and explanations.

6. Emily walks every day, and she keeps a record of the number of miles she walks each day. The histogram and five-number summary below were created from the recorded miles for a random sample of 25 of the days Emily walked.

Minimum	Q1	Median	Q3	Maximum
1.4	2.6	3.25	3.8	7.5

On one of the 25 days in the sample, Emily walked 7.5 miles. From the histogram, it appears that the value 7.5 might be an outlier relative to the other values. Two methods are proposed for identifying an outlier in a set of data.

(a) One method for identifying an outlier is to use the interquartile range (IQR). An outlier is any number that is greater than the upper quartile by at least 1.5 times the IQR or less than the lower quartile by at least 1.5 times the IQR. Does such a method identify the value of 7.5 miles as an outlier for Emily's set of data? Justify your answer.

GO ON TO THE NEXT PAGE.

Another method of identifying an outlier is to investigate whether there is evidence that a value might have come from a population with a mean different from the mean of the population of the other values.

Let X and Y represent random variables. X is distributed normally with mean μ_x and standard deviation σ, and Y is distributed normally with mean μ_y and standard deviation σ. Consider 1 randomly selected value of Y and $n - 1$ randomly selected values of X.

(b) Consider the difference $Y - \overline{X}$.

(i) In terms of μ_y and μ_x, what is the mean of the difference $Y - \overline{X}$?

(ii) In terms of n and σ, what is the standard deviation of the difference $Y - \overline{X}$?

Suppose that of the $n = 25$ recorded values from Emily's sample, the value of 7.5 comes from the distribution of Y and the remaining 24 values come from the distribution of X. The summary statistics for the 24 values that come from the distribution of X are given below.

$n - 1 = 24$
$\overline{x} = 3.171$
$s = 0.821$

(c) Use the value of the potential outlier and the summary statistics of the remaining 24 values to estimate the mean and standard deviation of the difference $Y - \overline{X}$.

The estimated mean of $Y - \overline{X}$:

The estimated standard deviation of $Y - \overline{X}$:

Recall that a method for identifying an outlier is to investigate whether there is evidence that a value might have come from a population with a mean different from the mean of the population of the other values. The following hypotheses can be used for such an investigation.

$$H_0 : \mu_y = \mu_x$$
$$H_a : \mu_y \neq \mu_x$$

(d) Calculate the value of the test statistic used for evaluating the hypotheses.

(e) The p-value for the hypothesis test described above is less than 0.0001. What conclusion can be made about the population means, and what conclusion can be made about identifying 7.5 as an outlier? Justify your answers.

STOP

END OF EXAM

THE FOLLOWING INSTRUCTIONS APPLY TO THE COVERS OF THE SECTION II BOOKLET.

- **MAKE SURE YOU HAVE COMPLETED THE IDENTIFICATION INFORMATION AS REQUESTED ON THE FRONT AND BACK COVERS OF THE SECTION II BOOKLET.**
- **CHECK TO SEE THAT YOUR AP NUMBER LABEL APPEARS IN THE BOX ON THE COVER.**
- **MAKE SURE YOU HAVE USED THE SAME SET OF AP NUMBER LABELS ON ALL AP EXAMS YOU HAVE TAKEN THIS YEAR.**

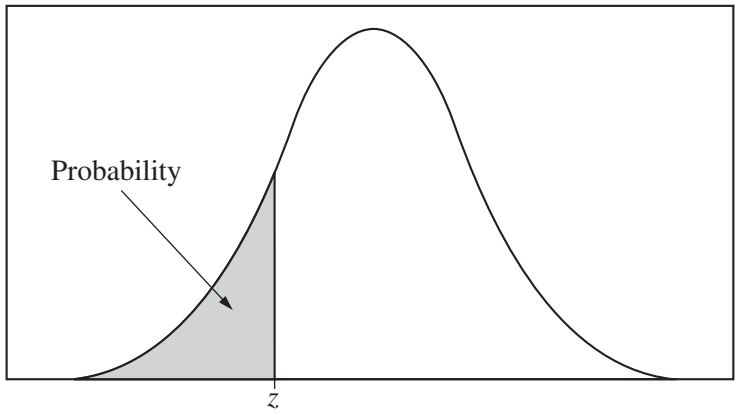


Table entry for z is the probability lying below z.

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

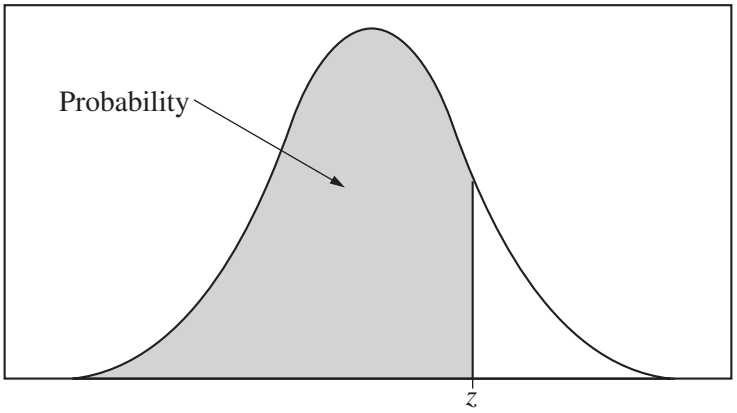


Table entry for z is the probability lying below z.

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^*.

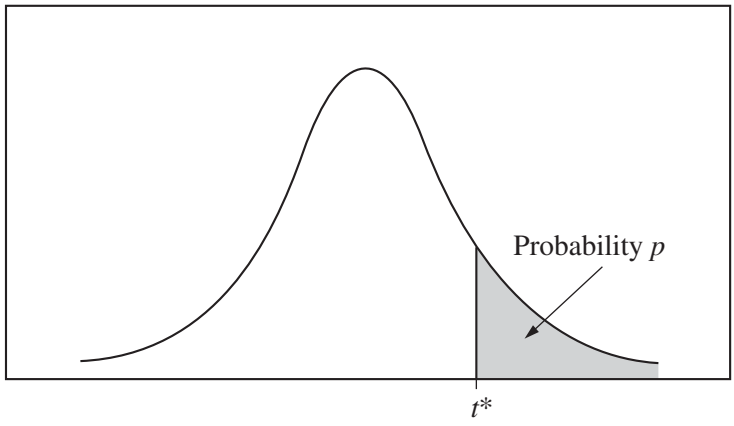


Table B ***t* distribution critical values**

	Tail probability p											
df	.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.

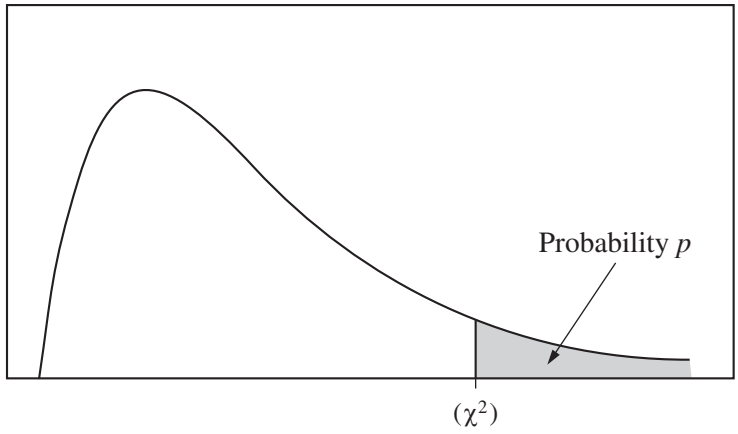


Table C χ^2 critical values

	Tail probability p											
df	.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

Multiple-Choice Answer Key

The following contains the answers to
the multiple-choice questions in this exam.

Answer Key for AP Statistics Practice Exam, Section I

Question 1: C

Question 2: E

Question 3: D

Question 4: D

Question 5: C

Question 6: E

Question 7: C

Question 8: B

Question 9: D

Question 10: D

Question 11: E

Question 12: B

Question 13: D

Question 14: D

Question 15: E

Question 16: C

Question 17: D

Question 18: B

Question 19: C

Question 20: C

Question 21: C

Question 22: D

Question 23: E

Question 24: A

Question 25: D

Question 26: C

Question 27: C

Question 28: B

Question 29: B

Question 30: D

Question 31: D

Question 32: C

Question 33: C

Question 34: B

Question 35: D

Question 36: A

Question 37: C

Question 38: D

Question 39: B

Question 40: D

Free-Response Scoring Guidelines

The following contains the scoring guidelines
for the free-response questions in this exam.

AP® STATISTICS
2017 SCORING GUIDELINES

Question 1

Intent of Question

The primary goals of this question are to assess a student's ability to (1) interpret a type of bar chart called a population pyramid; and (2) answer questions about age distributions within and between two countries using population pyramids.

Solution

Part (a):

No, the proportion of the female population age 60 or older in Country A is not greater than the corresponding proportion in Country B. This is clear without doing any calculations, because the bars in all of the age categories from 60 and above are longer for Country B than the corresponding bars for Country A, and both graphs use the same scale on the horizontal axis. Therefore, the sum of the proportions represented by those bars must be higher for Country B than for Country A.

Part (b):

Country B is the one that experienced an increase in the birth rate from 1946 to 1955 and again from about 1966 to 1975. The people born in 1946 to 1955 would be in the 60 to 69 age group in 2015, and those born about 20 years later would be in the 40 to 49 age group in 2015. The bars representing the proportions of the population in those age groups for Country B for both males and females are longer than the bars for the age groups above and below them, indicating that in Country B more people were born in the years in question than in the years immediately before and after those intervals. That pattern is not indicated for Country A.

Part (c):

The median age for the males in Country A in 2015 is in the 30 to 39 age group. The median age group corresponds to the bar such that at least 50% of the population is in that age group or higher, and at least 50% of the population is in that age group or lower. Adding the lengths of the bars either above or below the 30 to 39 age group shows that this group satisfies the condition.

Scoring

Parts (a), (b) and (c) are scored as essentially correct (E), partially correct (P), or incorrect (I).

Part (a) is scored as follows:

Essentially correct (E) if the response:

(1) says no;
(2) justifies the choice by either estimating the sum of the lengths of the bars or by comparing their lengths in each of the relevant age groups for the two countries; and
(3) includes an explicit comparison between Countries A and B for the bar lengths, such as by noting that the sum of the bars for Country A is less than the sum for Country B.

Question 1 (continued)

Partially correct (P) if the response says no and justifies the choice by adding or discussing the lengths of bars for age groups 60 and above in Country A or Country B, but does not explicitly compare them to the equivalent measure for the other Country. An example is "No, because in Country A, the bars for the age groups 60 and above are shorter;"
OR
if the response meets the three criteria for an E, but bases it on comparing the bars in the two graphs for the age group of 60 to 69 only.

Incorrect (I) if the response does not meet the criteria for E or P.

Part (b) is scored as follows:

Essentially correct (E) if the response:
(1) correctly identifies Country B;
(2) identifies the age groups that the people born in the designated years would be 20 years later (in 2015); and
(3) explains (or demonstrates on the graph) that the bars for the surrounding age groups in Country B are shorter than for the age groups in question, or at least that the bar for the 50-59 age group is shorter.

Partially correct (P) if the response correctly identifies Country B and includes one of the remaining two components required for an E, for instance by noting that the age groups of 40 to 49 and 60 to 69 have higher proportions than the age groups surrounding them, but not explicitly identifying that those would be the age groups in 2015 that satisfy the stated increases in birth rate.

Incorrect if the response does not meet the criteria for E or P.

Part (c) is scored as follows:

Essentially correct (E) if the response:
(1) correctly identifies the age group of 30 to 39;
(2) provides correct supporting work for the choice of the median age group; and
(3) describes why this age group contains the median.

Note: The response does not need to include numerical values verifying the calculation.

Partially correct (P) if the response correctly includes component (1) and one of the other two components.

Incorrect if the response includes at most one of the components required for E.

AP® STATISTICS
2017 SCORING GUIDELINES

Question 1 (continued)

4 Complete Response

Three parts essentially correct

3 Substantial Response

Two parts essentially correct and one part partially correct

2 Developing Response

Two parts essentially correct and no parts partially correct

OR

One part essentially correct and one or two parts partially correct

OR

Three parts partially correct

1 Minimal Response

One part essentially correct

OR

No parts essentially correct and two parts partially correct

AP® STATISTICS
2017 SCORING GUIDELINES

Question 2

Intent of Question

The primary goals of this question are to assess a student's ability to (1) describe how to randomly assign participants to treatment groups; (2) identify the appropriate test procedure and hypotheses to answer a question of interest and (3) provide information about how to increase the power of a test in an experiment.

Solution

Part (a):

Number the participants from 1 to 60, then using a random number generator on a calculator, statistical software, or a random number table, choose 40 numbers out of 1 to 60 without replacement. Use the first 20 of those numbers to choose the 20 individuals to assign to the driving game, and the next 20 to choose the individuals to assign to the sports game. The remaining 20 individuals are assigned to the puzzle game.

Part (b):

The appropriate test is a two sample *t*-test for the difference in means.

Define μ_D to be the mean improvement time if everyone in the population were to play the driving game, and μ_S to be the mean improvement time if everyone in the population were to play the sports game.

The null hypothesis is $H_0 : \mu_D = \mu_S$ and the alternative hypothesis is $H_a : \mu_D \neq \mu_S$.

Part (c):

To increase power, the researchers should use a larger sample size and/or increase the significance level α. Using a larger sample size reduces the standard error of the sampling distribution, which increases the value of the test statistic, making it easier to detect a difference in the population means if it exists. Using a larger significance level makes it easier to reject a false null hypothesis, which also increases the power of the test.

AP® STATISTICS
2017 SCORING GUIDELINES

Question 2 (continued)

Scoring

Parts (a), (b) and (c) are scored as essentially correct (E), partially correct (P), or incorrect (I).

Part (a) is scored as follows:

Essentially correct (E) if the response includes a method that:
(1) Uses a random process;
(2) Guarantees equal probability of assignment;
(3) Results in 20 volunteers per group;
(4) Specifies which game is assigned to each group/volunteer.

Partially correct (P) if the response includes two or three of the components required for E.

Note: A response that simply states "Randomly Assign" is not providing a method, so it is scored I.

Incorrect if the response does not meet the criteria for E or P.

Part (b) is scored as follows:

Essentially correct (E) if the response:
(1) Identifies the correct test;
(2) Defines appropriate parameter(s) in context for the stated test;
(3) Specifies the correct null and alternative hypotheses consistent with the stated test.

Partially correct (P) if the response includes two of the three components required for E.

Incorrect if the response does not meet the criteria for E or P.

Note: If the response describes a block design in part (a), with blocks of 3 people of similar skill, then the appropriate test in part (b) is a paired *t*-test.

Part (c) is scored as follows:

Essentially correct (E) if the response:
- Identifies increasing the sample size or increasing alpha;
- Provides a reasonable statistical explanation that illustrates how their choice relates to power.

Partially correct (P) if the response includes the first component required for E
OR
Displays an understanding of the concept of power.

Incorrect if the response does not meet the criteria for E or P.

AP® STATISTICS
2017 SCORING GUIDELINES

Question 2 (continued)

4 Complete Response

Three parts essentially correct

3 Substantial Response

Two parts essentially correct and one part partially correct

2 Developing Response

Two parts essentially correct and no parts partially correct

OR

One part essentially correct and one or two parts partially correct

OR

Three parts partially correct

1 Minimal Response

One part essentially correct

OR

No parts essentially correct and two parts partially correct

AP® STATISTICS
2017 SCORING GUIDELINES

Question 3

Intent of Question

The primary goals of this question are to assess a student's ability to (1) list possible outcomes of a random event; (2) calculate probabilities for compound events; (3) calculate a conditional probability given the individual and joint probabilities; and (4) construct a probability distribution and use it to find an expected value.

Solution

Part (a):

The possible outcomes are listed below, organized by who wins the match. Within each match winner category, who wins each set is shown.

i) Player V wins: V V V M V M V V

ii) Player M wins: M M M V M V M M

Part (b):

The ways in which Player V can win a match against Player M and the corresponding probabilities are shown below. Adding the probabilities for the various ways Player V wins the match yields the overall probability of 0.4575.

Outcome	Probability
V V	$(0.5)(0.6) = 0.3$
V M V	$(0.5)(1 - 0.6)(0.45) = 0.09$
M V V	$(0.5)(1 - 0.7)(0.45) = 0.0675$

Total: $0.3 + 0.09 + 0.0675 = 0.4575$

Part (c):

$$P(\text{3 sets} \mid \text{V wins}) = \frac{P(\text{3 sets and V wins})}{P(\text{V wins})} = \frac{(0.09 + 0.0675)}{0.4575} = \frac{0.1575}{0.4575} \approx 0.344$$

Part (d):

The number of sets played must be either two or three. The probability of exactly two sets is

$$P(\text{VV}) + P(\text{MM}) = (0.5)(0.6) + (0.5)(0.7) = 0.3 + 0.35 = 0.65.$$

Therefore, the probability of three sets is $1 - 0.65 = 0.035$.

The expected value is $(2)(0.65) + (3)(0.35) = 1.3 + 1.05 = 2.35$ sets.

Question 3 (continued)

Scoring

The response is scored in three sections. Section 1 consists of part (a), section 2 consists of parts (b) and (c) and section 3 consists of part (d). Each section is scored as essentially correct (E), partially correct (P), or incorrect (I).

Section 1 is scored as follows:

Essentially correct (E) if the response includes the three outcomes that result in a Match win for each player (parts a) i and a) ii), including the fact that the outcomes in which the same player wins the first two sets do not have a third set played. The outcomes can be displayed in a list, in a table, in a tree diagram, or in another reasonable format.

Partially correct (P) if the response includes the correct 3-set outcomes in parts a) i and a) ii, but expresses the 2-set outcomes as 3-set outcomes. For instance, the response might list the outcomes under Player V as VVV, VVM, VMV and MVV;
OR
if the response includes all correct outcomes in parts a) i and a) ii, but includes extras, such as VVV and/or VVM.

Incorrect (I) if the response does not meet the criteria for E or P.

Section 2 is scored as follows:

Essentially correct (E) if the response provides:
(1) the correct answer in part (b);
(2) links calculation to outcomes in (a);
(3) the correct answer in part (c);
(4) sufficient work shown to understand how the conditional probability in part (c) was calculated.

Partially correct (P) if the response provides two or three of the components for E.

***Note*:** If component (1) is incorrect, a response can still receive credit for components (3) and (4) if both are consistent with component (1).

Incorrect if the response does not meet the criteria for E or P.

Question 3 (continued)

Section 3 is scored as follows:

Essentially correct (E) if the response:
(1) Correctly determines the probability distribution for the number of sets played or provides a probability distribution for the number of sets played consistent with part (b);
(2) Correctly computes the expected value of the probability distribution in component (1).

Partially correct (P) if the response provides one of the components for E.

Incorrect (I) if the response does not meet the criteria for E or P.

Note: An expected value that is rounded to an integer cannot receive E.

4 Complete Response

Three sections essentially correct

3 Substantial Response

Two sections essentially correct and one section partially correct

2 Developing Response

Two sections essentially correct and no sections partially correct

OR

One section essentially correct and one section or two sections partially correct

OR

Three sections partially correct

1 Minimal Response

One section essentially correct

OR

No sections essentially correct and two sections partially correct

AP® STATISTICS
2017 SCORING GUIDELINES

Question 4

Intent of Question

The primary goals of this question were to assess a student's ability to (1) identify and compute an appropriate confidence interval after checking the necessary conditions, (2) interpret the confidence interval in context, and (3) use data to determine an appropriate estimate to answer a non-standard question.

Solution

Part (a):

Step 1: Identify the appropriate confidence interval (by name or formula) and check appropriate conditions.

The appropriate procedure is a paired *t*-interval for a population mean difference.

Conditions: 1. The sample is randomly selected from the population.
2. The population has a normal distribution, or the sample size is large.

Condition 1 is met because a random sample of students was used.
For condition 2, the sample size of 10 is not large, so we need to examine the sample data to assess whether there are any major outliers or skewness. The appropriate data to examine are the differences in ages (grandmother – grandfather). A stem and leaf plot is shown below. It does not exhibit substantial skewness or major outliers, so we will conclude that the second condition is not violated.

```
-1  0
-0  855
-0  43
 0  144
 0  8
```

Step 2: Correct mechanics

A 95% confidence interval for the population mean difference is given by $\bar{d} \pm t^* \left(\frac{s}{\sqrt{n}} \right)$. The critical value for 95% confidence, based on 10 – 1 = 9 degrees of freedom, is $t^* = 2.262$. The 95% confidence interval for the population mean difference in ages is

$$-1.8 \pm 2.262 \left(\frac{5.81}{\sqrt{10}} \right)$$
$$-1.8 \pm 4.16$$
$$-5.96 \text{ to } 2.36 \text{ years.}$$

Step 3: Interpretation

We can be 95% confident that for the population of high school students the mean difference in the ages of their maternal grandparents (grandmother's age – grandfather's age) is between –5.96 and 2.36 years.

Question 4 (continued)

Part (b):

The difference in age without taking into account which grandparent is older is the absolute value of the differences reported in the table. Therefore, the point estimate for the mean difference is

$$\frac{(1 + 5 + 10 + 8 + 5 + 8 + 3 + 4 + 4 + 4)}{10} = \frac{52}{10} = 5.2 \text{ years.}$$

Scoring

The question is scored in four sections. Section 1 consists of part (a) step 1; section 2 consists of part (a) step 2; section 3 consists of part (a) step 3, and section 4 consists of part (b). Each section is scored as essentially correct (E), partially correct (P), or incorrect (I).

Section 1 is scored as follows:

Essentially correct (E) if the response
1. identifies a paired *t*-interval for a population difference (either by name or by formula),
2. mentions the random sample condition, and
3. mentions and checks the normality condition with a visual display.

Notes:
- The random sample condition does not need to be explicitly checked because it is noted in the stem.
- A boxplot is acceptable for checking the normality condition, as long as a reasonable statement is made about the result.
- It is acceptable to name the procedure as a one-sample *t*-interval without calling it a paired *t*-interval as long as the response treats the differences as a single sample.

Partially correct (P) if the response includes component (1) and one of components (2) or (3), but not both *OR* names a two-sample *t*-interval, mentions the random sample condition, and checks the normality condition appropriate for that procedure by checking each set of ages separately.

Incorrect (I) if the response does not meet the criteria for E or P.

Section 2 is scored as follows:

Essentially correct (E) if the response gives the correct confidence interval. Supporting work is not required, but if included, it must be correct.

Partially correct (P) if the response gives an incorrect but reasonable confidence interval with appropriate supporting work shown, for instance by using the wrong degrees of freedom for the *t* multiplier;
OR
if the response gives a correct confidence interval with incorrect (but appropriate) supporting work shown.

Incorrect if the response does not meet the criteria for E or P.

Note: If the response in section 1 names a two-sample *t*-interval, then section 2 is scored E if a correct two-sample interval is computed from the data in section 2.

Question 4 (continued)

Section 3 is scored as follows:

Essentially correct (E) if the response gives a reasonable interpretation of the interval that includes three components:

1. Estimating a population mean difference;
2. 95% confidence; and
3. context (grandparents' ages).

Partially correct (P) if the response gives a reasonable interpretation of the interval that includes component (1) and one of the other two components;

OR

if the response gives a correct interpretation of the confidence level in context, which includes component (1), but does not attempt to interpret the confidence interval.

Incorrect (I) if the response does not meet the criteria for E or P.

Note: If a two-sample *t*-interval is computed in section 2 then section 3 can be scored as E if the interpretation is consistent with the two-sample interval.

Section 4 is scored as follows:

Essentially correct (E) if the response provides a correct numerical answer with supporting work.

Partially correct (P) if the response correctly identifies the mean of the absolute values of the differences as the appropriate point estimate, but does not carry out a correct calculation;

OR

if the response provides correct supporting work, but does not provide a correct numerical answer;

OR

if the response provides a correct numerical answer with no supporting work.

Incorrect (I) if the response does not meet the criteria for E or P.

AP® STATISTICS
2017 SCORING GUIDELINES

Question 4 (continued)

Each essentially correct (E) section counts as 1 point, and a partially correct (P) section counts as ½ point.

4 **Complete Response**

3 **Substantial Response**

2 **Developing Response**

1 **Minimal Response**

If a response is between two scores (for example, 2½ points), use a holistic approach to decide whether to score up or down, depending on the strength of the response and communication.

AP® STATISTICS
2017 SCORING GUIDELINES

Question 5

Intent of Question

The primary goals of this question are to assess a student's ability to (1) describe a method of obtaining a simple random sample from a population; (2) distinguish between a conditional percent and an unconditional percent; and (3) use the results of a random sample to estimate the number of individuals in a population that share a particular characteristic.

Solution

Part (a):

Number the customers from 1 to 30,000 and then use a calculator or computer to generate 1,000 random numbers between 1 and 30,000 without replacement. If a random number generator is used that generates non-unique numbers, the repeated numbers are ignored until 1,000 unique numbers are obtained. The customers whose numbers correspond to the randomly generated numbers are then selected for the sample.

Part (b):

32.5% should not be used to estimate the proportion of the entire population with power door lock problems because it represents the percent of cars that had door lock problems *given* that the car had some sort of problem. But only $\frac{40}{1000}$ or 4% of the cars in the sample had any sort of problem.

Part (c):

There were 13 customers out of 1,000 in the sample who had a problem with the power door locks, representing 1.3% of the sample. Therefore, a point estimate for the number of cars out of the 30,000 sold that experienced door lock problems is 1.3% of 30,000, which is 390.

AP® STATISTICS
2017 SCORING GUIDELINES

Question 5 (continued)

Scoring

Parts (a) and (b) and (c) are each scored as essentially correct (E), partially correct (P), or incorrect (I).

Part (a) is scored as follows:

Essentially correct (E) if the response describes a sampling plan that:
(1) Uses a random process;
(2) Results in a sample size of 1,000;
(3) Guarantees that every possible sample is equally likely;
(4) Specifies the sample consists of customers.

Partially correct (P) if the response includes two or three of the components required for E.

Note: A response that simply states "Randomly Select" is not providing a plan, so it is scored I.

Incorrect if the response does not meet the criteria for E or P.

Part (b) is scored as follows:

Essentially correct (E) if the response states:
(1) 32.5% should not be used because it is a conditional percent;
(2) That the percent is conditioned on the subset of the sample that had experienced a problem.

Note: If a response that is otherwise E implies that the proportion that should be used as the estimate is based on something other than 13 out of 1,000, then the score is reduced to P.

Partially correct (P) if the response only states 32.5% should not be used because it is a conditional percent;
OR
States only that 32.5% is not the percent of the entire sample that had power door lock problems.

Incorrect if the response does not meet the criteria for E or P.

Part (c) is scored as follows:

Essentially correct (E) if the response:
(1) states that the point estimate is 390 cars;
(2) provides sufficient details to justify how that number was calculated.

Partially correct (P) if the response states that the point estimate is 390 cars;
OR
Calculates the percent of cars with power door lock problems as 1.3%, or a proportion of 0.013, but does not provide the point estimate for the *number* of cars with the problem.

Incorrect (I) if the response does not meet the criteria for E or P.

AP® STATISTICS
2017 SCORING GUIDELINES

Question 5 (continued)

4 Complete Response

Three parts essentially correct

3 Substantial Response

Two parts essentially correct and one part partially correct

2 Developing Response

Two parts essentially correct and no parts partially correct

OR

One part essentially correct and one or two parts partially correct

OR

Three parts partially correct

1 Minimal Response

One part essentially correct

OR

No parts essentially correct and two parts partially correct

AP® STATISTICS
2017 SCORING GUIDELINES

Question 6

Intent of Question

The primary goals of this question are to assess a student's ability to (1) determine whether a value is an outlier using the definition that an outlier falls more than 1.5 IQRs above the upper quartile; (2) find the mean and standard deviation of a difference of two random variables; (3) use data to estimate the mean and standard deviation of a difference of two random variables; (4) calculate a test statistic for a non-standard situation; and (5) use a p-value to make a conclusion in a non-standard situation.

Solution

Part (a):

An outlier at the upper end is defined as a value greater than Q3 + (1.5) × (Q3 – Q1). For Emily's data, an outlier at the upper end is a value greater than 3.8 + (1.5) × (3.8 – 2.6) = 3.8 + 1.8 = 5.6. Because 7.5 is greater than 5.6, 7.5 is identified as an outlier.

Part (b):

(i) $E(Y-\bar{X}) = E(Y) - E(\bar{X}) = \mu_Y - \mu_X$.

(ii) $Var(Y - \bar{X}) = Var(Y) + Var(\bar{X}) = \sigma^2 + \frac{\sigma^2}{n-1} = \sigma^2\left(1 + \frac{1}{n-1}\right)$, so that the standard deviation is

$SD(Y - \bar{X}) = \sqrt{\sigma^2\left(1 + \frac{1}{n-1}\right)}$.

Part (c):

(i) Estimate $E(Y-\bar{X}) = \mu_Y - \mu_X$ by $y - \bar{x} = 7.5 - 3.171 = 4.329$.

(ii) To estimate $SD(Y - \bar{X})$, first estimate $Var(Y - \bar{X}) = \sigma^2\left(1 + \frac{1}{n-1}\right)$ by

$s^2_{Y-\bar{X}} = s^2\left(1 + \frac{1}{n-1}\right) = (0.821)^2\left(1 + \frac{1}{24}\right) \approx 0.7021$. Then the estimate of the standard deviation is

$s_{Y-\bar{X}} = \sqrt{0.7021} \approx 0.838$.

Part (d):

The appropriate test statistic has the point estimate of $\mu_Y - \mu_X$ in the numerator, and the point estimate of $SD(Y - \bar{X}) = \sqrt{\sigma^2\left(1 + \frac{1}{n-1}\right)}$ in the denominator. The test statistic is

$\frac{4.329}{\sqrt{0.7021}} = \frac{4.329}{0.838} = 5.17$.

Part (e):

Because the *p*-value is so small, there is convincing statistical evidence that $\mu_Y \neq \mu_X$. Therefore, the value of 7.5 appears to come from a population with a different mean than the mean of the population from which the remaining 24 observations came. There is very strong evidence that the value of 7.5 is an outlier using the new method for determining outliers.

AP® STATISTICS
2017 SCORING GUIDELINES

Question 6 (continued)

Scoring

This question is scored in four sections. Section 1 consists of part (a), section 2 consists of parts (b) and (c), section 3 consists of part (d) and section 4 consists of part (e). Each section is scored as essentially correct (E), partially correct (P), or incorrect (I).

Section 1 is scored as follows:

Essentially correct (E) if the response includes:
1. work supporting the calculation of the correct upper endpoint using the given method;
2. a comparison of 7.5 to the calculated upper endpoint; and
3. a consistent conclusion regarding whether or not 7.5 is an outlier.

Partially correct (P) if the response includes two of the three components required for E.

Incorrect (I) if the response does not meet the criteria for E or P.

Section 2 is scored as follows:

Essentially correct (E) if the response includes the following four components:
1. The correct formula for the mean in part (b);
2. The correct formula for the standard deviation in part (b);
3. The point estimate for the mean in part (c) is correct, or consistent with the formula in part (b); and
4. The point estimate for the standard deviation in part (c) is correct, or consistent with the formula in part (b).

Partially correct (P) if the response includes two or three of the four components required for E.

Incorrect if the response does not meet the criteria for E or P.

Section 3 is scored as follows:

Essentially correct (E) if the response uses the results from part (c) correctly to calculate a test statistic and provides appropriate supporting work.

Partially correct (P) if the response provides a value of the test statistic that is consistent with part (c), but without appropriate supporting work shown;
OR
if the response gives a consistent numerator for the test statistic, and the denominator makes use of the point estimate of the standard deviation from part (c), but with a mistake (e.g., dividing the denominator by $\sqrt{24}$ or $\sqrt{25}$).

Incorrect if the response does not meet the criteria for E or P.

Note: In sections 1, 2, and 3, minor arithmetic or transcription errors should be ignored.

Question 6 (continued)

Section 4 is scored as follows:

Essentially correct (E) if the response: (1) provides the correct conclusion about the population means by stating that there is convincing evidence that they differ; (2) links the conclusion to the *p*-value provided; and (3) concludes that there is strong evidence that 7.5 is an outlier.

Notes:

- If an incorrect value is computed for the test statistic in part (d) the response must still base the conclusion about population means on the *p*-value provided in part (e), and not on the test statistic computed in part (d).
- The response must base the conclusion on whether or not 7.5 is an outlier on the information in part (e), not on the result from part (a).

Partially correct (P) if the response:
provides the correct conclusion about the population means by stating there is convincing evidence that they differ, justified by correct linkage to the *p*-value, but does not make a conclusion about 7.5 being an outlier;
OR
provides a statement as to whether or not 7.5 is an outlier consistent with a conclusion about the population means, but does not link the conclusion concerning the population means to the *p*-value provided.

Incorrect (I) if the response does not meet the criteria for E or P.

Each essentially correct (E) section counts as 1 point, and a partially correct (P) section counts as ½ point.

4 Complete Response

3 Substantial Response

2 Developing Response

1 Minimal Response

If a response is between two scores (for example, 2½ points), use a holistic approach to decide whether to score up or down, depending on the strength of the response and communication.

Scoring Worksheet

The following provides a scoring worksheet and conversion table used for calculating a composite score of the exam.

2017 AP Statistics Scoring Worksheet

Section I: Multiple Choice

_____	× 1.2500 =	_____
Number Correct (out of 40)		Weighted Section I Score (Do not round)

Section II: Free Response

Question 1	_____ (out of 4)	× 1.8750 =	_____ (Do not round)
Question 2	_____ (out of 4)	× 1.8750 =	_____ (Do not round)
Question 3	_____ (out of 4)	× 1.8750 =	_____ (Do not round)
Question 4	_____ (out of 4)	× 1.8750 =	_____ (Do not round)
Question 5	_____ (out of 4)	× 1.8750 =	_____ (Do not round)
Question 6	_____ (out of 4)	× 3.1250 =	_____ (Do not round)

Sum = _____
Weighted Section II Score (Do not round)

Composite Score

_____	+ _____	= _____
Weighted Section I Score	Weighted Section II Score	Composite Score (Round to nearest whole number)

AP Score Conversion Chart
Statistics

Composite Score Range	AP Score
68-100	5
56-67	4
44-55	3
32-43	2
0-31	1

Question Descriptors and Performance Data

The following contains tables showing the content assessed,
the correct answer, and how AP students performed on each question.

2017 AP Statistics

Question Descriptors and Performance Data

Multiple-Choice Questions

Question	Topic	Key	% Correct
1	Exploring Data	C	85
2	Exploring Data	E	92
3	Probability and Simulation	D	35
4	Statistical Inference	D	38
5	Statistical Inference	C	30
6	Exploring Data	E	72
7	Probability and Simulation	C	57
8	Exploring Data	B	47
9	Probability and Simulation	D	80
10	Sampling and Experimentation	D	71
11	Statistical Inference	E	35
12	Sampling and Experimentation	B	49
13	Exploring Data	D	76
14	Probability and Simulation	D	52
15	Exploring Data	E	73
16	Exploring Data	C	69
17	Statistical Inference	D	53
18	Exploring Data	B	82
19	Probability and Simulation	C	85
20	Statistical Inference	C	77
21	Probability and Simulation	C	30
22	Statistical Inference	D	48
23	Statistical Inference	E	34
24	Sampling and Experimentation	A	71
25	Probability and Simulation	D	65
26	Statistical Inference	C	27
27	Statistical Inference	C	52
28	Statistical Inference	B	31
29	Exploring Data	B	76
30	Probability and Simulation	D	16
31	Exploring Data	D	53
32	Probability and Simulation	C	44
33	Statistical Inference	C	34
34	Probability and Simulation	B	35
35	Sampling and Experimentation	D	84
36	Statistical Inference	A	46
37	Sampling and Experimentation	C	76
38	Statistical Inference	D	37
39	Statistical Inference	B	35
40	Statistical Inference	D	50

AP Statistics

The College Board

The College Board is a mission-driven not-for-profit organization that connects students to college success and opportunity. Founded in 1900, the College Board was created to expand access to higher education. Today, the membership association is made up of over 6,000 of the world's leading educational institutions and is dedicated to promoting excellence and equity in education. Each year, the College Board helps more than seven million students prepare for a successful transition to college through programs and services in college readiness and college success — including the SAT® and the Advanced Placement Program®. The organization also serves the education community through research and advocacy on behalf of students, educators, and schools. The College Board is committed to the principles of excellence and equity, and that commitment is embodied in all of its programs, services, activities, and concerns.