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

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

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

Students are expected to bring graphing calculators with statistical capabilities to the AP Statistics Exam. Nongraphing scientific calculators are permitted as long as they have the required computational capabilities. Before starting the exam administration, make sure each student has a graphing calculator from the approved list on page 52 of the *2017–18 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 49–52 of the *AP Coordinator’s Manual* for more information. If the student does not want to use the calculator you provide, or does not want to use a calculator at all, he or she must hand copy, date, and sign the release statement on page 51 of the *AP Coordinator’s Manual*.

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

SECTION I: Multiple Choice

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

Make sure you begin the exam at the designated time. Remember, you must complete a seating chart for this exam. See pages 303–304 for a seating chart template and instructions. See the *2017–18 AP Coordinator’s Manual* for exam seating requirements (pages 55–58).

If you are giving the regularly scheduled exam, say:

It is Thursday afternoon, May 17, 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 23, and you will be taking the AP Statistics Exam.

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

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

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

In a moment, you will open the exam packet. By opening this packet, you agree to all of the AP Program’s policies and procedures outlined in the *2017–18 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. Place it on page 1 of your answer sheet on the light blue box near the top right corner that reads “AP Exam Label.” . . .

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

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

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

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

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

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

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

Are there any questions? . . .

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

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

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



Note Start Time _____ . Note Stop Time _____ .

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

After 1 hour and 20 minutes, say:

There are 10 minutes remaining.

After 10 minutes, say:

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

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

After all answer sheets have been collected, say:

Now you must seal your exam booklet using the white seals you set aside earlier. Remove the white seals from the backing and press one on each area of your exam booklet cover marked "PLACE SEAL HERE." Fold each seal over the back cover. When you have finished, place the booklet on your desk, faceup. I will now collect your Section I booklet. . . .

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

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

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

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



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

SECTION II: Free Response

After the break, say:

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

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

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

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

Read the last statement. . . .

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

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

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

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

Read Item 4. . . .

Are there any questions? . . .

If this is your last AP Exam, you may keep your Student Pack. Place it under your chair for now. Otherwise I will collect all Student Packs. . . .

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.

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

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

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

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



EXAMPLES OF INCOMPLETE MARKS



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

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

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

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

DO NOT WRITE IN THIS AREA

76	(A)	(B)	(C)	(D)	(E)
77	(A)	(B)	(C)	(D)	(E)
78	(A)	(B)	(C)	(D)	(E)
79	(A)	(B)	(C)	(D)	(E)
80	(A)	(B)	(C)	(D)	(E)
81	(A)	(B)	(C)	(D)	(E)
82	(A)	(B)	(C)	(D)	(E)
83	(A)	(B)	(C)	(D)	(E)
84	(A)	(B)	(C)	(D)	(E)
85	(A)	(B)	(C)	(D)	(E)
86	(A)	(B)	(C)	(D)	(E)
87	(A)	(B)	(C)	(D)	(E)
88	(A)	(B)	(C)	(D)	(E)
89	(A)	(B)	(C)	(D)	(E)
90	(A)	(B)	(C)	(D)	(E)

91	(A)	(B)	(C)	(D)	(E)
92	(A)	(B)	(C)	(D)	(E)
93	(A)	(B)	(C)	(D)	(E)
94	(A)	(B)	(C)	(D)	(E)
95	(A)	(B)	(C)	(D)	(E)
96	(A)	(B)	(C)	(D)	(E)
97	(A)	(B)	(C)	(D)	(E)
98	(A)	(B)	(C)	(D)	(E)
99	(A)	(B)	(C)	(D)	(E)
100	(A)	(B)	(C)	(D)	(E)
101	(A)	(B)	(C)	(D)	(E)
102	(A)	(B)	(C)	(D)	(E)
103	(A)	(B)	(C)	(D)	(E)
104	(A)	(B)	(C)	(D)	(E)
105	(A)	(B)	(C)	(D)	(E)

106	(A)	(B)	(C)	(D)	(E)
107	(A)	(B)	(C)	(D)	(E)
108	(A)	(B)	(C)	(D)	(E)
109	(A)	(B)	(C)	(D)	(E)
110	(A)	(B)	(C)	(D)	(E)
111	(A)	(B)	(C)	(D)	(E)
112	(A)	(B)	(C)	(D)	(E)
113	(A)	(B)	(C)	(D)	(E)
114	(A)	(B)	(C)	(D)	(E)
115	(A)	(B)	(C)	(D)	(E)
116	(A)	(B)	(C)	(D)	(E)
117	(A)	(B)	(C)	(D)	(E)
118	(A)	(B)	(C)	(D)	(E)
119	(A)	(B)	(C)	(D)	(E)
120	(A)	(B)	(C)	(D)	(E)

		/	/	/	
-
	0	0	0	0	
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9

-	.	/	/	/	.
1	0	0	0	0	0
2	1	1	1	1	1
3	2	2	2	2	2
4	3	3	3	3	3
5	4	4	4	4	4
6	5	5	5	5	5
7	6	6	6	6	6
8	7	7	7	7	7
9	8	8	8	8	8
	9	9	9	9	9

		/	/	/	
-
	0	0	0	0	0
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9

—	•	/	/	/	
1	0	0	0	0	0
2	1	1	1	1	1
3	2	2	2	2	2
4	3	3	3	3	3
5	4	4	4	4	4
6	5	5	5	5	5
7	6	6	6	6	6
8	7	7	7	7	7
9	8	8	8	8	8

		/	/	/	
-
	0	0	0	0	0
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9

		/	/	/	
-
	0	0	0	0	0
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9

131 (A) (B) (C) (D)

132 (A) (B) (C) (D)

133 (A) (B) (C) (D)

134 (A) (B) (C) (D)

135 (A) (B) (C) (D)

136 (A) (B) (C) (D)

137 (A) (B) (C) (D)

138 (A) (B) (C) (D)

139 (A) (B) (C) (D)
140 (A) (B) (C) (D)
141 (A) (B) (C) (D)
142 (A) (B) (C) (D)

AP[®] Statistics Exam

SECTION I: Multiple Choice

2018

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

At a Glance

Total Time

1 hour and 30 minutes

Number of Questions

40

Percent of Total Score

50%

Writing Instrument

Pencil required

Electronic Device

Graphing calculator
expected

Instructions

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

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

Sample Question Sample Answer

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

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

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

Form I
Form Code 4OBP4-S

90

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

Formulas

(I) Descriptive Statistics

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

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

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

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

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

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

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

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

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

(II) Probability

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

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

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

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

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

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

$$\mu_x = np$$

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

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

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

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

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

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

(III) Inferential Statistics

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

Confidence interval: $\text{statistic} \pm (\text{critical value}) \cdot (\text{standard deviation of statistic})$

Single-Sample

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

Two-Sample

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

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

STATISTICS

SECTION I

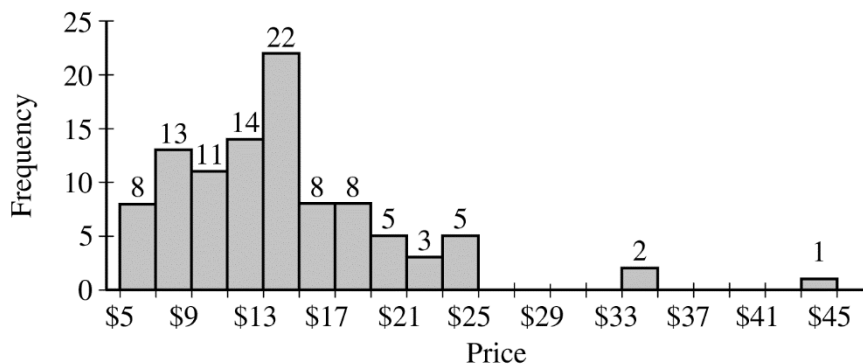
Time—1 hour and 30 minutes

Number of questions—40

Percent of total score—50

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

1. The histogram shown summarizes the responses of 100 people when asked, “What was the price of the last meal you purchased?”



Based on the histogram, which of the following could be the interquartile range of the prices?

- (A) \$40
- (B) \$21
- (C) \$10
- (D) \$5
- (E) \$3

2. Suppose a certain scale is not calibrated correctly, and as a result, the mass of any object is displayed as 0.75 kilogram less than its actual mass. What is the correlation between the actual masses of a set of objects and the respective masses of the same set of objects displayed by the scale?
- (A) -1
(B) -0.75
(C) 0
(D) 0.75
(E) 1

-
3. A veterinarian collected data on the weights of 1,000 cats and dogs treated at a veterinary clinic. The weight of each animal was classified as either healthy, underweight, or overweight. The data are summarized in the table.

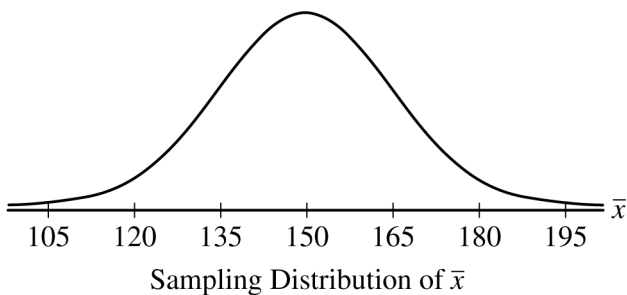
	Healthy	Underweight	Overweight	Total
Cat	386	54	105	545
Dog	299	83	73	455
Total	685	137	178	1,000

Based on the data in the table, which of the following is the most appropriate type of graph to visually show whether a relationship exists between the type of animal and the weight classification?

- (A) Back-to-back stemplots
(B) Scatterplot
(C) Side-by-side boxplots
(D) Segmented bar chart
(E) Dotplot

4. A program exists to encourage more middle school students to major in math and science when they go to college. The organizers of the program want to estimate the proportion of students who, after completing the program, go on to major in math or science in college. The organizers will select a sample of students from a list of all students who completed the program. Which of the following sampling methods describes a stratified random sample?
- (A) Select all female students on the list.
 - (B) Randomly select 50 students on the list.
 - (C) Randomize the names on the list and then select every tenth student on the randomized list.
 - (D) Randomly select 25 names from the female students on the list and randomly select 25 names from the male students on the list.
 - (E) Randomly select 50 students on the list who are attending college.

5. The normal curve shown represents the sampling distribution of a sample mean for sample size $n = 25$, selected at random from a population with standard deviation σ_x .



Which of the following is the best estimate of the standard deviation of the population, σ_x ?

- (A) 3
- (B) 6
- (C) 15
- (D) 30
- (E) 75

6. Two random samples, A and B, were selected from the same population to estimate the population mean. For each sample, the mean, standard deviation, and margin of error for a 95 percent confidence interval for the population mean are shown in the table.

	Mean	Standard Deviation	Margin of Error
Sample A	45	6.45	1.02
Sample B	43	7.84	0.72

Which of the following could explain why the margin of error of sample A is greater than the margin of error of sample B?

- (A) The sample size of A is greater than the sample size of B.
- (B) The sample size of A is less than the sample size of B.
- (C) The sample size of A is equal to the sample size of B.
- (D) The mean of sample A is greater than the mean of sample B.
- (E) The standard deviation of sample A is less than the standard deviation of sample B.

7. Nyasha's financial literacy project involved comparing the annual sales of companies in Canada and companies in the United States that produce software. Using the ratio of 1 Canadian dollar to 0.75 United States dollar, she converted all annual sales from the Canadian companies into United States dollars. For which of the following will the value of the statistic for the annual sales in Canadian dollars be equal to the value of the corresponding statistic in United States dollars?
- (A) The median annual sales
 - (B) The standard deviation of the annual sales
 - (C) The standardized score of the minimum annual sales
 - (D) The mean annual sales
 - (E) The interquartile range of the annual sales

8. The manager of a restaurant tracks the types of dinners that customers order from the menu to ensure that the correct amount of food is ordered from the supplier each week. Data from customer orders last year suggest the following weekly distribution.

Type of Dinner	Beef	Chicken	Fish	Pork	Vegetarian
Proportion	0.18	0.41	0.15	0.20	0.06

The manager believes that there might be a change in the distribution from last year to this year. A random sample of 200 orders was taken from all customer orders placed last week. The following table shows the results of the sample.

Type of Dinner	Beef	Chicken	Fish	Pork	Vegetarian
Frequency	32	86	34	30	18

Assume each order is independent. For which type of dinner is the value of its contribution to the appropriate test statistic the greatest?

- (A) Beef
- (B) Chicken
- (C) Fish
- (D) Pork
- (E) Vegetarian

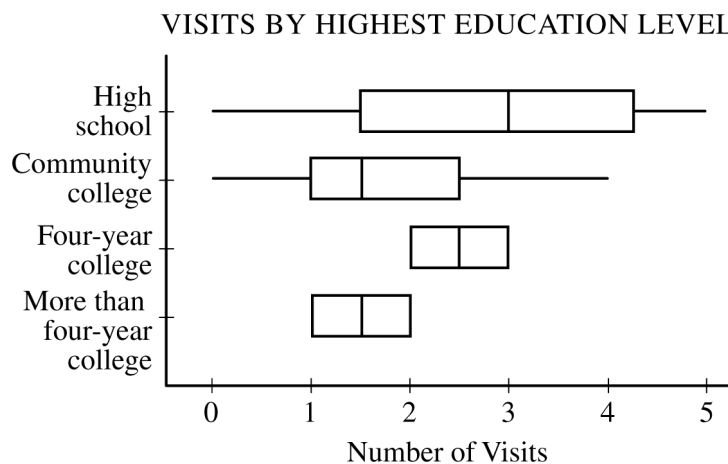
9. A company that makes fleece clothing uses fleece produced from two farms, Northern Farm and Western Farm. Let the random variable X represent the weight of fleece produced by a sheep from Northern Farm. The distribution of X has mean 14.1 pounds and standard deviation 1.3 pounds. Let the random variable Y represent the weight of fleece produced by a sheep from Western Farm. The distribution of Y has mean 6.7 pounds and standard deviation 0.5 pound. Assume X and Y are independent. Let W equal the total weight of fleece from 10 randomly selected sheep from Northern Farm and 15 randomly selected sheep from Western Farm. Which of the following is the standard deviation, in pounds, of W ?

- (A) $1.3 + 0.5$
- (B) $\sqrt{1.3^2 + 0.5^2}$
- (C) $\sqrt{10(1.3)^2 + 15(0.5)^2}$
- (D) $\sqrt{10^2(1.3)^2 + 15^2(0.5)^2}$
- (E) $\sqrt{\frac{1.3^2}{10} + \frac{0.5^2}{15}}$

-
10. According to a report for veterinarians in the United States, 36.5 percent of households in the United States own dogs and 30.4 percent of households in the United States own cats. If one household in the United States is selected at random, what is the probability that the selected household will own a dog or a cat?

- (A) 0.111
- (B) 0.331
- (C) 0.558
- (D) 0.669
- (E) Not enough information is given to determine the probability.

11. A sociologist collected data from a sample of people on their highest level of education and the number of times they visited any fast food restaurant during the previous week. The data are summarized in the boxplots.



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

- (A) The number of people surveyed at the more than four-year college level is greater than the number of people surveyed at the high school level.
- (B) The proportion of people surveyed from the first quartile to the third quartile at the four-year college level is less than the respective proportion at the community college level.
- (C) The interquartile range (IQR) for the number of visits at the more than four-year college level is less than the IQR for the number of visits at the community college level.
- (D) The maximum number of visits at the community college level is greater than the maximum number of visits at the high school level.
- (E) The median number of visits at the four-year college level is greater than the median number of visits at the high school level.

12. For a recent season in college football, the total number of rushing yards for that season is recorded for each running back. The mean number of rushing yards for the running backs that season is 790 yards. One running back had 1,637 rushing yards for the season, which is 2.42 standard deviations above the mean number of rushing yards. What is the standard deviation of the number of rushing yards for the running backs that season?
- (A) 250 yards
(B) 300 yards
(C) 350 yards
(D) 400 yards
(E) 450 yards

-
13. First-year students enrolled at a college were asked whether they play video games. The responses, classified by whether the students were enrolled in the school of sciences or the school of arts, are shown in the table.

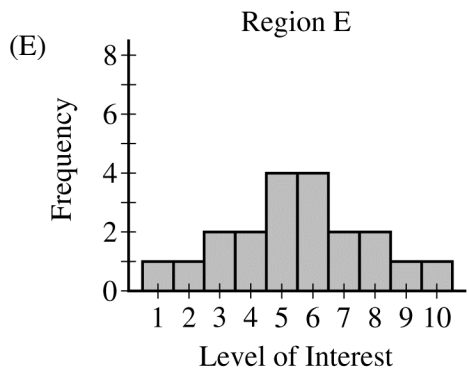
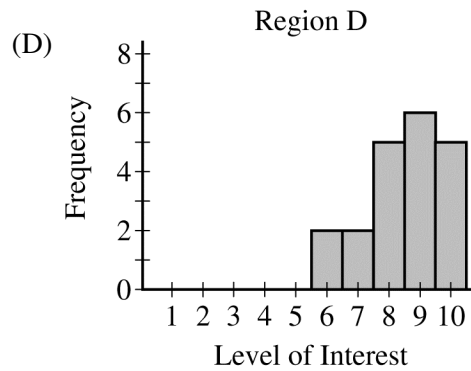
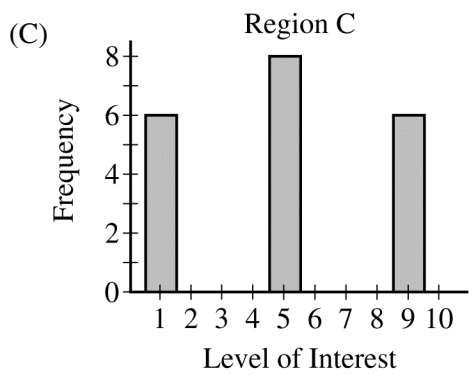
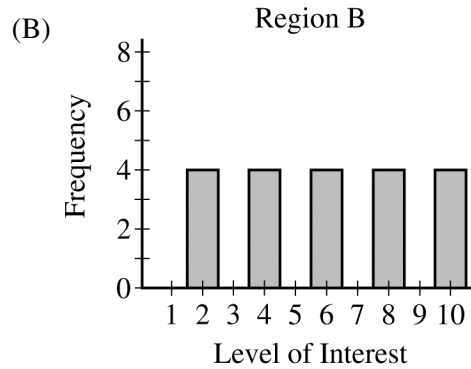
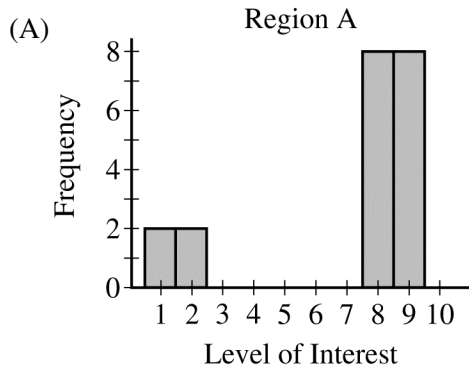
	Play Video Games	Do Not Play Video Games	Total
Sciences	519	120	639
Arts	347	446	793
Total	866	566	1,432

Of all the students enrolled in the school of arts who responded, approximately what proportion responded that they play video games?

- (A) 0.242
(B) 0.401
(C) 0.438
(D) 0.554
(E) 0.605

14. A pharmaceutical company manufactures medicine to reduce pain caused by migraine headaches. The company is investigating whether a new medicine is more effective in reducing pain than the current medicine. A random sample of 500 participants who experience migraines was selected, and the participants were randomly assigned to one of two groups of equal size. The first group received the current medicine and the second group received the new medicine. When a participant experienced a migraine, he or she was instructed to take the medicine and, 15 minutes after taking the medicine, to rate the pain relief on a scale from 1 to 10, with 1 being no relief to 10 being complete relief. At the end of six months, the average pain relief for each participant was calculated. Which of the following is the best description of the study?
- (A) An experiment using a completely randomized design
 - (B) An experiment using a matched-pairs design
 - (C) An observational study using a simple random sample
 - (D) An observational study using a cluster sample
 - (E) An observational study using a stratified sample

15. A marketing firm obtained random samples of 20 people in five regions of the country to investigate the level of interest in a new product. People in the sample were asked to rate their level of interest on a scale from 1 to 10, with 1 being the least amount of interest and 10 being the greatest. The histograms show the results for each region. The graph for which region displays data for level of interest with the least standard deviation?



16. The transportation department of a large city wants to estimate the proportion of residents who would use a system of aerial gondolas to commute to work. The gondolas would be part of the city's effort to relieve traffic congestion. The department asked a random sample of residents whether they would use the gondolas. The residents could respond with yes, no, or maybe. Which of the following is the best description of the method for data collection used by the department?
- (A) A census
 - (B) A sample survey
 - (C) An experiment with a completely randomized design
 - (D) An experiment with a randomized block design
 - (E) An experiment with a matched-pairs design

17. To obtain certification for a certain occupation, candidates take a proficiency exam. The exam consists of two sections, and neither section should be more difficult than the other. To investigate whether one section of the exam was more difficult than the other, a random sample of 50 candidates was selected. The candidates took the exam and their scores on each section were recorded. The table shows the summary statistics.

	Mean Percent Correct	Standard Deviation Percent Correct
First section	75	10
Second section	65	5
Difference	10	8

Which of the following is the test statistic for the appropriate test to determine if there is a significant mean difference between the percent correct on the two sections (first minus second) for all candidates similar to those in the investigation?

(A) $t = \frac{75 - 65}{\frac{8}{\sqrt{50}}}$

(B) $t = \frac{75 - 65}{\sqrt{\frac{10^2}{50} + \frac{5^2}{50}}}$

(C) $\chi^2 = \frac{(75 - 70)^2}{70} + \frac{(65 - 70)^2}{70}$

(D) $\chi^2 = \frac{(75 - 70)^2}{75} + \frac{(65 - 70)^2}{65}$

(E) $z = \frac{0.75 - 0.65}{\sqrt{0.7(1 - 0.7)\left(\frac{1}{50} + \frac{1}{50}\right)}}$

18. New employees at a large corporation go through a training program during their first week of employment. The new employees take a written assessment at the completion of the program to determine how well prepared they are for their jobs. A score greater than the mean indicates a well-prepared employee. Assume the following distributions of new employee scores have the same mean score, the same maximum score, and the same minimum score. Which distribution has a shape that is most likely to represent the greatest percent of well-prepared employees?
- (A) The distribution of scores is skewed to the right.
 - (B) The distribution of scores is skewed to the left.
 - (C) The distribution of scores is bimodal and symmetric.
 - (D) The distribution of scores is uniform.
 - (E) The distribution of scores is approximately normal.

19. Based on his past record, Luke, an archer for a college archery team, has a probability of 0.90 of hitting the inner ring of the target with a shot of the arrow. Assume that in one practice Luke will attempt 5 shots of the arrow and that each shot is independent from the others. Let the random variable X represent the number of times he hits the inner ring of the target in 5 attempts. The probability distribution of X is given in the table.

X	0	1	2	3	4	5
$P(X)$	0.00001	0.00045	0.00810	0.07290	0.32805	0.59049

What is the probability that the number of times Luke will hit the inner ring of the target out of the 5 attempts is less than the mean of X ?

- (A) 0.40951
- (B) 0.50000
- (C) 0.59049
- (D) 0.91854
- (E) 0.99144

20. A medical center conducted a study to investigate cholesterol levels in people who have had heart attacks. A random sample of 16 people was obtained from the names of all patients of the medical center who had a heart attack in the previous year. Of the people in the sample, the mean cholesterol level was 264.70 milligrams per deciliter (mg/dL) with standard deviation 42.12 mg/dL. Assuming all conditions for inference were met, which of the following is a 90 percent confidence interval for the mean cholesterol level, in mg/dL, of all patients of the medical center who had a heart attack in the previous year?
- (A) (242.26, 287.14)
 - (B) (244.06, 285.34)
 - (C) (246.24, 283.16)
 - (D) (247.38, 282.02)
 - (E) (260.09, 269.31)

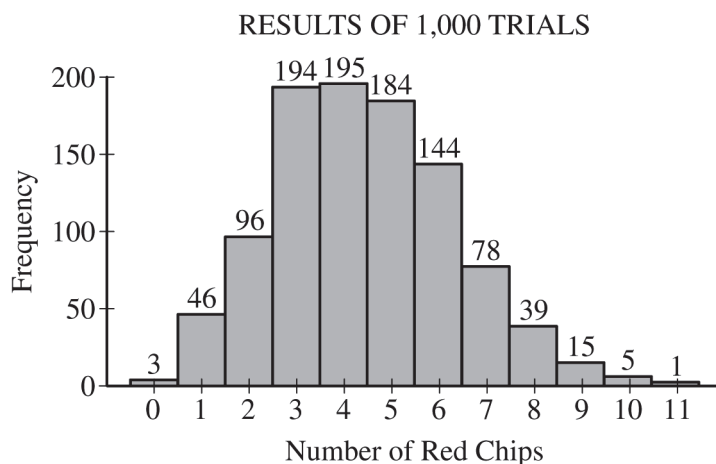
21. For a school fund-raiser, 600 raffle tickets were sold by students at the school, of which 88 were sold by one student, Audrey. Of the 600 tickets sold, 30 were randomly selected to receive prizes, and 7 of the 30 tickets selected were tickets sold by Audrey. To investigate how likely it was by chance alone that at least 7 of the 30 selected tickets could have been sold by Audrey, students in a statistics class ran a simulation. One trial of the simulation is described by the following steps.

Step 1: From 600 chips, assign 88 red and the rest blue.

Step 2: Select 30 chips at random without replacement.

Step 3: Record the number of red chips in the selection of 30.

The results of 1,000 trials of the simulation are shown in the histogram.



Based on the results of the simulation, is there convincing statistical evidence at the significance level of 0.05 that the event of Audrey selling at least 7 of the 30 selected tickets is unlikely to have occurred by chance alone?

- (A) Yes, because the distribution of the trials in the simulation is skewed to the right.
- (B) Yes, because the number in the histogram with the greatest frequency is 4, not 7.
- (C) Yes, because 7 appears in the right tail of the distribution, indicating that it is more than 2 standard deviations away from the mean.
- (D) No, because the simulation suggests that it is likely that Audrey could sell anywhere from 0 to 11 of the selected tickets.
- (E) No, because the simulation suggests that Audrey selling at least 7 of 30 selected tickets would occur about 13.8% of the time.

22. As part of a study on facility needs, the administrators of a university wanted to estimate the percent of students who use the exercise facilities on a regular basis. From the 34,000 students who attend the university, a random sample of 370 male students and 400 female students was selected. Of the 770 students selected, 493 students indicated that they use the exercise facilities on a regular basis. What are the population and the sample of the study?
- (A) The population is the 770 students who were selected, and the sample is the 493 students who indicated that they use the exercise facilities on a regular basis.
 - (B) The population is the 770 students who were selected, and the sample is whether each student in the survey uses the exercise facility on a regular basis.
 - (C) The population is the 34,000 students who attend the university, and the sample is whether each student in the survey is male or female.
 - (D) The population is the 34,000 students who attend the university, and the sample is the 770 students who were selected.
 - (E) The population is the 34,000 students who attend the university, and the sample is the 493 students who indicated that they use the exercise facilities on a regular basis.

-
23. A study will be conducted to examine a new medicine intended to reduce high blood pressure in adult men who have high blood pressure. As part of the study, a random sample of 40 men with high blood pressure will have their blood pressure measured, and then they will take the new medicine every day for one month. At the end of the month, their blood pressure will be measured again. Of the following, which is the best procedure to investigate whether there will be convincing statistical evidence of a change, on average, in blood pressure for men with high blood pressure who take the new medicine?
- (A) A one-sample z -test for a proportion
 - (B) A two-sample z -test for a difference between proportions
 - (C) A two-sample t -test for the difference between two means
 - (D) A matched-pairs t -test for a mean difference
 - (E) A chi-square test of independence

24. A roadrunner is a desert bird that tends to run instead of fly. While running, the roadrunner uses its tail as a balance. A sample of 10 roadrunners was taken, and the birds' total length, in centimeters (cm), and tail length, in cm, were recorded. The output shown in the table is from a least-squares regression to predict tail length given total length.

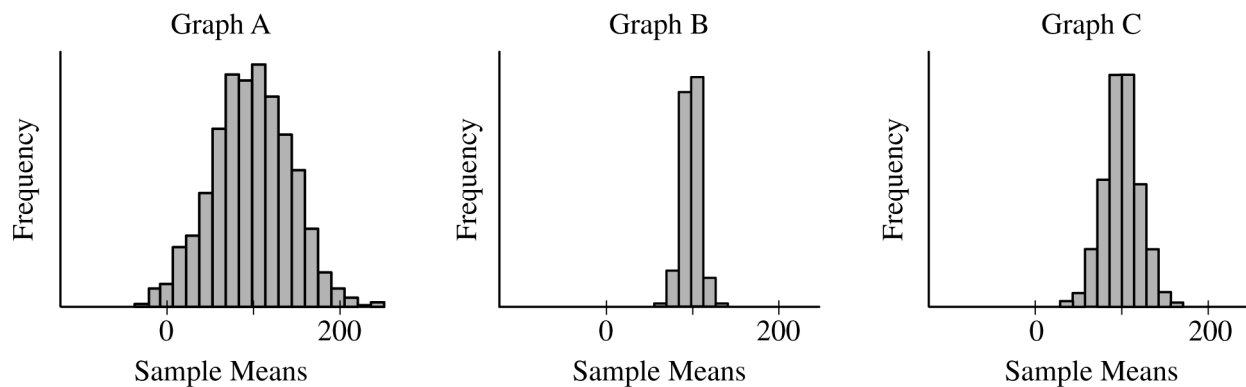
Term	Coef	SE Coef
Constant	-1.281	2.673
Total Length	0.5264	0.0467

Suppose a roadrunner has a total length of 59.0 cm and tail length of 31.1 cm. Based on the residual, does the regression model overestimate or underestimate the tail length of the roadrunner?

- (A) Underestimate, because the residual is positive.
- (B) Underestimate, because the residual is negative.
- (C) Overestimate, because the residual is positive.
- (D) Overestimate, because the residual is negative.
- (E) Neither, because the residual is 0.

25. The distribution of assembly times required to assemble a certain smartphone is approximately normal with mean 4.6 minutes and standard deviation 0.6 minute. Of the following, which is closest to the percentage of assembly times between 4 minutes and 5 minutes?
- (A) 34%
 - (B) 41%
 - (C) 59%
 - (D) 68%
 - (E) 95%
-
26. A company produces millions of 1-pound packages of bacon every week. Company specifications allow for no more than 3 percent of the 1-pound packages to be underweight. To investigate compliance with the specifications, the company's quality control manager selected a random sample of 1,000 packages produced in one week and found 40 packages, or 4 percent, to be underweight. Assuming all conditions for inference are met, do the data provide convincing statistical evidence at the significance level of $\alpha = 0.05$ that more than 3 percent of all the packages produced in one week are underweight?
- (A) Yes, because the sample estimate of 0.04 is greater than the company specification of 0.03.
 - (B) Yes, because the p -value of 0.032 is less than the significance level of 0.05.
 - (C) Yes, because the p -value of 0.064 is greater than the significance level of 0.05.
 - (D) No, because the p -value of 0.032 is less than the significance level of 0.05.
 - (E) No, because the p -value of 0.064 is greater than the significance level of 0.05.

27. The histograms show the results of three simulations of a sampling distribution of a sample mean. For each simulation, 1,500 samples of size n were selected from the same population and the sample mean was recorded. The value of n was different for each of the three simulations.



Which of the following is the correct ordering of the graphs from least value of n to greatest value of n ?

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

28. Researchers conducted a study to investigate the effects of soft drink consumption on fat stored in muscle tissue. From a sample of 80 adult volunteers, 40 were randomly assigned to consume one liter of a soft drink each day. The remaining 40 were asked to drink one liter of water each day and not to consume any soft drinks. At the end of six months, the amount of fat stored in each person's muscle tissue was recorded. The people in the group who drank the soft drink had, on average, a higher percentage of fat stored in the tissue than the people who drank only water. Which of the following is the most appropriate conclusion?
- (A) There is evidence that consuming soft drinks causes more fat storage in muscle tissue than drinking only water, and the conclusion can be generalized to all adults.
 - (B) There is evidence that consuming soft drinks causes more fat storage in muscle tissue than drinking only water, and the conclusion can be generalized to all people who consume soft drinks.
 - (C) There is evidence that consuming soft drinks causes more fat storage in muscle tissue than drinking only water, and the conclusion can be generalized to adults similar to those in the study.
 - (D) Although cause-and-effect cannot be established, there is an association between consuming soft drinks and fat storage in muscle tissue for the population of all adults.
 - (E) Although cause-and-effect cannot be established, there is an association between consuming soft drinks and fat storage in muscle tissue for the population of all adults who consume soft drinks.

29. A random sample of 1,018 city residents were asked to rate their level of support for a proposal being considered by the city council. The table shows the responses by level of support.

Level of Support	Number of Responses
Very supportive	336
Somewhat supportive	387
Not supportive	295

Based on the responses, which of the following is a 95 percent confidence interval for the proportion of all city residents who would respond very supportive or somewhat supportive of the proposal?

- (A) 0.33 ± 0.029
- (B) 0.38 ± 0.030
- (C) 0.71 ± 0.058
- (D) 0.71 ± 0.031
- (E) 0.71 ± 0.028

30. A manufacturer of cell phone batteries claims that the average number of recharge cycles for its batteries is 400. A consumer group will obtain a random sample of 100 of the manufacturer's batteries and will calculate the mean number of recharge cycles. Which of the following statements is justified by the central limit theorem?
- (A) The distribution of the number of recharge cycles for the sample is approximately normal because the population mean of 400 is greater than 30.
 - (B) The distribution of the number of recharge cycles for the sample is approximately normal because the sample size of 100 is greater than 30.
 - (C) The distribution of the number of recharge cycles for the population is approximately normal because the sample size of 100 is greater than 30.
 - (D) The distribution of the sample means of the number of recharge cycles is approximately normal because the sample size of 100 is greater than 30.
 - (E) The distribution of the sample means of the number of recharge cycles is approximately normal because the population mean of 400 is greater than 30.

31. A news organization conducted a survey about preferred methods for obtaining the news. A random sample of 1,605 adults living in a certain state was selected, and 16.2 percent of the adults in the sample reported that television was their preferred method. Which of the following is an appropriate margin of error for a 90 percent confidence interval to estimate the population proportion of all adults living in the state who would report that television is their preferred method for obtaining the news?

(A) $1.645\sqrt{\frac{(0.162)(1 - 0.162)}{1,605}}$

(B) $1.645\sqrt{\frac{(0.5)(1 - 0.5)}{1,605}}$

(C) $1.96\sqrt{\frac{(0.162)(1 - 0.162)}{1,605}}$

(D) $1.96\sqrt{\frac{(0.5)(1 - 0.5)}{1,605}}$

(E) $1.83\sqrt{\frac{(0.162)(1 - 0.162)}{1,605}}$

32. A fitness center offers a one-month program designed to reduce body fat through exercise. The table shows the body fat percentage before and after completing the program for 10 randomly selected participants.

Participant	A	B	C	D	E	F	G	H	I	J
Before (%)	10.8	21.5	18.9	17.0	20.8	24.6	15.4	18.2	19.9	21.2
After (%)	10.7	20.4	19.1	16.1	20.6	22.3	15.5	18.1	18.5	20.0

The director of the program wants to investigate whether knowing the body fat percentage before beginning the program can help to predict body fat percentage for someone who completes the program. Which of the following procedures is the most appropriate for such an investigation?

- (A) A matched-pairs t -test for a mean difference
- (B) A two-sample t -test for a difference between means
- (C) A two-sample z -test for a difference between proportions
- (D) A chi-square test of association
- (E) A linear regression t -test for slope

33. A recent survey estimated that 19 percent of all people living in a certain region regularly use sunscreen when going outdoors. The margin of error for the estimate was 1 percentage point. Based on the estimate and the margin of error, which of the following is an appropriate conclusion?
- (A) Approximately 1% of all the people living in the region were surveyed.
 - (B) Between 18% and 20% of all the people living in the region were surveyed.
 - (C) All possible samples of the same size will result in between 18% and 20% of those surveyed indicating they regularly use sunscreen.
 - (D) The probability is 0.01 that a person living in the region will use sunscreen when going outdoors.
 - (E) It is plausible that the percent of all people living in the region who regularly use sunscreen is 18.5%.

34. According to a recent report, customers who shop at a certain online store spend, on average, \$1,500 a year at the store. To investigate whether the mean amount spent was greater than the reported average, an economist obtained the mean and standard deviation of the amount spent in the past year by a random sample of 120 customers who shop at the store. With all conditions for inference met, the economist conducted the appropriate hypothesis test and obtained a p -value of 0.25. Which of the following statements is the most appropriate conclusion for the investigation?
- (A) There is convincing statistical evidence that the mean amount of money spent each year by all customers who shop at the store is \$1,500.
 - (B) There is convincing statistical evidence that the mean amount of money spent each year by all customers who shop at the store is greater than \$1,500.
 - (C) There is convincing statistical evidence that the mean amount of money spent each year by all customers who shop at the store is less than \$1,500.
 - (D) There is not convincing statistical evidence that the mean amount of money spent each year by all customers who shop at the store is greater than \$1,500.
 - (E) There is not convincing statistical evidence that the mean amount of money spent each year by any sample of 120 customers who shop at the store is greater than \$1,500.

35. Scientists working for a water district measure the water level in a lake each day. The daily water level in the lake varies due to weather conditions and other factors. The daily water level has a distribution that is approximately normal with mean water level of 84.07 feet. The probability that the daily water level in the lake is at least 100 feet is 0.064. Which of the following is closest to the probability that on a randomly selected day the water level in the lake will be at least 90 feet?
- (A) 0.29
 - (B) 0.31
 - (C) 0.34
 - (D) 0.37
 - (E) 0.50

36. The president of a large company recommends that employees perform, on average, 24 hours of community service each year. The president believes that the mean number of hours of community service performed last year was different from the recommended 24 hours. To estimate the mean number of hours of community service performed last year, the president obtained data from a random sample of employees and used the data to construct the 95 percent confidence interval (20.37, 23.49). If all conditions for inference were met, does the interval provide convincing statistical evidence, at a level of significance of $\alpha = 0.05$, to support the president's belief that the mean number of hours of community service performed last year is different from what is recommended?
- (A) Yes, the interval supports the president's belief because 0 is not contained in the interval.
 - (B) Yes, the interval supports the president's belief because 24 is not contained in the interval.
 - (C) No, the interval does not support the president's belief because a 90% confidence interval is required for a 5% level of statistical evidence.
 - (D) No, the interval does not support the president's belief because confidence intervals should only be used for estimation and cannot provide convincing statistical evidence.
 - (E) No, the interval does not support the president's belief because the significance level is equal to 1 minus the confidence level, indicating that the results are not convincing.

37. An international polling agency estimates that 36 percent of adults from Country X were first married between the ages of 18 and 32, and 26 percent of adults from Country Y were first married between the ages of 18 and 32. Based on the estimates, which of the following is closest to the probability that the difference in proportions between a random sample of 60 adults from Country X and a random sample of 50 adults from Country Y (Country X minus Country Y) who were first married between the ages of 18 and 32 is greater than 0.15 ?
- (A) 0.1398
 - (B) 0.2843
 - (C) 0.4315
 - (D) 0.5685
 - (E) 0.7157

38. A consumer group wanted to investigate the relationship between the number of items purchased at a single visit to the local grocery store and the total cost of the items purchased. The group obtained a random sample of 11 receipts from the store and recorded the total number of items and the total cost from each receipt. The computer output of an analysis of total cost versus number of items purchased is shown in the table.

	Estimate	Std Error	t Ratio	Prob > t
Intercept	1.882	6.6854	0.28	0.7847
Number of items	2.784	0.2265	12.29	< 0.0001

Assume all conditions for inference were met. Based on the results shown in the table, which of the following is a 95 percent confidence interval for the average change in total cost for each increase of 1 item purchased?

- (A) $2.784 \pm 12.29(0.2265)$
- (B) $2.784 \pm 2.262(0.2265)$
- (C) $2.784 \pm 2.262\left(\frac{0.2265}{\sqrt{11}}\right)$
- (D) $1.882 \pm 1.96(6.6854)$
- (E) $1.882 \pm 2.262(6.6854)$

39. A doctor uses a new diagnostic test to indicate whether a patient has a certain disease. The doctor will prescribe medication for the patient if the doctor believes the patient has the disease, as indicated by the diagnostic test. The situation is similar to using a null hypothesis and an alternative hypothesis to decide whether to prescribe the medication. The hypotheses can be stated as follows.

H_0 : The patient does not have the disease.

H_a : The patient has the disease.

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

- (A) The probability that the new test is better than an older test to indicate whether a patient has the disease
- (B) The probability that the new test indicates the disease in a patient who has the disease
- (C) The probability that the new test indicates the disease in a patient who does not have the disease
- (D) The probability that the new test does not indicate the disease in a patient who has the disease
- (E) The probability that the new test does not indicate the disease in a patient who does not have the disease

40. To investigate the relationship between age and preference for two mayoral candidates in an upcoming election, a random sample of city residents was surveyed. The residents were asked which candidate they preferred, and each resident was classified into one of three age-groups. The test statistic for the appropriate hypothesis test was 3.7408. Approximately what is the probability that the observed responses would be as far or farther from the expected responses if there is no association between age-group and preference?
- (A) 0.0001
 - (B) 0.1541
 - (C) 0.2908
 - (D) 0.5873
 - (E) 0.7117

END OF SECTION I

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

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

MAKE SURE YOU HAVE DONE THE FOLLOWING.

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

Table entry for z is the probability lying below z .

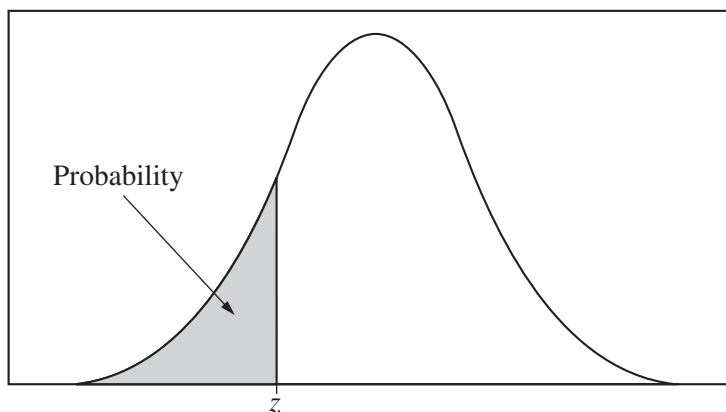


Table A Standard normal probabilities

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

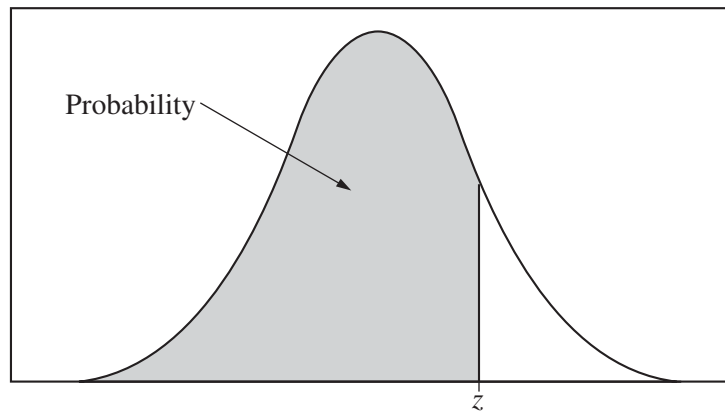


Table entry for z is the probability lying below z .

Table A (Continued)

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

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

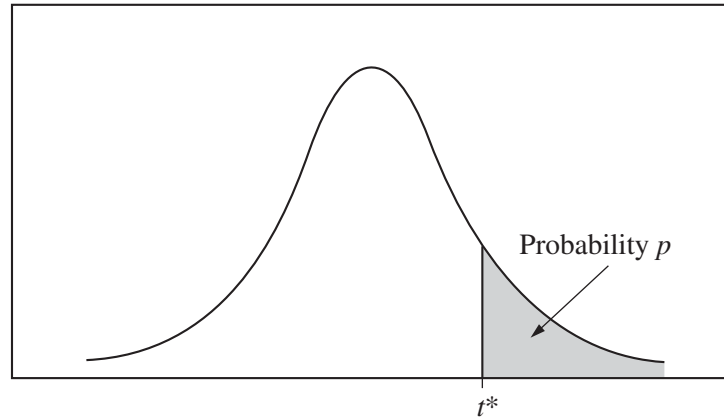


Table B t distribution critical values

df	Tail probability p											
	.25	.20	.15	.10	.05	.025	.02	.01	.005	.0025	.001	.0005
1	1.000	1.376	1.963	3.078	6.314	12.71	15.89	31.82	63.66	127.3	318.3	636.6
2	.816	1.061	1.386	1.886	2.920	4.303	4.849	6.965	9.925	14.09	22.33	31.60
3	.765	.978	1.250	1.638	2.353	3.182	3.482	4.541	5.841	7.453	10.21	12.92
4	.741	.941	1.190	1.533	2.132	2.776	2.999	3.747	4.604	5.598	7.173	8.610
5	.727	.920	1.156	1.476	2.015	2.571	2.757	3.365	4.032	4.773	5.893	6.869
6	.718	.906	1.134	1.440	1.943	2.447	2.612	3.143	3.707	4.317	5.208	5.959
7	.711	.896	1.119	1.415	1.895	2.365	2.517	2.998	3.499	4.029	4.785	5.408
8	.706	.889	1.108	1.397	1.860	2.306	2.449	2.896	3.355	3.833	4.501	5.041
9	.703	.883	1.100	1.383	1.833	2.262	2.398	2.821	3.250	3.690	4.297	4.781
10	.700	.879	1.093	1.372	1.812	2.228	2.359	2.764	3.169	3.581	4.144	4.587
11	.697	.876	1.088	1.363	1.796	2.201	2.328	2.718	3.106	3.497	4.025	4.437
12	.695	.873	1.083	1.356	1.782	2.179	2.303	2.681	3.055	3.428	3.930	4.318
13	.694	.870	1.079	1.350	1.771	2.160	2.282	2.650	3.012	3.372	3.852	4.221
14	.692	.868	1.076	1.345	1.761	2.145	2.264	2.624	2.977	3.326	3.787	4.140
15	.691	.866	1.074	1.341	1.753	2.131	2.249	2.602	2.947	3.286	3.733	4.073
16	.690	.865	1.071	1.337	1.746	2.120	2.235	2.583	2.921	3.252	3.686	4.015
17	.689	.863	1.069	1.333	1.740	2.110	2.224	2.567	2.898	3.222	3.646	3.965
18	.688	.862	1.067	1.330	1.734	2.101	2.214	2.552	2.878	3.197	3.611	3.922
19	.688	.861	1.066	1.328	1.729	2.093	2.205	2.539	2.861	3.174	3.579	3.883
20	.687	.860	1.064	1.325	1.725	2.086	2.197	2.528	2.845	3.153	3.552	3.850
21	.686	.859	1.063	1.323	1.721	2.080	2.189	2.518	2.831	3.135	3.527	3.819
22	.686	.858	1.061	1.321	1.717	2.074	2.183	2.508	2.819	3.119	3.505	3.792
23	.685	.858	1.060	1.319	1.714	2.069	2.177	2.500	2.807	3.104	3.485	3.768
24	.685	.857	1.059	1.318	1.711	2.064	2.172	2.492	2.797	3.091	3.467	3.745
25	.684	.856	1.058	1.316	1.708	2.060	2.167	2.485	2.787	3.078	3.450	3.725
26	.684	.856	1.058	1.315	1.706	2.056	2.162	2.479	2.779	3.067	3.435	3.707
27	.684	.855	1.057	1.314	1.703	2.052	2.158	2.473	2.771	3.057	3.421	3.690
28	.683	.855	1.056	1.313	1.701	2.048	2.154	2.467	2.763	3.047	3.408	3.674
29	.683	.854	1.055	1.311	1.699	2.045	2.150	2.462	2.756	3.038	3.396	3.659
30	.683	.854	1.055	1.310	1.697	2.042	2.147	2.457	2.750	3.030	3.385	3.646
40	.681	.851	1.050	1.303	1.684	2.021	2.123	2.423	2.704	2.971	3.307	3.551
50	.679	.849	1.047	1.299	1.676	2.009	2.109	2.403	2.678	2.937	3.261	3.496
60	.679	.848	1.045	1.296	1.671	2.000	2.099	2.390	2.660	2.915	3.232	3.460
80	.678	.846	1.043	1.292	1.664	1.990	2.088	2.374	2.639	2.887	3.195	3.416
100	.677	.845	1.042	1.290	1.660	1.984	2.081	2.364	2.626	2.871	3.174	3.390
1000	.675	.842	1.037	1.282	1.646	1.962	2.056	2.330	2.581	2.813	3.098	3.300
∞	.674	.841	1.036	1.282	1.645	1.960	2.054	2.326	2.576	2.807	3.091	3.291
	50%	60%	70%	80%	90%	95%	96%	98%	99%	99.5%	99.8%	99.9%
Confidence level C												

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

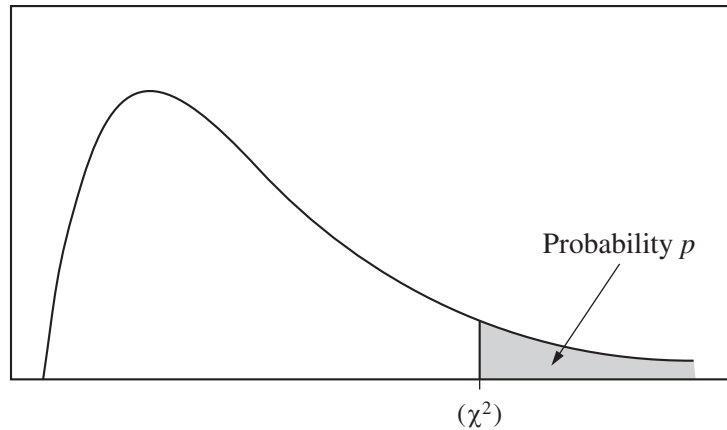


Table C χ^2 critical values

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