AP Statistics Practice Exam

From the 2013 Administration

This Practice Exam is provided by the College Board for AP Exam preparation. Teachers are permitted to download the materials and make copies to use with their students in a classroom setting only. To maintain the security of this exam, teachers should collect all materials after their administration and keep them in a secure location.

Exams may **not** be posted on school or personal websites, nor electronically redistributed for any reason. Further distribution of these materials outside of the secure College Board site disadvantages teachers who rely on uncirculated questions for classroom testing. Any additional distribution is in violation of the College Board's copyright policies and may result in the termination of Practice Exam access for your school as well as the removal of access to other online services such as the AP Teacher Community and Online Score Reports.

Contents

Exam Instructions

Student Answer Sheet for the Multiple-Choice Section

Section I: Multiple-Choice Questions

Section II: Free-Response Questions

Multiple-Choice Answer Key

Free-Response Scoring Guidelines

Scoring Worksheet

<u>Note:</u> This publication shows the page numbers that appeared in the *2012–13 AP Exam Instructions* book and in the actual exam. This publication was not repaginated to begin with page 1.

© 2013 The College Board. College Board, Advanced Placement Program, AP, SAT and the acorn logo are registered trademarks of the College Board. All other products and services may be trademarks of their respective owners. Permission to use copyrighted College Board materials may be requested online at: www.collegeboard.com/inquiry/cbpermit.html.

Exam Instructions

The following contains instructions taken from the ***2012–13 AP Exam Instructions*** book.

AP® Statistics Exam

Regularly Scheduled Exam Date: Friday afternoon, May 10, 2013

Late-Testing Exam Date: Wednesday morning, May 22, 2013

Section I: 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

Section II: 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%

Section I: Multiple Choice Booklet 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.

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.

Section II: Free Response Booklet 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.

What Proctors Need to Bring to This Exam

- Exam packets
- Answer sheets
- AP Student Packs
- *2012-13 AP Coordinator's Manual*
- This book — *AP Exam Instructions*
- School Code and Home-School/Self-Study Codes
- Extra graphing calculators
- Pencil sharpener
- 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"

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 42 of the *2012-13 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 39–42 of the *2012-13 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 40 of the *2012-13 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.

If you are giving the regularly scheduled exam, say:

It is Friday afternoon, May 10, and you will be taking the AP Statistics Exam.

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

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

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 *2012-13 Bulletin for AP Students and Parents*. 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 dark blue box near the top right-hand 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 will 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 and read it completely. Look up when you have finished. . . .

Are there any questions? . . .

Section I is the multiple-choice portion of the exam. You may never discuss these specific multiple-choice questions at any time in any form with anyone, including your teacher and other students. If you disclose these questions through any means, your AP Exam score will be canceled. Are there any questions? . . .

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 30 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. I will now collect your answer sheet.**

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

> **Now you must seal your exam booklet. 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. Everything you placed under your chair at the beginning of the exam must stay there. Leave your shrinkwrapped Section II packet on your desk during the break. You are not allowed to consult teachers, other students, or textbooks about the exam 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 are not allowed to discuss the multiple-choice section of this exam. If you do not follow these rules, your score could 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 place an AP number label on the shaded box. If you don't have any AP number labels, write your AP number in the box. Look up when you have finished. . . .**
>
> **Read the last statement. . . .**

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

Turn to the back cover and 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. . . .

While Student Packs are being collected, 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 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 piece of paper you use, be sure to write only your AP number and the number of the question you are working on. Do not write your name. Are there any questions? . . .

You may begin Part A.

Note Start Time here _____. Note Stop Time here _____. Check that students are writing their answers in their exam booklets. 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 the free-response section, have those students staple the extra sheet/s to the first page corresponding to that question in their exam booklets. 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 these specific free-response questions with anyone unless they are released on the College Board website in about two days. Your AP score results will be delivered online in July.

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

None of the questions in this exam may ever be discussed or shared in any way at any time. Your AP score results will be delivered 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.

All exam materials should be put 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 *2012-13 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 2013

AP Number Label
(from Student Pack)

B123456789T

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 questions. I will seal the multiple-choice booklet when asked to do so, and I will not discuss these questions 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 *2012-13 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®

Yes No

H. AP EXAM I AM TAKING USING THIS ANSWER SHEET

Exam Name: Form: Form Code:

768252

SCHOOL USE ONLY

Section Number: 1 2 3 4 5 6 7 8 9

Fee Reduction Granted: 1 Option 1 2 Option 2

94117-00657 • TF213E4735 • UNLWEB213

Q3468/1-4

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, 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). Use a No. 2 pencil only. Mark only one response per question. If a question has only four answer options, do not mark option E. Answers written in the multiple-choice booklet will not be scored.

Your answer sheet will be scored by machine. Any improper gridding may affect your score.

- **Completely fill in the circle for your response next to the number of the question you are answering.**
- **Erase carefully and completely. Stray marks and smudges could be read as answers.**

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)

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

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

ETS USE ONLY

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

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

© 2012 The College Board. College Board, AP, Student Search Service and the acorn logo are registered trademarks of the College Board.

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. ETHNICITY/RACE

- American Indian or Alaska Native
- Asian, Asian American or Pacific Islander
- Black or African American
- Mexican or Mexican American
- Puerto Rican
- Other Hispanic, Latino or Latin American
- White
- Other

Y. PARENTAL EDUCATION LEVEL

Father/ Male Guardian	Mother/ Female Guardian	
		Grade school
		Some high school
		High school diploma or equivalent
		Business or trade school
		Some college
		Associate or two-year degree
		Bachelor's or four-year degree
		Some graduate or professional school
		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 in accordance with the policies in the *2012-13 Bulletin for AP Students and Parents*.

Section I: Multiple-Choice Questions

This is the multiple-choice section of the 2013 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.)

PLACE SEAL HERE

AP® Statistics Exam

SECTION I: Multiple Choice

2013

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.

PLACE SEAL HERE

Form I
Form Code 4JBP4-S
90

PLACE SEAL HERE
DO NOT seal answer sheet inside

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

Formulas

(I) Descriptive Statistics

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

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

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

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

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

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

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

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

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

(II) Probability

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

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

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

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

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) • (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 $p_1 = p_2$ $\sqrt{p(1-p)}\sqrt{\dfrac{1}{n_1} + \dfrac{1}{n_2}}$

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

STATISTICS
SECTION I
Time—1 hour and 30 minutes
Number of questions—40
Percent of total score—50

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

1. Height, in meters, is measured for each person in a sample. After the data are collected, all the height measurements are converted from meters to centimeters by multiplying each measurement by 100. Which of the following statistics will remain the same for both units of measure?

   (A) The mean of the height measurements

   (B) The median of the height measurements

   (C) The standard deviation of the height measurements

   (D) The maximum of the height measurements

   (E) The z-scores of the height measurements

Unauthorized copying or reuse of any part of this page is illegal.

GO ON TO THE NEXT PAGE.

2. A school principal wanted to investigate student opinion about the food served in the school cafeteria. The principal selected at random samples of 50 first-year students, 50 second-year students, 50 third-year students, and 50 fourth-year students to complete a questionnaire. Which of the following best describes the principal's sampling plan?

(A) A stratified random sample
(B) A simple random sample
(C) A cluster sample
(D) A convenience sample
(E) A systematic sample

---

3. A candy company produces individually wrapped candies. The quality control manager for the company believes that the weight of the candies is approximately normally distributed with mean 720 milligrams (mg). If the manager's belief is correct, which of the following intervals of weights will contain the largest proportion of the candies in the distribution of weights?

(A) 740 mg to 780 mg

(B) 700 mg to 740 mg

(C) 680 mg to 720 mg

(D) 660 mg to 700 mg

(E) 620 mg to 660 mg

Unauthorized copying or reuse of any part of this page is illegal.

4. A company currently uses Brand A lightbulbs, which have a mean life of 1,000 hours. A salesperson marketing Brand B, a new brand of bulb, contacts the company. The company will switch to the new brand of bulb only if there is convincing evidence that the mean life of Brand B is greater than 1,000 hours. Which of the following hypotheses should the company test?

(A) H_0 : The mean life of Brand B bulbs is 1,000 hours.
H_a : The mean life of Brand B bulbs is more than 1,000 hours.

(B) H_0 : The mean life of Brand B bulbs is 1,000 hours.
H_a : The mean life of Brand B bulbs is less than 1,000 hours.

(C) H_0 : The mean life of Brand A bulbs is 1,000 hours.
H_a : The mean life of Brand A bulbs is more than 1,000 hours.

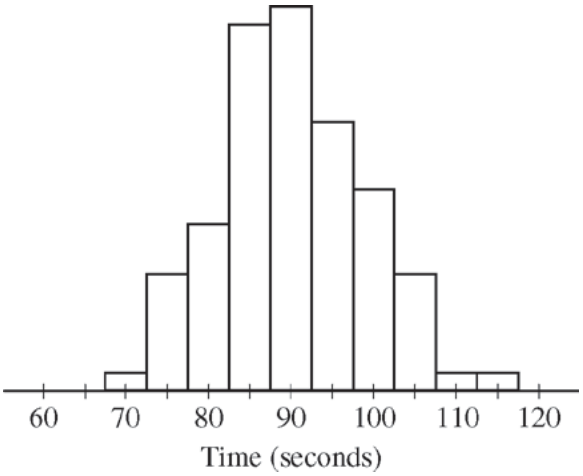
(D) H_0 : The mean life of Brand A bulbs is 1,000 hours.
H_a : The mean life of Brand A bulbs is less than 1,000 hours.

(E) H_0 : The mean life of Brand A bulbs is equal to the mean life of Brand B bulbs.
H_a : The mean life of Brand A bulbs is not equal to the mean life of Brand B bulbs.

Unauthorized copying or reuse of any part of this page is illegal.

GO ON TO THE NEXT PAGE.

5. The amount of time required for each of 100 mice to navigate through a maze was recorded. The histogram below shows the distribution of times, in seconds, for the 100 mice.



Which of the following values is closest to the standard deviation of the 100 times?

(A) 2.5 seconds

(B) 10 seconds

(C) 20 seconds

(D) 50 seconds

(E) 90 seconds

Unauthorized copying or reuse of any part of this page is illegal.

6. A graph (not shown) of the selling prices of homes in a certain city for the month of April reveals that the distribution is skewed to the left. Which of the following statements is the most reasonable conclusion about the selling prices based on the graph?

(A) The mean is greater than the median.

(B) The median is the average of the first quartile and the third quartile.

(C) There are fewer selling prices between the first quartile and the median than there are between the median and the third quartile.

(D) There are more selling prices that are less than the mean than selling prices that are greater than the mean.

(E) The value of maximum minus third quartile is less than the value of first quartile minus minimum.

---

7. A survey was conducted in which both men and women were asked a question about a current issue. Possible responses to this question were "in favor of," "not in favor of," or "no opinion." A chi-square test is to be used to determine whether the response to this question is independent of gender. The number of degrees of freedom for the chi-square test in this situation is

(A) 6

(B) 5

(C) 3

(D) 2

(E) 1

Unauthorized copying or reuse of any part of this page is illegal.

GO ON TO THE NEXT PAGE.

8. If a probability distribution is symmetric, which of the following statements must be true?

(A) The distribution is normal.

(B) The distribution is uniform.

(C) The distribution is bimodal.

(D) The mean of the distribution is equal to the median of the distribution.

(E) The interquartile range of the distribution is equal to the standard deviation of the distribution.

---

9. Let X represent the number on the face that lands up when a fair six-sided number cube is tossed. The expected value of X is 3.5, and the standard deviation of X is approximately 1.708. Two fair six-sided number cubes will be tossed, and the numbers appearing on the faces that land up will be added. Which of the following values is closest to the standard deviation of the resulting sum?

(A) 1.708

(B) 1.848

(C) 2.415

(D) 3.416

(E) 5.835

Unauthorized copying or reuse of any part of this page is illegal.

GO ON TO THE NEXT PAGE.

10. Based on previous research, the standard deviation of the distribution of the age at which children begin to walk is estimated to be 1.5 months. A random sample of children will be selected, and the age at which each child begins to walk will be recorded. A 99 percent confidence interval for the average age at which children begin to walk will be constructed using the data obtained from the sample of children. Of the following, which is the smallest sample size that will result in a margin of error of 0.1 month or less for the confidence interval?

(A) 400

(B) 900

(C) 1,300

(D) 1,600

(E) 2,100

Unauthorized copying or reuse of any part of this page is illegal.

11. Let X be a random variable that has a skewed distribution with mean $\mu = 10$ and standard deviation $\sigma = 10$. Based on random samples of size 400, the sampling distribution of $\bar{x}$ is

(A) highly skewed with mean 10 and standard deviation 10

(B) highly skewed with mean 10 and standard deviation 5

(C) highly skewed with mean 10 and standard deviation 0.5

(D) approximately normal with mean 10 and standard deviation 10

(E) approximately normal with mean 10 and standard deviation 0.5

Unauthorized copying or reuse of any part of this page is illegal.

12. The number of hurricanes reaching the East Coast of the United States was recorded for each of the last ten decades by the National Hurricane Center. Summary measures are shown below.

Min = 12	Max = 24
Lower quartile = 15	Upper quartile = 18
Median = 16	n = 10

Which of the following statements is true?

(A) The smallest observation is 12 and it is an outlier. No other observations in the data set could be outliers.

(B) The largest observation is 24 and it is an outlier. No other observations in the data set could be outliers.

(C) Both 12 and 24 are outliers. It is possible that there are also other outliers.

(D) 12 is an outlier and it is possible that there are other outliers at the low end of the data set. There are no outliers at the high end of the data set.

(E) 24 is an outlier and it is possible that there are other outliers at the high end of the data set. There are no outliers at the low end of the data set.

Unauthorized copying or reuse of any part of this page is illegal.

13. Makers of a new pain-relieving medication claim that it relieves chronic pain faster than the current top-selling pain reliever on the market. A double-blind experiment was conducted in which 10 people who experience chronic pain were randomly selected to take either the new or the current medication. Each of the 10 people recorded the time, in minutes, from taking the medication until pain relief. After an appropriate time period, each of the 10 people took the other medication and recorded the time from taking the medication until pain relief. The medication each person took first was randomly determined, and because both medications look the same, the people in the study did not know which medication was taken first. The table below shows summary statistics for the results.

	Minutes until Pain Relief		Difference (new minus current)
	New Medication	Current Medication	
Mean	15.600	16.025	–0.425
Standard deviation	4.811	4.833	1.395

Which of the following values is closest to the p-value of the appropriate t-test?

(A) 0.1802

(B) 0.3604

(C) 0.4230

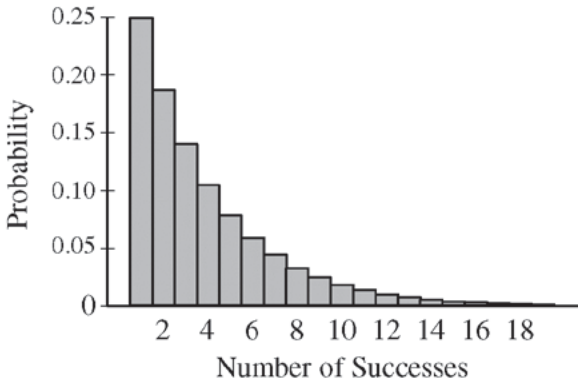
(D) 0.5770

(E) 0.8198

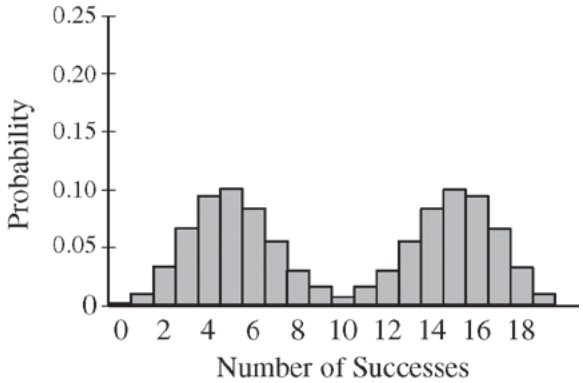
Unauthorized copying or reuse of any part of this page is illegal.

14. Which of the following graphs represents a binomial distribution with $n = 20$ and $p = 0.25$?

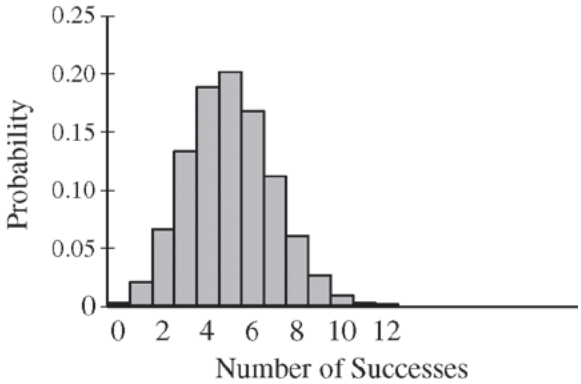
(A)



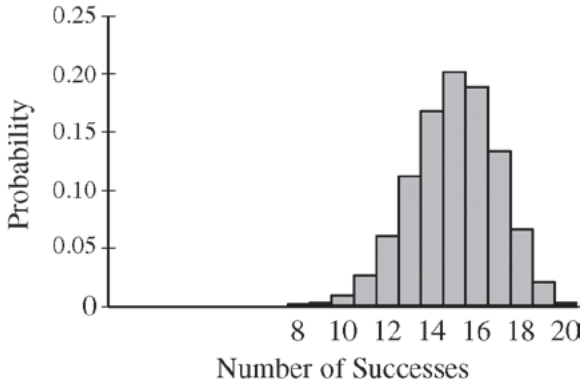
(B)



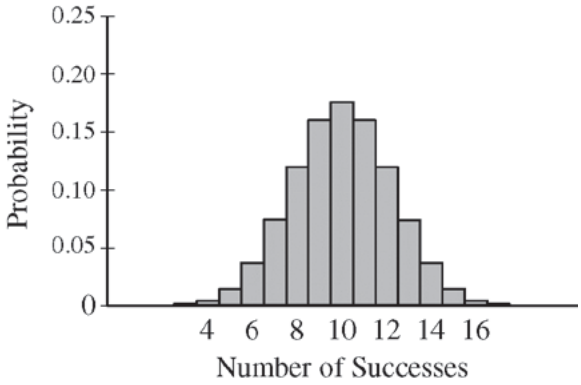
(C)



(D)



(E)



Unauthorized copying or reuse of any part of this page is illegal.

GO ON TO THE NEXT PAGE.

15. An experiment will be conducted to determine whether children learn their multiplication facts better by practicing with flash cards or by practicing on a computer. Children who volunteer for the experiment will be randomly assigned to one of the two treatments. Because the children's gender may affect the outcome, there will be blocking by gender. After practice, the children will be given a test on their multiplication facts. Why will it be impossible to conduct a double-blind experiment?

(A) The experimenter will know whether the child is a boy or a girl and whether he or she used flash cards or the computer.

(B) The child will know whether he or she is a boy or a girl.

(C) The child will know whether he or she used flash cards or the computer.

(D) The person who grades the tests will know whether the child was a boy or a girl.

(E) The person who grades the tests will know whether the child used flash cards or the computer.

Unauthorized copying or reuse of any part of this page is illegal.

16. A police officer is using a radar device to check motorists' speeds. Prior to beginning the speed check, the officer estimates that 40 percent of motorists will be driving more than 5 miles per hour over the speed limit. Assuming that the police officer's estimate is correct, what is the probability that among 4 randomly selected motorists, the officer will find at least 1 motorist driving more than 5 miles per hour over the speed limit?

(A) 0.0256

(B) 0.1296

(C) 0.3456

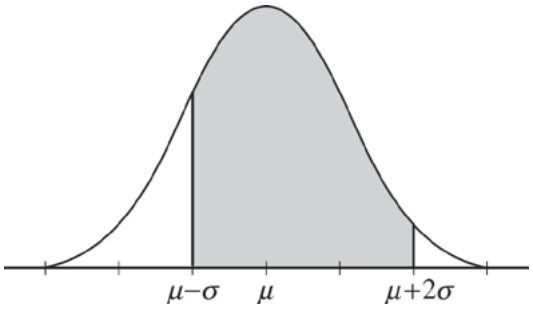
(D) 0.8704

(E) 0.9744

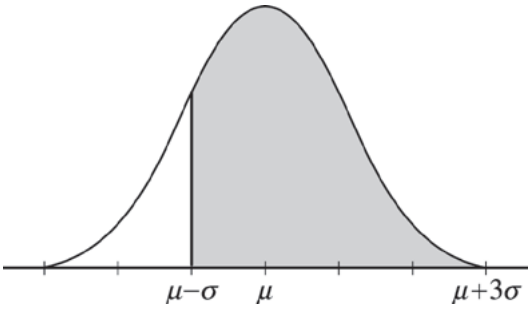
Unauthorized copying or reuse of any part of this page is illegal.

17. Zucchini weights are approximately normally distributed with mean 0.8 pound and standard deviation 0.25 pound. Which of the following shaded regions best represents the probability that a randomly selected zucchini will weigh between 0.55 pound and 1.3 pounds?

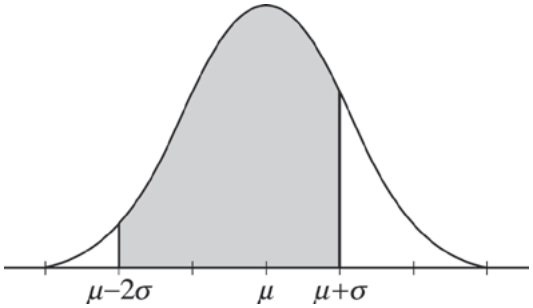
(A)



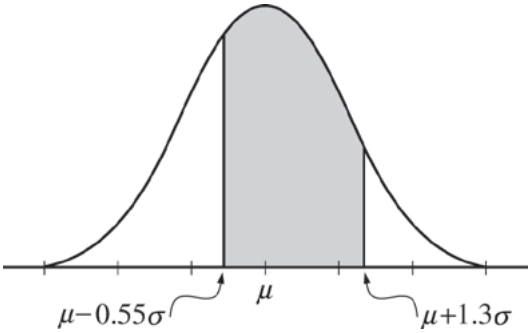
(B)



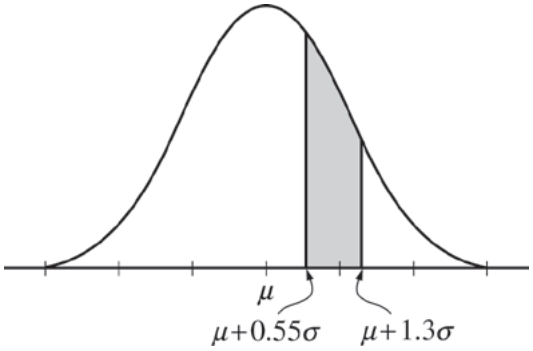
(C)



(D)



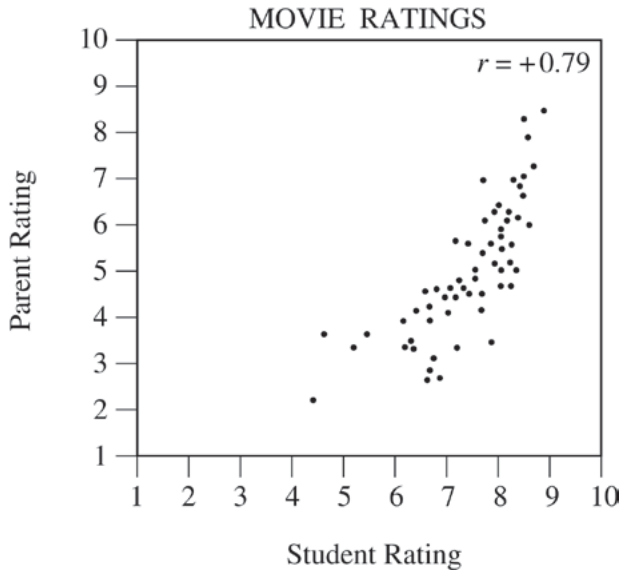
(E)



Unauthorized copying or reuse of any part of this page is illegal.

GO ON TO THE NEXT PAGE.

18. In a recent survey, high school students and their parents were asked to rate 60 recently released movies. The ratings were on a scale from 1 to 9, where 1 was "horrible" and 9 was "excellent". For each movie, the average rating by the students and the average rating by their parents was calculated and the scatterplot below was constructed. The horizontal axis represents the student rating, and the vertical axis represents the parent rating. Thus, an individual data point would represent the rating of a single movie.



Which of the following statements is justified by the scatterplot?

(A) The movies that the students liked the best also tended to be the movies that the parents liked the best, but the students tended to give lower scores.
(B) The movies that the students liked the best also tended to be the movies that the parents liked the best, but the students tended to give higher scores.
(C) The movies that the students liked the best also tended to be the movies that the parents liked the best, but each group tended to give the same scores.
(D) The movies that the students liked the best tended to be the movies that the parents liked the least, but the students tended to give lower scores.
(E) The movies that the students liked the best tended to be the movies that the parents liked the least, but the students tended to give higher scores.

Unauthorized copying or reuse of any part of this page is illegal.

19. Jessica wanted to determine if the proportion of males for a certain species of laboratory animal is less than 0.5. She was given access to appropriate records that contained information on 12,000 live births for the species. To construct a 95 percent confidence interval, she selected a simple random sample of 100 births from the records and found that 31 births were male.

Based on the study, which of the following expressions is an approximate 95 percent confidence interval estimate for p, the proportion of males in the 12,000 live births?

(A) $0.31 \pm 1.96\sqrt{\frac{(0.31)(0.69)}{12,000}}$

(B) $0.31 \pm 1.645\sqrt{\frac{(0.31)(0.69)}{12,000}}$

(C) $0.31 \pm 1.96\sqrt{\frac{(0.5)(0.5)}{12,000}}$

(D) $0.31 \pm 1.645\sqrt{\frac{(0.5)(0.5)}{100}}$

(E) $0.31 \pm 1.96\sqrt{\frac{(0.31)(0.69)}{100}}$

Unauthorized copying or reuse of any part of this page is illegal.

20. A town manager is interested in comparing requests for various town-provided services (such as street maintenance and garbage pickup) with nationally published proportions of requests for the same services. Each request in a random sample of 500 service requests from the town was classified into one of 10 different categories. Which of the following tests could be used to determine whether the proportions of service requests classified into the 10 service categories for the town differ from national proportions?

(A) A two-sample *t*-test for a difference of means

(B) A matched-pairs *t*-test for means

(C) A chi-square test of association

(D) A chi-square goodness-of-fit test

(E) A *t*-test for a correlation of proportions

Unauthorized copying or reuse of any part of this page is illegal.

21. Dan selected a random sample of 100 students from the 1,200 at his school to investigate preferences for making up school days lost due to emergency closings. The results are shown in the table below.

Preference	Number of Students
Extend the school year into the summer	58
Go to school on Saturdays in the spring	42

Dan incorrectly performed a large sample test of the difference in two proportions using $\frac{58}{100}$ and $\frac{42}{100}$ and calculated a p-value of 0.02. Consequently, he concluded that there was a significant difference in preference for the two options. Which of the following best describes his error in the analysis of these data?

(A) No statistical test was necessary because 0.58 is clearly larger than 0.42.

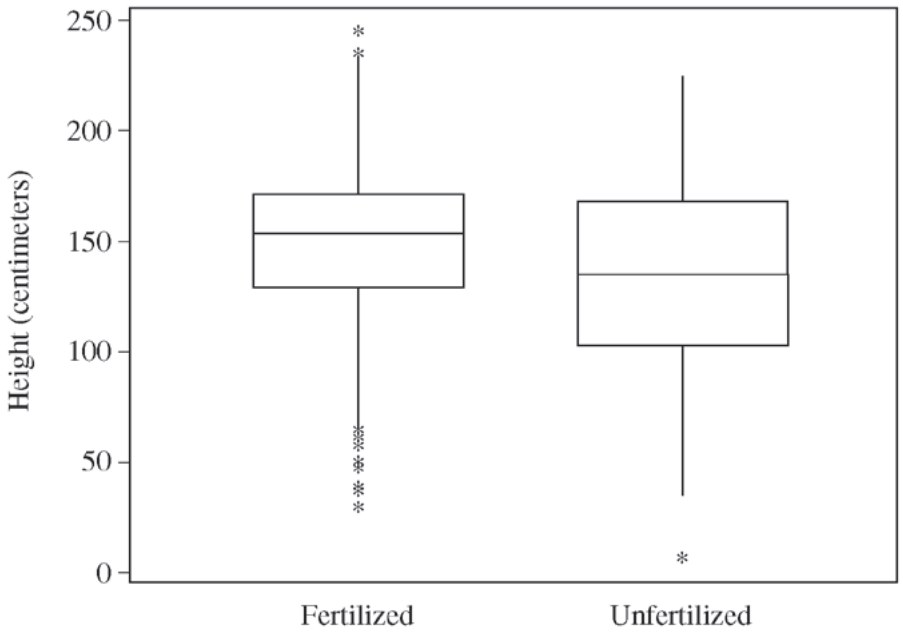
(B) The results of the test were invalid because less than 10% of the population was sampled.

(C) Dan performed a two-tailed test and should have performed a one-tailed test.

(D) A one-sample test for a proportion should have been performed because only one sample was used.

(E) More options should have been included, and a chi-square test should have been performed.

Unauthorized copying or reuse of any part of this page is illegal.



22. The figure above summarizes the heights, in centimeters, of approximately 400 pine seedlings six years after they were planted at a center for environmental study. Approximately half of the trees were fertilized yearly, and the remaining trees were never fertilized. Which of the following statements about the medians and interquartile ranges (IQRs) of the heights of the two groups of trees 6 years after being planted is true?

(A) The medians and IQRs are the same for the unfertilized trees and the fertilized trees.

(B) The median for the unfertilized trees is greater than the median for the fertilized trees, and the IQR is also greater for the unfertilized trees.

(C) The median for the unfertilized trees is the same as the median for the fertilized trees, and the IQR is greater for the unfertilized trees.

(D) The median for the unfertilized trees is less than the median for the fertilized trees, and the IQR is greater for the unfertilized trees.

(E) The median for the unfertilized trees is less than the median for the fertilized trees, and the IQR is less for the unfertilized trees.

Unauthorized copying or reuse of any part of this page is illegal.

23. In a certain school, 17 percent of the students are enrolled in a psychology course, 28 percent are enrolled in a foreign language course, and 32 percent are enrolled in either a psychology course or a foreign language course or both. What is the probability that a student chosen at random from this school will be enrolled in both a foreign language course and a psychology course?

(A) 0.45

(B) 0.32

(C) 0.20

(D) 0.13

(E) 0.05

Unauthorized copying or reuse of any part of this page is illegal.

24. Monthly rent was determined for each apartment in a random sample of 100 apartments. The sample mean was \$820 and the sample standard deviation was \$25. An approximate 95 percent confidence interval for the true mean monthly rent for the population of apartments from which this sample was selected is (\$815, \$825). Which of the following statements is a correct interpretation of the 95 percent confidence level?

(A) In this population, about 95 percent of all rental prices are between \$815 and \$825.

(B) In this sample, about 95 percent of the 100 rental prices are between \$815 and \$825.

(C) In repeated sampling, the method produces intervals that include the population mean approximately 95 percent of the time.

(D) In repeated sampling, the method produces intervals that include the sample mean approximately 95 percent of the time.

(E) There is a probability of 0.95 that the true mean is between \$815 and \$825.

---

25. Two friends, Andy and Bob, participate in a game of bowling every week. From past experiences, it is known that both friends' scores are approximately normally distributed, where Andy has a mean score of 150 with a standard deviation of 30, and Bob has a mean score of 165 with a standard deviation of 15. Assuming that their scores are independent, which of the following values is closest to the probability that Andy will have a greater score than Bob in a single game?

(A) 0.16

(B) 0.28

(C) 0.31

(D) 0.33

(E) 0.37

Unauthorized copying or reuse of any part of this page is illegal.

GO ON TO THE NEXT PAGE.

26. Scientists have long believed that linear regression could be used to predict the brain weight of nonhuman mammals from the body weight. In one study, body weight, in kilograms, and brain weight, in grams, of 22 nonhuman mammals were measured. A linear regression analysis was performed, yielding the output below.

Reg Analysis: Brain Wt vs Body Wt n = 22

Predictor	Coef	SE Coef	T	P
Constant	68.688	3.1270	21.966	0.000
Body Wt	1.096	0.1308	8.379	0.000

s = 103.995 R-sq = 77.8% R-sq (adj) = 77.6%

Assuming that all conditions for inference are met, which of the following expressions represents a 95 percent confidence interval for the slope of the least squares regression line?

(A) $1.096 \pm 2.086(0.1308)$

(B) $1.096 \pm 2.086(103.995)$

(C) $1.096 \pm 2.086\left(\frac{0.1308}{\sqrt{22}}\right)$

(D) $1.096 \pm 2.086\left(\frac{103.995}{\sqrt{22}}\right)$

(E) $68.688 \pm 2.086(3.1270)$

Unauthorized copying or reuse of any part of this page is illegal.

27. A certain motel is roughly 20 miles from the entrance to Yosemite National Park. The motel manager wants to get a better estimate of the distance and asks five people to each measure the distance, to the nearest tenth of a mile, using the odometer in his or her car. The manager will use the median of the five measurements as the estimate of the distance. Which of the following statements is NOT a statistical justification for the manager's plan?

(A) Odometer reading should be considered a variable when used to measure this distance.
(B) The median of the five measurements is more likely to be close to the actual distance than is a single measurement.
(C) The actual distance should be considered a variable, and taking five measurements allows the manager to estimate the variability in the actual distance.
(D) If one or two odometers give inaccurate readings, the estimate still should be fairly close to the actual distance.
(E) The manager can get some indication of how far off the estimate might be.

Unauthorized copying or reuse of any part of this page is illegal.

28. A marketing research consultant for a hotel chain hypothesizes that men and women differ in their color preference for guest rooms. The consultant shows pictures of rooms decorated with three different color schemes to each person in a random sample of 110 men and to each person in a random sample of 90 women. The consultant asks each person to choose his or her favorite color scheme. A chi-square test for homogeneity of proportions will be used to test the consultant's hypothesis. Assuming that the conditions for inference are met, which of the following statements is true for the test?

(A) The null hypothesis for the test is that the proportion of each gender who prefer each color scheme is $\frac{1}{3}$.

(B) The sample size is too small to detect a significant difference in a chi-square test for homogeneity of proportions.

(C) The test is not valid because the sample sizes are not equal.

(D) The more that men and women differ in their color preferences, the larger the chi-square statistic will be.

(E) The test would also be appropriate if 90 married couples had been used for the two samples.

Unauthorized copying or reuse of any part of this page is illegal.

29. The distribution of heights of 6-year-old girls is approximately normally distributed with a mean of 46.0 inches and a standard deviation of 2.7 inches. Aliyaah is 6 years old, and her height is 0.96 standard deviation above the mean. Her friend Jayne is also 6 years old and is at the 93rd percentile of the height distribution. At what percentile is Aliyaah's height, and how does her height compare to Jayne's height?

(A) Aliyaah's height is at the 17th percentile of the distribution, and she is shorter than Jayne.

(B) Aliyaah's height is at the 67th percentile of the distribution, and she is shorter than Jayne.

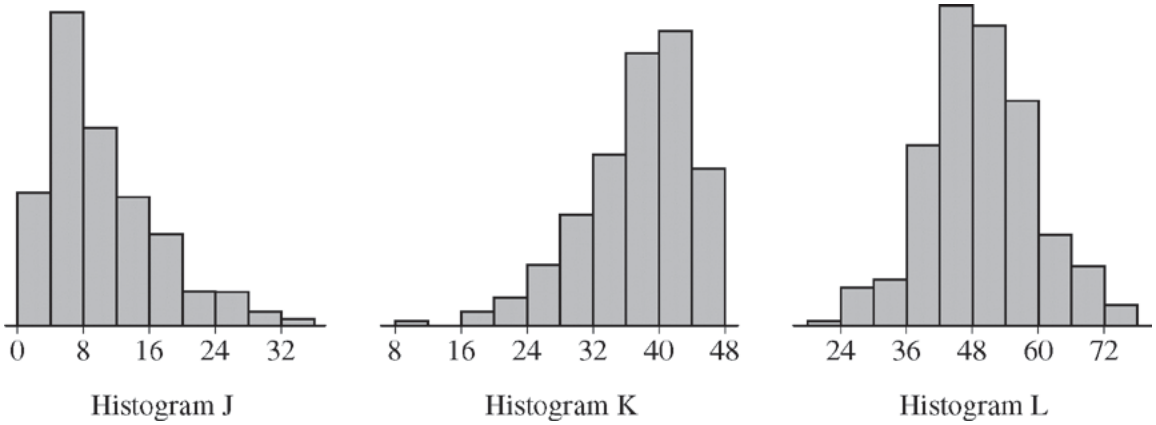
(C) Aliyaah's height is at the 67th percentile of the distribution, and she is taller than Jayne.

(D) Aliyaah's height is at the 83rd percentile of the distribution, and she is shorter than Jayne.

(E) Aliyaah's height is at the 83rd percentile of the distribution, and she is taller than Jayne.

Unauthorized copying or reuse of any part of this page is illegal.

GO ON TO THE NEXT PAGE.



30. For the three histograms above, which of the following correctly orders the histograms from the one with the smallest proportion of data above its mean to the one with the largest proportion of data above its mean?

(A) J, K, L

(B) J, L, K

(C) K, L, J

(D) L, K, J

(E) All three histograms have the same proportion of data above their respective means.

Unauthorized copying or reuse of any part of this page is illegal.

31. A recent study examined 699 car accidents in Toronto over a fourteen-month period. Records of phone-service providers were used to determine whether the driver was using a cell phone during or immediately before the accident. Overall, the researchers found that drivers using cell phones were 4.3 times as likely to have an accident as drivers who were not using cell phones. The result was statistically significant. Which of the following can be concluded from this study?

(A) Cell phone use increases the likelihood of a car accident.

(B) There is an association between cell phone use and accidents, but not necessarily a causal relationship.

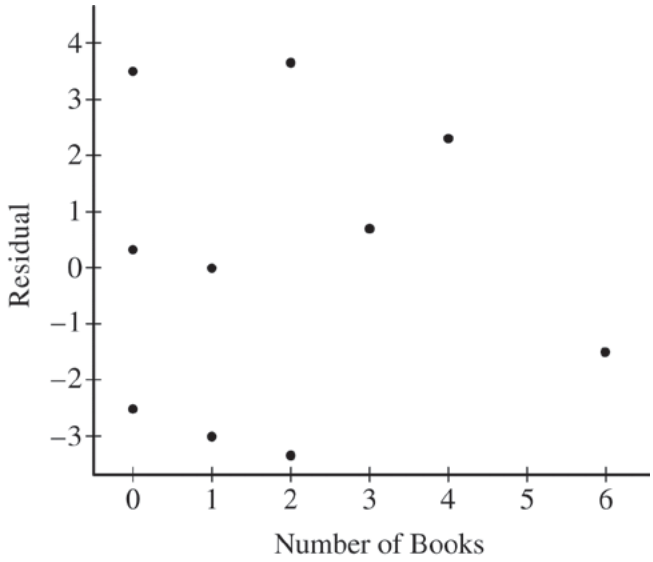
(C) There is a correlation between cell phone use and accidents, but not necessarily an association.

(D) The association between cell phone use and accidents is negative.

(E) Cell phone use causes more accidents in Canada, but not necessarily in the United States.

Unauthorized copying or reuse of any part of this page is illegal.

32. The weight, in pounds, of a full backpack and the corresponding number of books in the backpack were recorded for each of 10 college students. The resulting data were used to create the residual plot and the regression output shown below.



Parameter	Estimate	Std. Err.	Alternative	DF	T-Stat	P-Value
Intercept	10.53	1.23	$\neq 0$	8	8.57	< 0.0001
Slope	0.53	0.46	$\neq 0$	8	1.15	0.2825

Which of the following values is closest to the actual weight, in pounds, of the backpack for the student who had 4 books in the backpack?

(A) 8

(B) 10

(C) 13

(D) 15

(E) 17

Unauthorized copying or reuse of any part of this page is illegal.

33. A regional transportation authority is interested in estimating the mean number of minutes working adults in the region spend commuting to work on a typical day. A random sample of working adults will be selected from each of three strata: urban, suburban, and rural. Selected individuals will be asked the number of minutes they spend commuting to work on a typical day. Why is stratification used in this situation?

(A) To remove bias when estimating the proportion of working adults living in urban, suburban, and rural areas

(B) To remove bias when estimating the mean commuting time

(C) To reduce bias when estimating the mean commuting time

(D) To decrease the variability in estimates of the proportion of working adults living in urban, suburban, and rural areas

(E) To decrease the variability in estimates of the mean commuting time

Unauthorized copying or reuse of any part of this page is illegal.

34. A randomized block design will be used in an experiment to compare two lotions that protect people from getting sunburned. Which of the following should guide the formation of the blocks?

(A) Participants in the same block should receive the same lotion.

(B) Participants should be randomly assigned to the blocks.

(C) Participants should be kept blind as to which block they are in.

(D) Participants within each block should be as similar as possible with respect to how easily they get sunburned.

(E) Participants within each block should be as different as possible with respect to how easily they get sunburned.

Unauthorized copying or reuse of any part of this page is illegal.

35. A group of students wanted to investigate the claim that the average number of text messages sent yesterday by students in their school was greater than 100. They asked each student in a random sample of 50 students how many text messages he or she sent yesterday. An appropriate t-test was conducted and resulted in a p-value of 0.0853. Assuming the conditions for the t-test were met, which of the following is an appropriate conclusion?

(A) Because $p < 0.10$, at the 10% significance level, it can be concluded that the mean number of text messages sent yesterday by students in the school is less than 100.

(B) Because $p < 0.10$, at the 10% significance level, it cannot be concluded that the mean number of text messages sent yesterday by students in the school is greater than 100.

(C) Because $p > 0.05$, at the 5% significance level, it can be concluded that the mean number of text messages sent yesterday by students in the school is greater than 100.

(D) Because $p > 0.05$, at the 5% significance level, it can be concluded that the mean number of text messages sent yesterday by students in the school is less than 100.

(E) Because $p > 0.05$, at the 5% significance level, it cannot be concluded that the mean number of text messages sent yesterday by students in the school is greater than 100.

Unauthorized copying or reuse of any part of this page is illegal.

36. Two college roommates have each committed to donating to charity each week for the next year. The roommates' weekly incomes are independent of each other. Suppose the amount donated in a week by one roommate is approximately normal with mean \$30 and standard deviation \$10, and the amount donated in a week by the other roommate is approximately normal with mean \$60 and standard deviation \$20. Which of the following is closest to the expected number of weeks in a 52-week year that their combined donation will exceed \$120 ?

(A) 0; the combined donation never exceeds \$120 in a week

(B) 1 week

(C) 3 weeks

(D) 5 weeks

(E) 8 weeks

Unauthorized copying or reuse of any part of this page is illegal.

37. A university will add fruit juice vending machines to its classroom buildings if the student body president is convinced that more than 20 percent of the students will use them. A random sample of n students will be selected and asked whether or not they would use the vending machines. A large-sample test for proportions at the significance level of $\alpha = 0.05$ will be performed. The null hypothesis that the proportion of all students who would use the vending machines is 20 percent will be tested against the alternative that more than 20 percent of all students would use them. For which of the following situations would the power of the test be highest?

(A) The sample size is $n = 750$, and 20 percent of all students use the vending machines.

(B) The sample size is $n = 750$, and 25 percent of all students use the vending machines.

(C) The sample size is $n = 1{,}000$, and 25 percent of all students use the vending machines.

(D) The sample size is $n = 500$, and 50 percent of all students use the vending machines.

(E) The sample size is $n = 1{,}000$, and 50 percent of all students use the vending machines.

Unauthorized copying or reuse of any part of this page is illegal.

38. Each of the faces of a fair six-sided number cube is numbered with one of the numbers 1 through 6, with a different number appearing on each face. Two such number cubes will be tossed, and the sum of the numbers appearing on the faces that land up will be recorded. What is the probability that the sum will be 4, given that the sum is less than or equal to 6 ?

(A) $\frac{2}{36}$

(B) $\frac{3}{36}$

(C) $\frac{3}{15}$

(D) $\frac{2}{9}$

(E) $\frac{4}{6}$

Unauthorized copying or reuse of any part of this page is illegal.

39. A study compared the language skills and mental development of two groups of 24-month-old children. One group consisted of children identified as talkative, and the other group consisted of children identified as quiet. The scores for the two groups on a test that measured language skills are shown in the table below.

Talkative	75	70	70	65	85	85	80	90	90	60
Quiet	80	75	65	70	90	90	75	85	75	80

Assuming that it is reasonable to regard the groups as simple random samples and that the other conditions for inference are met, what statistical test should be used to determine if there is a significant difference in the average test score of talkative and quiet children at the age of 24 months?

(A) A chi-square goodness-of-fit test

(B) A chi-square test of independence

(C) A matched-pairs *t*-test for means

(D) A two-sample *t*-test for means

(E) A linear regression *t*-test

Unauthorized copying or reuse of any part of this page is illegal.

40. An experiment will be conducted to test the effectiveness of a weight-loss supplement. Volunteers will be randomly assigned to take either the supplement or a placebo for 90 days, with 12 volunteers in each group. The subjects will not know which treatment they receive. At the end of the experiment, researchers plan to calculate the mean weight loss for each of the two groups and to construct a two-sample t-confidence interval for the difference of the two treatment means. Which of the following assumptions is necessary for the confidence interval to be valid?

(A) The sample size is greater than or equal to 10 percent of the population size.

(B) Each of the two groups has at least 5 successes and at least 5 failures.

(C) The distributions of weight loss of the two treatments are approximately normally distributed.

(D) The volunteers in the supplement group are paired with volunteers in the placebo group.

(E) The expected number of people who lose weight in each group is at least 5.

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**

Unauthorized copying or reuse of any part of this page is illegal.

Table entry for z is the probability lying below z.

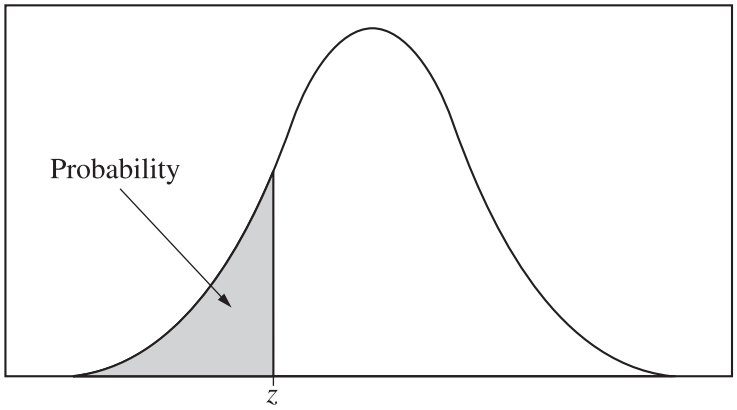


Table A Standard normal probabilities

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.

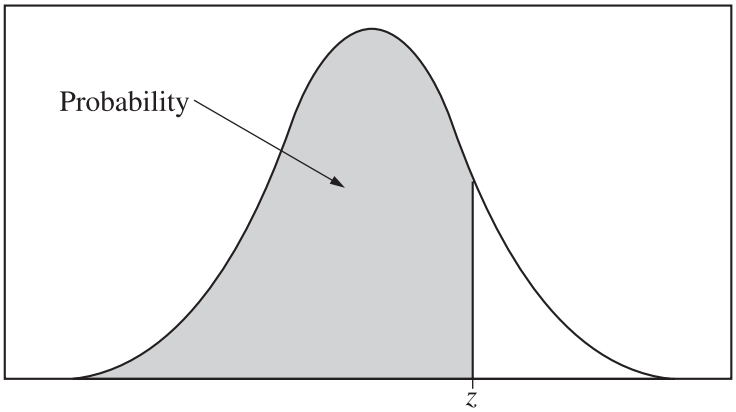


Table A (***Continued***)

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^*.

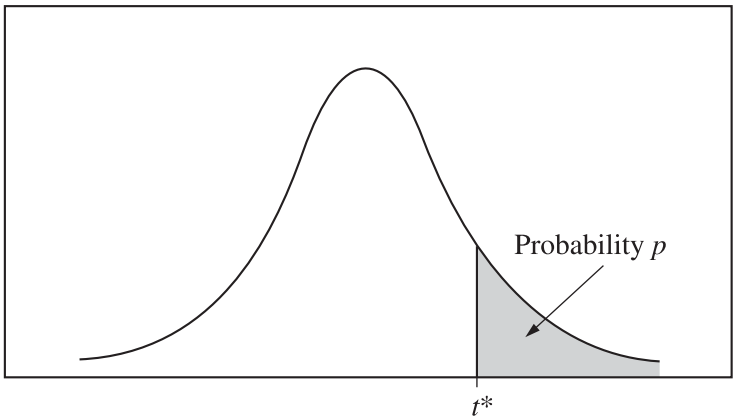


Table B ***t* distribution critical values**

	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.

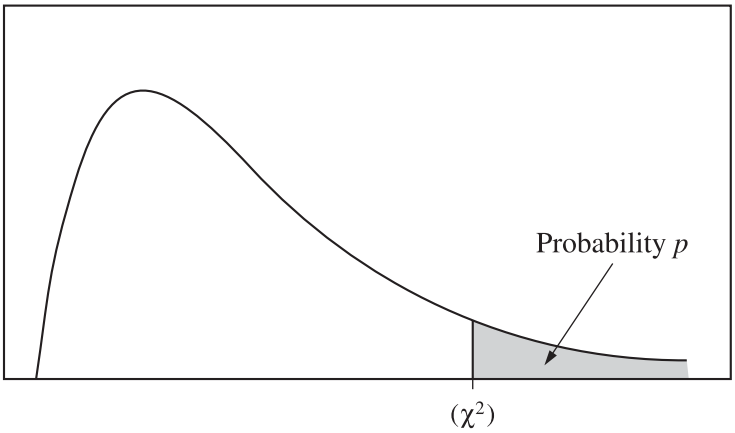


Table C χ^2 **critical values**

	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 2013 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

2013

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 4FBP2-S2

Formulas begin on page 3.
Questions begin on page 6.
Tables begin on page 20.

Formulas

(I) Descriptive Statistics

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

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

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

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

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

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

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

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

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

(II) Probability

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

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

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

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

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) • (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 $p_1 = p_2$ $\sqrt{p(1-p)}\sqrt{\dfrac{1}{n_1} + \dfrac{1}{n_2}}$

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

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 graded on the correctness of your methods as well as on the accuracy and completeness of your results and explanations.

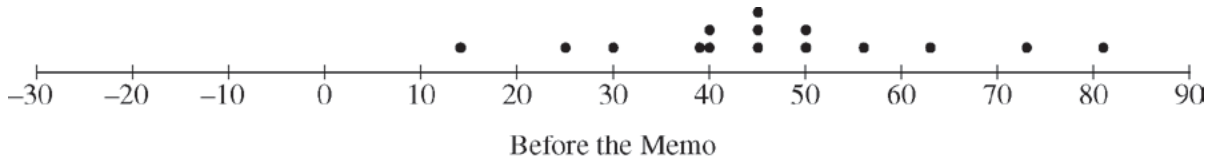
1. A hospital administrator noticed that the first nonemergency surgery scheduled each day often started late. If the first scheduled surgery got delayed, then all of the other surgeries scheduled for that day also got delayed. For three weeks (a total of 15 days) the administrator recorded how many minutes past the scheduled time the first surgery began each weekday. The data are shown in the table below.

Minutes Past Scheduled Starting Time														
25	45	73	50	81	40	56	40	45	14	30	63	50	39	45

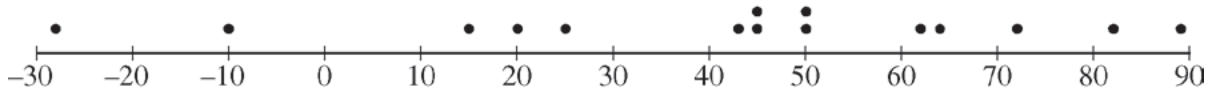
The administrator sent a memo to the hospital's entire surgical staff to ask that everyone work to reduce the delay in the starting time for the first nonemergency surgery each day. The administrator recorded how many minutes past the scheduled starting time the first scheduled surgery began each weekday for the three weeks after the memo was sent out. The data are shown in the table below. A negative number in the table indicates that the surgery started earlier than the scheduled time.

Minutes Past Scheduled Starting Time After the Memo Was Sent Out														
64	43	20	–28	15	45	72	82	25	50	62	89	–10	45	50

The dotplots below display the distributions of minutes past the scheduled starting time before the memo went out and after the memo went out.



Before the Memo



After the Memo

Unauthorized copying or reuse of any part of this page is illegal.

(a) Based only on the dotplots, does it appear that the distribution of minutes past the scheduled starting time changed after the memo was sent? Explain.

(b) The hospital administrator wants to perform a two-sample t-test to determine whether the average number of minutes past the scheduled starting time changed after the memo was sent. State the conditions for that test. For each condition, comment on whether it appears to be met.

Unauthorized copying or reuse of any part of this page is illegal.

2. A certain company makes three grades (A, B, and C) of a particular electrical component. Historically, grade A components have a 2 percent defective rate, grade B components have a 5 percent defective rate, and grade C components have a 10 percent defective rate. Since grade A components are less likely to be defective, the company can charge more money for those components than it can charge for the grade B or C components. Similarly, the company can charge more money for grade B components than it can charge for grade C components.

   Recently, the company found a batch of components in a warehouse that were known to be of the same grade, but the grade was not labeled on the components. To determine the grade (A, B, or C), the company selected from that batch a random sample of 200 components, which contained 16 defective components.

   (a) Construct and interpret a 95 percent confidence interval for the proportion of defective components in the batch.

Unauthorized copying or reuse of any part of this page is illegal.

If you need more room for your work in part (a), use the space below.

(b) Does the interval calculated in part (a) allow the company to clearly determine the grade of component that was produced in the batch? Explain.

Unauthorized copying or reuse of any part of this page is illegal.

3. An environmental research agency conducted a study of a certain state's roadsides to estimate the mean number of discarded cans and bottles per mile of public road. The state's public roads were grouped into three types:

Major highways: major paved roads designed for high traffic volume

Minor highways: smaller paved roads designed for low traffic volume

Unpaved roads: gravel and dirt roads

There are about 100,000 miles of public roads in the state. The environmental research agency defined a sampling unit to be a one-mile segment of public road. Using a database supplied by the state's department of transportation, the agency randomly selected 30 one-mile road segments for each of the three types of roads. Researchers from the agency searched the roadsides along each of the selected one-mile road segments and recorded the number of discarded cans and bottles. Results are shown in the table below.

Type of Road	Sample Size (n)	Sample Mean $(\bar{x})$	Sample Standard Deviation (s)	Total Number of Miles
Major highways	30	11.2	6.4	24,000
Minor highways	30	32.6	9.6	58,000
Unpaved roads	30	21.7	8.3	18,000

(a) What is the variable of interest in the study?

What is the parameter of interest?

Unauthorized copying or reuse of any part of this page is illegal.

GO ON TO THE NEXT PAGE.

(b) Were the data in the study obtained by a simple random sample, a stratified random sample, or a cluster sample? Explain.

(c) Two methods for estimating the mean number of discarded cans and bottles per mile along all public roads in the state are given below.

Method 1

$$0.24\bar{x}_{\text{major}} + 0.58\bar{x}_{\text{minor}} + 0.18\bar{x}_{\text{unpaved}} =$$

$$(0.24)(11.2) + (0.58)(32.6) + (0.18)(21.7) = 25.5$$

Method 2

$$\frac{\bar{x}_{\text{major}} + \bar{x}_{\text{minor}} + \bar{x}_{\text{unpaved}}}{3} = \frac{11.2 + 32.6 + 21.7}{3} = 21.83$$

Which of these methods gives a better estimate of this mean? Explain.

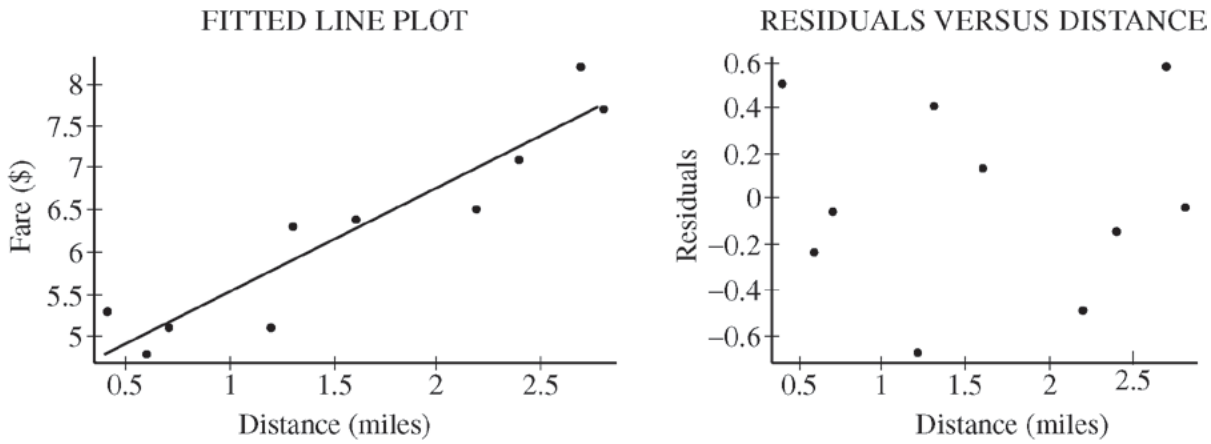
Unauthorized copying or reuse of any part of this page is illegal.

4. A taxicab company in a large city charges passengers a flat fee to enter a cab plus an additional fee per mile. There is also a charge for time spent stopped in traffic. The company wants to develop a new method for determining fares based on mileage and a flat fee only, not on time spent stopped in traffic. A random sample of 10 recent cab fares was selected, and the distance, in miles, and the fare, in dollars, were recorded. A regression model was fit to the data, and the output, scatterplot, and residual plot are given below.

Parameter	Estimate	Std. Err.	T-Stat	P-Value
Intercept	4.296	0.298	14.400	< 0.0001
Mileage	1.229	0.166	7.418	< 0.0001

R-sq = 0.87306005

s = 0.44294646



(a) State the equation of the least squares regression line for these data. Define any variables used in the equation.

Unauthorized copying or reuse of any part of this page is illegal.

(b) A 95 percent confidence interval for the intercept of the least squares regression line is (3.61, 4.98). Construct and interpret a 95 percent confidence interval for the slope of the least squares regression line. Assume the conditions for inference are met.

(c) The company wants to know if charging a flat fee of $3.00 and a per-mile charge of $1.50 will maintain its current revenue. Based on the information in part (b), is a flat fee of $3.00 a reasonable value? Explain.

Unauthorized copying or reuse of any part of this page is illegal.

GO ON TO THE NEXT PAGE.

5. In a report to the department of transportation of a western state, a large trucking firm stated that the distribution of weights of its fully loaded tractor trailer trucks is approximately normal with a mean of 19,016 pounds and a standard deviation of 2,324 pounds. The state police decided to check a sample of 40 of the company's trucks to test the company's claim concerning the mean weight and standard deviation of the weights of its trucks.

(a) Assume that the company's claim is true. Describe the distribution of the sample mean weight for random samples, each consisting of 40 trucks.

(b) At the company's large terminal, a state police crew selects a random sample of 40 fully loaded trucks and finds that the mean weight of those trucks is 19,168 pounds. What is the probability that a random sample of 40 of the company's fully loaded trucks would have a mean weight of 19,168 pounds or more if the company's claim is true?

Unauthorized copying or reuse of any part of this page is illegal.

GO ON TO THE NEXT PAGE.

If you need more room for your work for part (b), use the space below.

(c) A second state police crew is assigned to check trucks at the same terminal as in part (b) but on a different day. However, the second crew believes that the instructions to carry out a random sample are too complicated and too time-consuming. Instead, the crew weighs the first 40 fully loaded trucks as they leave the terminal and finds that the mean weight of the selected trucks is 18,894 pounds. Why is the lack of random selection in using the first 40 trucks a potential problem?

Unauthorized copying or reuse of any part of this page is illegal.

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 graded on the correctness of your methods as well as on the accuracy and completeness of your results and explanations.

6. A drug company currently sells a prescription pain reliever that has been shown to be effective at lowering arthritis pain. However, since the drug also causes stomach irritation in some patients, the company has created a new formulation that it hopes will reduce that side effect.

   To see if the new formulation reduces the occurrence of stomach irritation for users of the pain reliever, the company conducted a small preliminary study to compare the new formulation with the current pain reliever. In the preliminary study of 100 subjects with arthritis, 50 were randomly assigned to take the current pain reliever and 50 were randomly assigned to take the new formulation.

   Patient responses at the end of the study are summarized in the table below.

Patient Response	Current Pain Reliever	New Formulation	Total
Had stomach irritation	21	17	38
Had no stomach irritation	29	33	62
Total	50	50	100

   (a) Do the data from the preliminary study indicate, at the 10 percent level of significance, that the new formulation helps to reduce the proportion of patients with stomach irritation compared to the current pain reliever? (The conditions for inference have been checked and verified.)

Unauthorized copying or reuse of any part of this page is illegal.

If you need more room for your work for part (a), use the space below.

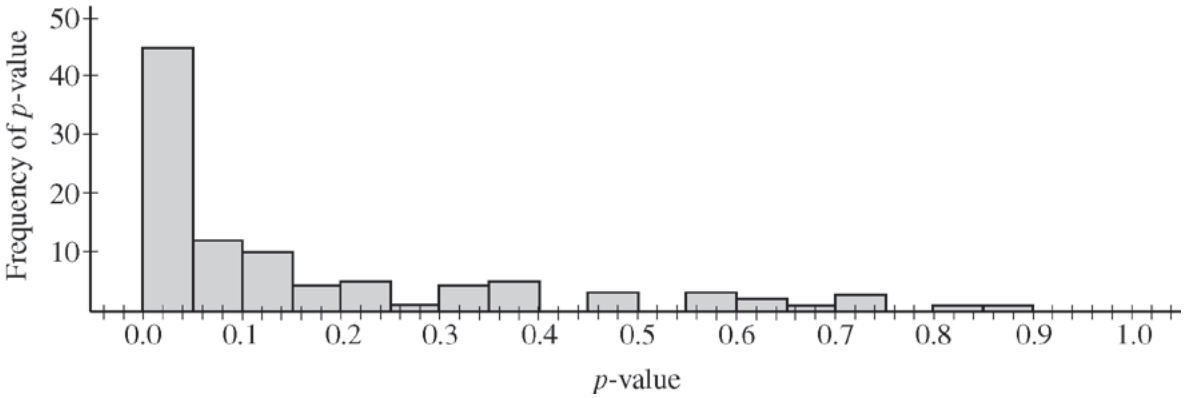
(b) Based on your conclusion in part (a), which type of error, Type I or Type II, is possible? Describe the consequences of each error in the context of this study.

Unauthorized copying or reuse of any part of this page is illegal.

(c) After the preliminary study, one of the researchers of the company suggested that the procedure described above would have more statistical power if the sample size was increased and recommended that a simulation study be conducted to investigate that more completely.

For the purposes of the simulation, the researcher assumed that 40 percent of the patients on the current pain reliever will have stomach irritation and that only 30 percent of the patients on the new formulation will have stomach irritation. Further, the total sample size will now be 200, with 100 subjects randomly assigned to each treatment.

One-hundred trials of the simulation were conducted, and a p-value was calculated for each trial based on the testing procedure, significance level, and hypotheses used in part (a). A histogram of the p-values is given below.



Use the information in the histogram to estimate the power of the test if the test is performed at the 0.10 level of significance. Indicate how you obtained your estimate.

Unauthorized copying or reuse of any part of this page is illegal.

(d) Explain, in the context of this study, what the value obtained in part (c) represents.

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(ES) ON THE COVER(S).**
- **MAKE SURE YOU HAVE USED THE SAME SET OF AP NUMBER LABELS ON ALL AP EXAMS YOU HAVE TAKEN THIS YEAR.**

Unauthorized copying or reuse of any part of this page is illegal.

Table entry for z is the probability lying below z.

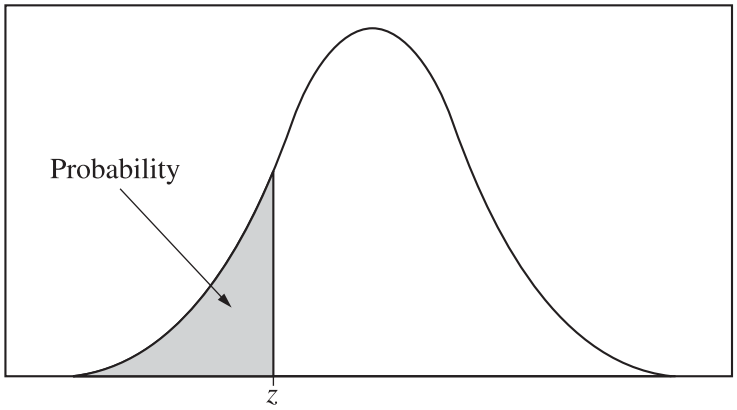


Table A Standard normal probabilities

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.

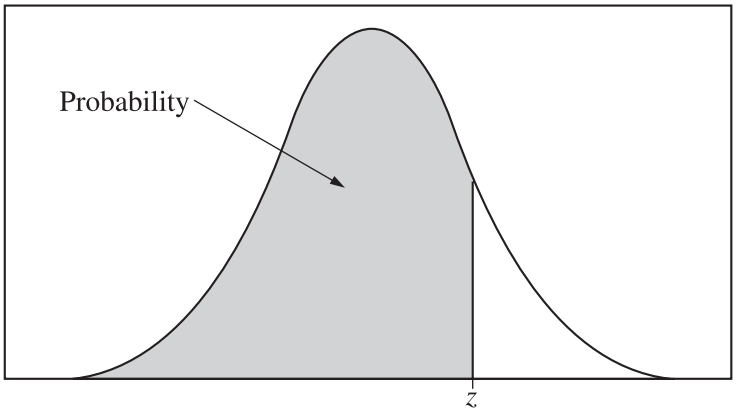


Table A (***Continued***)

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^*.

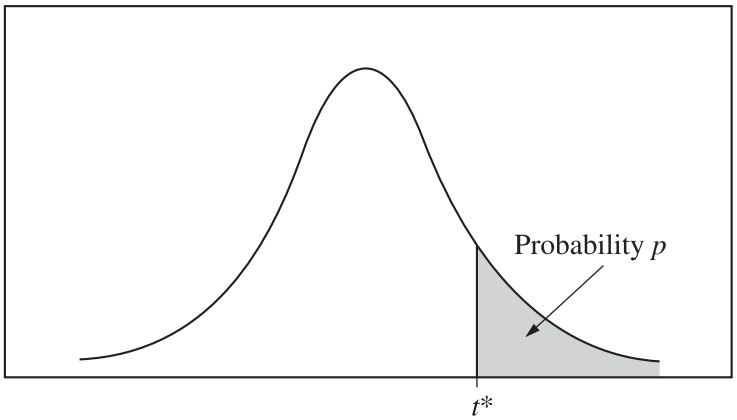


Table B ***t* distribution critical values**

	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.

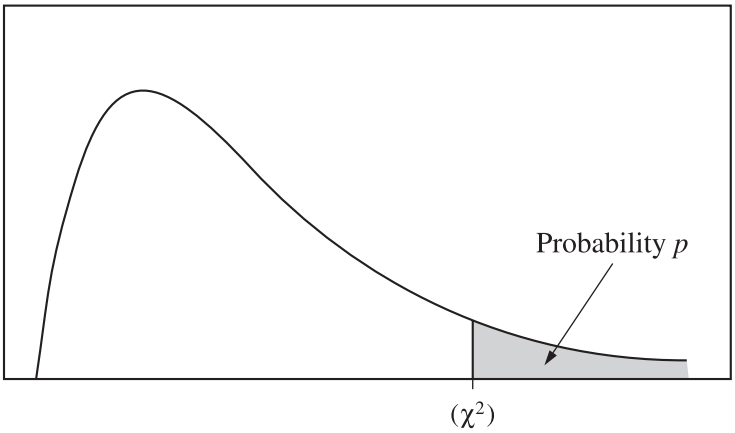


Table C χ^2 **critical values**

	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: E
Question 2: A
Question 3: B
Question 4: A
Question 5: B
Question 6: E
Question 7: D
Question 8: D
Question 9: C
Question 10: D
Question 11: E
Question 12: E
Question 13: A
Question 14: C
Question 15: C
Question 16: D
Question 17: A
Question 18: B
Question 19: E
Question 20: D
Question 21: D
Question 22: D
Question 23: D
Question 24: C
Question 25: D
Question 26: A
Question 27: C
Question 28: D
Question 29: D
Question 30: B
Question 31: B
Question 32: D
Question 33: E
Question 34: D
Question 35: E
Question 36: D
Question 37: E
Question 38: C
Question 39: D
Question 40: C

Free-Response Scoring Guidelines

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

Question 1

Intent of Question

The primary goals of this question are to assess a student's ability to: (1) use dotplots for comparing two distributions and (2) evaluate the appropriateness of using a specified statistical test.

Solution

Part (a):

Based on the dotplots, we observe that the distributions are centered in about the same place. The variability of the distributions is different with the after memo distribution being much more variable (the range of 67 (81-14) from the before memo distribution compared to 117 (89 – (-28)) with 2 observations below the value of 14 for the after memo distribution).

Part (b):

The conditions to check for using the two sample *t-test* are (1) independent samples, (2) the normality of the two population distributions of minutes past surgery, and (3) random samples.

(1) There doesn't seem to be any reason why starting times of surgeries in different weeks are connected; therefore, it seems reasonable to assume independent samples.

(2) Based on the graphical display from part (a), the condition of normality appears reasonable for the before memo distribution although not as clear for the after memo distribution (longer left tail with 2 negative values that could be potential outliers).

(3) The condition of random samples is not met since the 15 days in each sample were not selected at random.

© 2013 The College Board.
Visit the College Board on the Web: www.collegeboard.org.

Question 1 (continued)

Scoring

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

Part (a) is scored as follows:

Essentially correct (E) if the student correctly compares center and spread of the two distribution in the context of the before and after memo. Specific numerical values are not required.

Partially correct (P) if the student correctly compares only one of the two characteristics (center or spread) of the two distributions in context
OR
correctly compares center and spread of the two distributions but not in context
OR
correctly describes (but not compares) the center and spread of the two distributions in context.

Note: Shape is addressed in part (b). Although not required in part (a), if the student makes statements about shape they must be reasonable (for example, approximately symmetric, or approximately normal, or skewed). If the student says that the distribution is normal, part (a) cannot be scored as essentially correct (E).

Part (b) is scored as follows:

Essentially correct (E) if the student identifies the three conditions (independent samples, random samples, and normality) *AND* provides a reasonable assessment of whether or not each condition appears to be met.

Partially correct (P) if the student only identifies and addresses one or two conditions
OR
the student identifies all three conditions with no assessment of whether or not each condition appears to be met.

Incorrect (I) if the student identifies one or two of the conditions but provides no assessment of whether or not they appear to be met.

Notes:

1. For the normality and independence conditions, it is possible to argue for either that the condition appears to be met or that it appears not to be met, as long as a reasonable justification is provided for the argument.
2. The discussion of the independence assumption needs to address independence of the samples, not just independence of the observations within each sample.
3. If the response includes conditions that are not appropriate for the two-sample t test (such as expected counts > 5 or $n\hat{p} > 5$), the score for this part should be lowered one level (that is, from E to P or from P to I).

© 2013 The College Board.
Visit the College Board on the Web: www.collegeboard.org.

Question 1 (continued)

4 Complete Response

Two parts essentially correct

3 Substantial Response

One part essentially correct and one part partially correct

2 Developing Response

One part essentially correct and one part incorrect
OR
Two parts partially correct

1 Minimal Response

One part partially correct and one part incorrect

© 2013 The College Board.
Visit the College Board on the Web: www.collegeboard.org.

Question 2

Intent of Question

The primary goals of this question are to evaluate a student's ability to: (1) identify and compute an appropriate confidence interval, after checking the necessary conditions; (2) interpret the interval in the context of the question; and (3) use the confidence interval to make an inference about whether or not this company can identify the batch of components.

Solution

Part (a):

Step 1: Identifies the appropriate confidence interval by name or formula and checks appropriate conditions.

One sample z-interval for a proportion, p, the true proportion of defective components in a batch or $\hat{p} \pm z^* \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$.

Conditions: 1. Random sample of components
2. The sample size is large enough such that the number of successes and the number of failures are both greater than 10 (or 5 or 15) in order to assume the distribution of the sample proportion will be approximately normal.

Checks: A random sample of 200 components was selected from the large batch.
The number of successes and failures are both greater than 15 (16 and 184).

Step 2: Correct Mechanics

$0.08 \pm 1.96\sqrt{\frac{0.08(0.92)}{200}} = 0.08 \pm 0.0376$ which results in the interval $(0.0424, 0.1176)$

Step 3: Interpretation in context

Based on this sample, we are 95% confident that an interval of plausible values for the true percentage of defective components in the batch is between 4.24% and 11.76%.

Part (b):

The 95% confidence interval found in part (a) allows the company to eliminate grade A because its defective rate of 2% is not one of the plausible values listed in the interval. However, this interval does not allow the company to decide between grades B and C because both of their defective rates (5% and 10%) are in the interval.

© 2013 The College Board.
Visit the College Board on the Web: www.collegeboard.org.

Question 2 (continued)

Scoring:

This 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 one-sample z-interval for a proportion is identified (either by name or formula) *AND* the condition of random sampling is stated and checked *AND* the sample size condition is stated and checked.

Partially correct (P) if two of the three requirements for an E are met.

Incorrect (I) if the response fails to meet the criteria for E or P.

Note: It is not necessary to check the condition that the sample size be small relative to the population size or to comment on this condition in order for Step 1 to be scored as essentially correct (E).

Section 2 is scored as follows:

Essentially correct (E) if a 95% confidence interval is correctly computed.

Partially correct (P) for any of the following:

- If a correct method (confidence interval for a proportion) is used, but an incorrect critical z-value or a t-value is used.
- There are errors in the calculation of the interval (unless such errors follow from an incorrect procedure in Step 1).

Section 3 is scored as follows:

Essentially correct (E) if the response is a reasonable interpretation in context *AND* makes clear that it estimates the proportion of all defectives in the batch *AND* references that we have 95% confidence in the interval.

Partially correct (P) the response is a reasonable interpretation in context *AND* includes one of the other two requirements listed for an E (parameter or level).

Incorrect (I) if the response is not a reasonable interpretation or is not given in context.

Note: The correct interpretation of the confidence interval for Step 3 of part (a) may be found in part (b).

© 2013 The College Board.
Visit the College Board on the Web: www.collegeboard.org.

Question 2 (continued)

Section 4 is scored as follows:

Essentially correct (E) if the response says that a decision cannot be made between grades B and C and provides an explanation based on the confidence interval.

Partially correct (P) if the response only indicates that grade A can be ruled out with an explanation based on the interval
OR
the response indicates that a decision cannot be made between grades B and C but no justification based on the interval is given
OR
the response indicates that a decision cannot be made but the justification is weak.

Incorrect (I) if the student gives an incorrect conclusion.

Each essentially correct (E) response counts as 1 point and a partially correct (P) response 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 determine whether to score up or down depending on the strength of the response and communication.

© 2013 The College Board.
Visit the College Board on the Web: www.collegeboard.org.

Question 3

Intent of Question

The primary goals of this question are to assess a student's ability to: (1) identify the variable and parameter of interest in a study, (2) recognize the type of sampling used in the study, and (3) recognize which of two methods gives an unbiased estimate for the population mean.

Solution

Part (a):

The variable of interest is the number of bottles/cans per one-mile segment.

The parameter of interest is the mean number of bottles/cans per one-mile segment of all roads in the state.

Part (b):

This survey was conducted as a stratified random sample with three strata corresponding to the three road types: major highways, minor highways, and unpaved roads. Separate random samples of 30 one-mile segments were taken within each of the three strata.

Part (c):

The Method I estimate is an unbiased estimate of the mean number of discarded cans and bottles per mile of public road in the state. The Method I estimate weights the sample means according to the proportion of each type of road in the population. The Method II estimate is biased in under-estimating the population mean. By giving equal weight to each type of road, the Method II estimate assigns too little weight to the minor highways and the minor highways appear to have more discarded cans and bottles than the other two types of roads.

© 2013 The College Board.
Visit the College Board on the Web: www.collegeboard.org.

Question 3 (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 both components (identifying the variable of interest and population parameter) are correct.

Partially correct (P) if only one component is correct.

Notes:

1. The definition of the parameter must include wording that would distinguish it from a sample mean.
2. The response does not need to include "per mile" in the definition of the variable or parameter.

Part (b) is scored as follows:

Essentially correct (E) if the student identifies a stratified random sample and provides a reasonable explanation that includes identification of road types as strata and indicates that a sample is selected from each stratum.

Partially correct (P) if the student identifies a stratified random sample but provides an incomplete explanation (such as stating that the state highways were grouped into three types but failing to clearly indicate that separate random samples of one mile road segments were taken within each group).
OR
The response clearly shows that the student knows the difference between cluster and stratified sampling by discussing both types, but has the names of the two types of sampling reversed.

Incorrect (I) if the student identifies a stratified random sample with no justification or an incorrect justification
OR
chooses an incorrect sampling method.

© 2013 The College Board.
Visit the College Board on the Web: www.collegeboard.org.

Question 3 (continued)

Part (c) is scored as follows:

Essentially correct (E) if student chooses Method I and provides a justification that *explicitly indicates that the strata sizes are different* (for example, the state has more miles of minor highways than miles of major highways and unpaved roads) and therefore weighting by strata size is preferable to the unweighted average.

Partially correct (P) if a student chooses Method I but provides a weak justification (one that does not explicitly indicate that the strata sizes are different, such as "it adjusts for road types" or "it uses the mileage proportions").

Incorrect (I) if the student chooses Method 1 with no justification or an incorrect justification
OR
chooses Method II.

4 Complete Response

All three parts essentially correct

3 Substantial Response

Two parts essentially correct and one part partially correct

2 Developing Response

Two parts essentially correct and one part incorrect
OR
One part essentially correct and one or two parts partially correct
OR
Three parts partially correct

1 Minimal Response

One part essentially correct and two parts incorrect
OR
Two parts partially correct and one part incorrect

© 2013 The College Board.
Visit the College Board on the Web: www.collegeboard.org.

Question 4

Intent of Question

The primary goal of this question is to assess a student's ability to: (1) identify the estimated regression line equation and define the variables in the equation, (2) construct and interpret a confidence interval for the slope, and (3) use an appropriate confidence interval to make a recommendation.

Solution

Part (a):

The regression line equation is $\hat{y} = 4.296 + 1.229x$, where $\hat{y} =$ the predicted taxi fare (in dollars) and $x =$ the distance traveled (in miles).

Part (b):

Step 1: Identifies the appropriate confidence interval by name or formula and checks appropriate conditions.

The stem of the problem states to assume that conditions for inference are met.

The confidence interval for the slope, β, the rate per mile charged by the taxi cab company is $b \pm t^*_{n-2}(\textit{standard error of } b)$.

Step 2: Correct Mechanics

The 95% confidence interval is

$$b \pm t^*_{n-2}(\textit{standard error of } b) = 1.229 \pm 2.306(0.1657) = 1.229 \pm 0.382 = (0.85, 1.61)$$

Step 3: Interpretation in context

At the 95% confidence level, an interval of plausible values for the true rate per mile charged by the taxi cab company is from \$0.85 to \$1.61.

Part (c):

The flat fee of \$3.00 is lower than any of the plausible values from the 95% confidence interval for the intercept (\$3.61 to \$4.98) which was based on the taxi company's original method of calculating fares. Thus, \$3.00 appears too low to maintain current revenue.

© 2013 The College Board.
Visit the College Board on the Web: www.collegeboard.org.

Question 4 (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 estimated regression line equation is correctly identified *AND* the variables are defined. A correct identification of the estimated regression line requires correct values for the estimated intercept and the estimated slope and an indication that the estimated regression line provides estimates (or predictions) of fares.

Partially correct (P) if the estimated regression line equation is correctly identified, but the variables (x and y) are not defined
OR
if it is unclear that the regression line provides an *estimated/predicted* fare.

Incorrect (I) if the regression line is specified using the standard errors as parameter estimates
OR
the regression line is specified with the parameter estimates reversed $(\hat{y} = 1.229 + 4.296x)$.

Notes:
The reported regression equation must use $\hat{y}$ or <u>estimated</u> y to get this part essentially correct (E). For example,

- $\hat{y} = 4.296 + 1.229x$ is scored essentially correct (E) if y is identified as the fare and x is identified as the mileage.
- $\text{estimated fare} = 4.296 + 1.229 \text{ mileage}$ is scored essentially correct (E).
- $y = 4.296 + 1.229x$ is scored partially correct (P) if y is identified as the fare and x is identified as the mileage.
- $\text{fare} = 4.296 + 1.229 \text{ mileage}$ is scored partially correct (P).
- $y = 4.296 + 1.229x$ is scored incorrect (I) if either y or x is not defined or either y or x is not defined correctly.

Part (b) is scored as follows:

Essentially correct (E) if the appropriate confidence interval is identified (Step 1) *AND* the confidence interval is correctly computed (Step 2) *AND* a correct interpretation is given in context (Step 3).

Partially correct (P) if correct responses are provided for two of the three steps
OR
the confidence interval is correctly specified (Step 1) *AND* the only error in the computation of the confidence interval is using 9 degrees of freedom rather than 8 *AND* an interpretation is given that is not in context.

Incorrect (I) if only one or none of the three steps is correct.

© 2013 The College Board.
Visit the College Board on the Web: www.collegeboard.org.

Question 4 (continued)

Part (c) is scored as follows:

Essentially correct (E) if the response indicates that $3 is not reasonable *AND* the explanation is in context and makes a clear reference to the confidence interval for the intercept.

Partially correct (P) if the response indicates that $3 is not reasonable *AND* the explanation is in context and tied to the regression analysis, but it does not clearly reference the confidence interval for the intercept.

Incorrect (I) otherwise.

Note: To be scored essentially correct (E), the response in part (c) must show that the interval for the intercept was used in making the decision. This can be done by

- Including the interval ($3.61, $4.98) in the explanation.
- Indicating that $3 is lower than all values in the interval, the use of the correct interval can be assumed as long as the computed interval for the slope in part (b) lies entirely below $3.
- Stating that $3 is not in the interval and revenue would decrease. This implies that $3 is lower than all values in the interval and the use of the correct interval can be assumed as long as the computed interval for the slope in part (b) lies entirely below $3.

If the student says only that $3 is not in the interval, the use of the correct interval cannot be assumed.

4 Complete Response

All three parts essentially correct

3 Substantial Response

Two parts essentially correct and one part partially correct

2 Developing Response

Two parts essentially correct and one part incorrect
OR
One part essentially correct and one or two parts partially correct
OR
Three parts partially correct

1 Minimal Response

One part essentially correct and two parts incorrect
OR
Two parts partially correct and one part incorrect

© 2013 The College Board.
Visit the College Board on the Web: www.collegeboard.org.

Question 5

Intent of Question

This question was developed to assess a student's understanding of the sampling distribution of the sample mean, in particular, a student's ability to (1) describe a sampling distribution; (2) compute an appropriate probability using this sampling distribution; and (3) explain how non-random selection might introduce bias.

Solution

Part (a):

The sampling distribution of the sample mean $\bar{X}$

1. is approximately normal
2. has mean $\mu = 19{,}016$ pounds
3. has standard deviation $\sigma/\sqrt{n} = 2324/\sqrt{40} = 367.46$ pounds.

Part (b):

$$P(\bar{x} > 19{,}168) = P\left(z > \frac{19{,}168 - 19{,}016}{367.46}\right) = P\left(z > \frac{152}{367.46}\right) = P(z > 0.41) = 0.34$$

Part (c):

The sampling method used in part (c) may not produce a sample that is representative of the population of trucks if the trucks leaving earlier in the day are heavier or lighter than usual. For example, it may be that trucks going out early in the day (the first trucks to leave the terminal) may carry lighter loads than the trucks leaving the terminal later in the day due to less loading time. In this case, the sampling method would provide data leading to a biased estimate of the population mean (in this case, a systematic underestimation of the population mean weight).

© 2013 The College Board.
Visit the College Board on the Web: www.collegeboard.org.

Question 5 (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 student (1) says the sampling distribution will be approximately normal, (2) gives a correct value for the mean, and (3) gives a correct value for the standard deviation.

Partially correct (P) if student answers two of the three parts (sampling distribution shape, mean, and standard deviation) correctly.

Incorrect (I) if the student answers only one part correctly
OR
The student is clearly talking about the data distribution, the sample distribution, or the population distribution.

Note: If the student says that the sampling distribution is normal rather than approximately normal, this can be overlooked.

Part (b) is scored as follows:

Essentially correct (E) if the probability is calculated correctly with a reasonable sketch or evidence of calculation shown.

Partially correct (P) if the wrong standard deviation is used to compute the probability and a reasonable sketch or evidence of calculation is shown.

Notes:

1. If the solution uses 2,324 as the standard deviation in the calculation of the probability (to obtain $z = 0.065$ and a probability of 0.474), then part (b) is at best partially correct, even though this mistake was also penalized in part (a). (Don't penalize further for a table reading error—some students look up 0.65 instead of 0.065 in the z table to obtain a probability of 0.2578.)
2. Because the probability requested is equivalent to the p-value from a z-test, if a student sets up part (b) as a hypothesis test and it is clear that a z-test is being used and a correct p-value is computed, part (b) can be scored as essentially correct. Hypotheses, conclusions, etc. can be ignored. However, if the student uses a t-test, part (b) is at best partially correct. Because the value of the test statistic and the p-value are nearly identical for the z-test and the t-test, the reader will need to look carefully at the notation and test statistic. If the t-distribution is used and the standard deviation is incorrect, part (b) should be scored as incorrect.
3. If the mean and standard deviation are identified in part (a), then the calculator command Normalcdf (19168, ∞, 19016, 367.46) is provided along with 0.3395, then the response should be scored as essentially correct (E). If the mean and standard deviation are not identified in part (a), then for the calculator command to be considered sufficient for evidence of calculation, the mean and standard deviation must be clearly identified in part (b).
4. If no supporting work is shown and only the numerical answer (for example, 0.3395 from calculator) is given, part (b) is scored as incorrect.

© 2013 The College Board.
Visit the College Board on the Web: www.collegeboard.org.

Question 5 (continued)

Part (c) is scored as follows:

Essentially correct (E) if the response (1) indicates that the first 40 trucks could differ from the rest of the trucks in some systematic way and (2) provides a plausible reason why this might be the case.

Partially correct (P) if the response indicates that the first 40 trucks could differ from the rest of the trucks in some systematic way but does not provide a plausible reason why this might be the case.

Incorrect (I) if the student gives a generic response, such as "the sampling method results in bias" with no reference to the context of the problem
OR
gives some other incorrect solution.

4 Complete Response

All three parts essentially correct

3 Substantial Response

Two parts essentially correct and one part partially correct

2 Developing Response

Two parts essentially correct and one part incorrect
OR
One part essentially correct and one or two parts partially correct
OR
Three parts partially correct

1 Minimal Response

One part essentially correct and two parts incorrect
OR
Two parts partially correct and one part incorrect

© 2013 The College Board.
Visit the College Board on the Web: www.collegeboard.org.

Question 6

Intent of Question

The primary goals of this investigative task are to assess a student's ability to: (1) identify and conduct an appropriate test of hypothesis for the differences in two proportions; (2) identify the potential error (Type I or Type II) based on the conclusion of the statistical test and describe a potential consequence; (3) using simulation to estimate power; and (4) describe in context what power measures.

Solution

Part (a):

Step 1: State a correct pair of hypotheses

Let p_C = proportion of patients who would suffer stomach irritation if treated with the current pain medication
p_N = proportion of patients who would suffer stomach irritation if treated with the new pain medication

$H_0: p_C - p_N = 0$

$H_a: p_C - p_N > 0$

Step 2: Identify a correct test (by name or by formula) and checks appropriate assumptions.

Two-sample z-test for proportions

$$z = \frac{\hat{p}_C - \hat{p}_N}{\sqrt{\frac{\hat{p}(1-\hat{p})}{n_C} + \frac{\hat{p}(1-\hat{p})}{n_N}}}$$

Assumptions/Conditions:
It is given that the conditions for inference have been checked and verified.

Step 3: Correct mechanics, including the value of the test statistic and p-value (or rejection region)

$$\hat{p}_C = \frac{21}{50} = 0.42$$

$$\hat{p}_N = \frac{17}{50} = 0.34$$

$$\hat{p} = \frac{21+17}{50+50} = \frac{38}{100} = 0.38$$

© 2013 The College Board.
Visit the College Board on the Web: www.collegeboard.org.

Question 6 (continued)

$$z = \frac{0.42 - 0.34}{\sqrt{\frac{(0.38)(0.62)}{50} + \frac{(0.38)(0.62)}{50}}} = \frac{0.08}{\sqrt{0.0094}} = \frac{0.08}{0.097} = 0.82$$

p-value $= 0.2061$

Calculator: $z = 0.8241$, p-value $= 0.2049$

Step 4: State a correct conclusion in the context of the problem, using the results of the statistical test.

Since the p-value $= 0.20$ is greater than the significance level, $\alpha = 0.10$, the null hypothesis is not rejected. There is not sufficient evidence to conclude that the proportion suffering stomach irritation is less for patients treated with the new pain medication than for patients treated with the current pain medication.

Part (b):

Since we did not reject the null hypothesis in part (a), it is possible we committed a Type II error which is the failure to reject a false null hypothesis. A possible consequence is that the marketing of the drug will be delayed, preventing more people from receiving this medication who could be helped with the new medication for pain relief and experience less stomach irritation.

A possible consequence of a Type I error (rejecting a true null hypothesis) is to market and promote the new drug over the current drug when in fact the new drug is not less likely to cause stomach irritation than the current drug. However, based on the decision in part (a), a Type I error can't occur.

Part (c):

From the simulated distribution of p-values, we want to estimate the probability that the simulated p-value is less than the significance level of $\alpha = 0.10$. We note that the frequencies for the first two intervals (0 to 0.05 and 0.05 to 0.10) of simulated p-values are about 45 and 11. The estimated power of this test would be about (45 + 11)/100 = 56/100 = 0.56.

Part (d):

The value of 0.56 is an estimate of the probability of rejecting the null hypothesis (which assumes the proportions of patients with stomach irritation are the same for the two medications) when actually 40% of the patients taking the current medication have stomach irritation and 30% of the patients taking the new medication have stomach irritation, the sample size is 200, and a significance level of 0.10 is used. In repeated random assignment, we would expect about 56% of the time to make a correct decision to reject the null hypothesis under these circumstances.

© 2013 The College Board.
Visit the College Board on the Web: www.collegeboard.org.

Question 6 (continued)

Scoring

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

Part (a) is scored as follows:

Steps 2 and 3 in part (a) will be considered as one step. Each of the three steps 1, 2 and 3 together, and 4 is scored as correct or incorrect.

Essentially correct (E) if all three steps are correct.

Partially correct (P) if two steps are correct.

Incorrect (I) if, at most, one step or less is correct.

Notes:

1. If the student says "accept H_0" (or something equivalent, such as reject H_a) in the conclusion step, the conclusion step is scored as incorrect.
2. It is possible to answer part (a) using a Chi Square test of homogeneity. If a student does a Chi Square test, to get the hypotheses step the hypotheses must be in terms of proportions (not independence) and the alternative hypothesis must be one sided. To get credit for the test statistic/computation step, the *p*-value must be correct for the alternative hypothesis given in part (a) For the Chi Square test, $\chi^2 = 0.679$, df = 1, and *p*-value = $\frac{0.410}{2} = 0.205$.
3. It is possible to answer part (a) using a one-sided confidence interval. Papers using a confidence interval approach should be referred to a table leader for scoring.
4. Some students may work with the proportion that do not experience stomach irritation. This is acceptable as long as the parameters are defined and the hypotheses are correct for this situation. The *p*-value will be the same.

Part (b) is scored as follows:

Essentially correct (E) if the correct error is named based on the decision in part (a) and a reasonable consequence is described in context for the error named.

Partially correct (P) if the incorrect error is named based on the decision in part (a) but a reasonable consequence is described in context for this type of error,
OR
the consequences of both types of error are described in context, but there is no decision about which type of error is possible or the student says both types of error are possible,
OR
the consequences for both types of errors are discussed in context but the labeling of type I and type II is reversed,
OR
no consequences are given but the error is named *AND* is linked to the conclusion in part (a) *AND* the definition of both errors are given in context.

Incorrect (I) if an error is named but a reasonable consequence is not described or no consequence is described.

© 2013 The College Board.
Visit the College Board on the Web: www.collegeboard.org.

Question 6 (continued)

Notes:
1. If a student only describes the consequence of one type of error, you can assume that the student selected this type of error as the type of error that might have occurred.
2. If the student also describes a consequence of a Type I error, but the description is incorrect, part (b) is at best partially correct.

Part (c) is scored as follows:

Essentially correct (E) if the student gives (1) a reasonable value for the estimated power and (2) a reasonable justification.

Partially correct (P) if the response demonstrates that the student knows the difference between power and type II error and a justification is provided, but the student mistakenly computes probability of type II error as 0.56 and therefore gets $\text{power} = 0.44$
OR
the student gives a reasonable value for the estimated power, but the justification is weak.

Notes:
1. The student must show how they obtained the estimated value either through description or by marking the distribution of simulated *p*-values.
2. If the student calculates an estimate for β (the probability of type II error) rather than power, part (c) is scored as incorrect, but part (d) can be scored as correct if a correct interpretation is given for β.

Part (d)

There are 4 aspects to a thorough response:
1. The response should be in context.
2. The response should indicate that power looks at the probability of rejecting the null hypothesis.
3. The response should indicate that the value computed in part (c) is only an *estimate* of power (based on the simulation).
4. The response should indicate that the value computed in part (c) is an estimate of power that is for the particular circumstances described in the problem (that is, population proportions of 0.4 and 0.3, $n = 200$, $\alpha = 0.10$).

Part (d) is scored as follows:

Essentially correct (E) if the response includes aspects1 and 2 above and at least one of aspects 3 and 4.

Partially correct (P) if the response includes at least 2 of the four aspects listed above, but does not have the necessary components for an E.

Incorrect (I) if the response includes zero or one of the four aspects listed above.

© 2013 The College Board.
Visit the College Board on the Web: www.collegeboard.org.

Question 6 (continued)

Each essentially correct (E) response counts as 1 point. Each partially correct (P) response 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 determine whether to score up or down depending on the overall strength of the response and communication.

© 2013 The College Board.
Visit the College Board on the Web: www.collegeboard.org.

Scoring Worksheet

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

2013 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
52-67	4
39-51	3
28-38	2
0-27	1

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.

Visit the College Board on the Web: www.collegeboard.org.