FAST TRACK TO A 5

Preparing for the **AP® Statistics Examination**

To Accompany

Introduction to Statistics & Data Analysis

5th and 6th Editions

by Roxy Peck, Tom Short, Chris Olsen, and Jay L. Devore

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PREFACE

The field of statistics is relevant to nearly every career you will encounter. As such, most college majors will require at least a cursory knowledge of statistics. Statistics is an integral tool used in the fields of medicine, genetics, business, mathematics, engineering, psychology, sociology, education, and political science as well as a vast majority of other careers not mentioned. Because of this, we believe this course is critical for well-educated people to be successful in their careers.

Dealing with statistics in each field of study can vary depending on the subject matter. However, the basic statistical principles are the same in all fields and all majors. Thus, the study of AP® Statistics will allow you the unique opportunity to be well prepared for virtually any college major you choose. The statistician uses mathematics to crunch numbers appropriately, but the science of statistics is found in what happens once a set of values is calculated. After these numerical values are obtained, the statistician tries to answer the question "what does this mean" by delving into connections between what one might expect to see in similar scenarios. Through the scientific use of experimental design, data analysis, probability theory, and inference testing, our decisions become critical to a vast number of careers in our world.

We hope this guide will help you successfully navigate the waters of an introductory statistics course as well as give you the ability to apply these concepts to your future studies. Hopefully, some of you will find such an interest in this field that you consider changing your career plans to become a statistician! We trust that you will find this guide to be a useful aid in your preparation for and success on the AP® Statistics exam.

Joshua Wilkerson

Viva Hathaway

Vicki Greenberg

Edward Moulton

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Joshua Wilkerson

I would like to dedicate this to my four wonderful granddaughters who keep me moving with their excitement. I want to thank my husband, Bill, for always pushing me to go beyond my comfort zone. Without this encouragement, I most likely would never have fallen in love with statistics in the first place. Thanks to my colleague Linda for keeping me real in analyzing data and my classes. Finally, without my mentor, Bill Speer, I would most likely not be as involved in mathematics. Thanks to you all! You're great! My thanks also to the reviewers, Brendan Murphy and Chris Olsen, as well as to all those involved in the editing and final production of this work.

Viva Hathaway

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Vicki Greenberg

I would like to acknowledge my late father and thriving mother, both of whom dedicated their lives to teaching undergraduate math and computer science. My thanks also to the reviewers, Brendan Murphy and Chris Olsen, the editors, and the other professionals who contributed to the publication of this work.

Ed Moulton

Part I

Strategies for the AP® Exam

PREPARING FOR THE AP® STATISTICS EXAMINATION

Advanced Placement® Statistics is an exciting, practical course that is also very challenging academically. It is designed to help the student delve deeply into the methods and concepts of the appropriate use and analysis of research. Whether you are taking AP® Statistics in a classroom or online, this year will prove to be both challenging and intellectually stimulating as you progress in your study of statistical analysis, inference, and experimental design.

The closer the school year gets to May, the more intimidating the looming Advanced Placement® test may seem. Learning how to take all the information you have learned this year and apply it in a way that will demonstrate your expertise can be very overwhelming at times.

The best way to achieve success on any AP® exam is to master it, rather than let it master you. If you think of these tests as a way to demonstrate how well your mind works, you will have an advantage—attitude does help.

This book is designed to put you on a fast track to a successful score. *Focused* review and practice time will help you master the examination so that you can walk in better prepared, more confident, and ready to do well on the test.

WHAT'S IN THIS BOOK

This book is keyed to *Introduction to Statistics & Data Analysis,* fifth and sixth editions, by Roxy Peck, Chris Olsen, and Jay L. Devore. Because this book follows the College Board Topic Outline for AP® Statistics, it is compatible with other statistics textbooks as well; we have designed this book to help students prepare for this exam irrespective of the text being used. This book is divided into three sections. Part I offers suggestions for preparing for the exam, from signing up to take the test and having the correct calculators to writing a complete response for each free-response question. Part I ends with a diagnostic test that will help you determine which sections may need more focus as you prepare for the exam. The diagnostic test is designed in the same format as the Advanced Placement® Examination, with 40 multiple-choice questions and six free-response questions that follow the College Board Topic Outline.

The diagnostic test should help you identify the areas where you need the most practice; to make this easier for you, the content areas for each problem are noted. In reviewing the answers to the diagnostic test, you will be able to recognize gaps in your knowledge by noting when there are groups of questions from the same content area that gave you trouble. Page references

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with each answer will allow you to go to the textbook and review the content area where you need to focus your attention. You will also be able to analyze your responses to the free-response questions to identify weaknesses that may exist in conveying your written response to the AP® Statistics test readers.

Part II consists of 12 review sections that encompass the four content areas covered by the AP® Statistics examination. Each of these corresponds to a key topic in the College Board content outline. The percentages below indicate the approximate proportion of exam questions devoted to each of the four content areas.

Review Section 1	Exploring Data	Exploratory Analysis 20–30%
Review Section 2	Numerical Methods for Describing Data	
Review Section 3	Summarizing Bivariate Data	
Review Section 4	Collecting Data Sensibly	Planning and Conducting a Study 10–15%
Review Section 5	Probability	Probability 20–30%
Review Section 6	Random Variables and Probability Distributions	
Review Section 7	Sampling Distributions	
Review Section 8	Estimation Using a Single Sample	Statistical Inference 30–40%
Review Section 9	Hypothesis Testing Using a Single Sample	
Review Section 10	Comparing Two Populations or Treatments	
Review Section 11	Categorical Data and Goodness of Fit Tests; Chi-Square Tests	
Review Section 12	Inference for Linear Regression and Correlation	

The review sections are **not** intended to be a substitute for a textbook and class discussions; they offer review and help you prepare further for the exam. Each review section also has the textbook sections listed for further review if, as you prepare for the exam, you find a topic that needs more study. At the end of each review section, you will find 15 multiple-choice and two free-response questions based on the content of that section. Again, you will find page references with each answer directing you to the appropriate discussion on each point in the fifth and sixth editions of *Introduction to Statistics & Data Analysis.*

Part III offers two complete AP® Statistics examinations. At the end of each test, you will find the answers, explanations, and references to the first and second editions for the 40 multiple-choice and six free-response

questions. Part IV contains formulas and tables useful for solving the problems you will encounter in the AP® Statistics exam.

SETTING UP A REVIEW SCHEDULE

If you have been steadily doing your homework and keeping up with the coursework, you will be in good shape. The key to preparing for the examination is to begin as early as possible; don't wait until the exam is just a week or two away to begin your studying. But even if you've done all that—or if it's too late to do all that—there are other ways to pull it all together.

To begin, read Part I of this book. You will be much more comfortable going into the test if you understand how the test questions are designed and how best to approach them. Then, take the diagnostic test and see where you stand.

Set up a schedule for yourself on a calendar. If you begin studying early, you can chip away at the review sections in Part II. You'll be surprised—and pleased—by how much material you can cover if you devote a half hour per day of study for a month or so before the test. Look carefully at the sections of the diagnostic test; if you missed a number of questions in one particular area, allow more time for the review sections that cover that area of the course. The practice tests in Part III will give you more experience with different kinds of multiple-choice questions and the wide range of free-response questions.

If time is short, reading the review sections may not be your best course of action. Instead, skim through the review sections to refamiliarize yourself with the main ideas. Spend the bulk of your time working on the multiple-choice and free-response questions at the end of each review. This will give you a good idea of your understanding of that particular topic. Then take the tests in Part III.

If time is really short, go straight from Part I to Part III. Taking practice tests repeatedly is one of the fastest, most practical ways to prepare.

BEFORE THE EXAM

By February, long before the exam, you should make sure that you are registered to take it. Many schools take care of the paperwork and handle the fees for their AP® students, but check with your teacher or the AP® coordinator to be certain that you are on the list. This is especially important if you have a documented disability and need testing accommodations. If you are studying AP® independently, call AP® Services at the College Board for the name of an AP® coordinator at a local school who will help you through the registration process.

The evening before the exam is not a great time for partying—nor is it a great time for cramming. If you like, look over class notes or skim through your textbook, concentrating on the broad outlines rather than the small details of the course. You might also skim over the AP® Statistics approved formula sheets one last time to remind yourself of the formulas you can check during the test if you need to confirm your idea, and skim through the book and read the AP® Tips. This is a great time to get your things together

for the next day. Sharpen a fistful of number 2 pencils with good erasers; be sure your calculator is in good working order with either spare or extra batteries in case you have a malfunction of some sort; check out your watch and make sure the alarm is off if it has one; pack a healthy snack for the break like a piece of fruit, granola bar, and bottled water; make sure you have whatever identification is required as well as the admission ticket. Then relax and get a good night's sleep.

On the day of the examination, it is wise to eat breakfast—studies show that students who eat a healthy breakfast before testing generally do better. Be careful not to drink a lot of liquids, thereby necessitating a trip to the bathroom during the test. Breakfast will give you the energy you need to power you through the test—and more. Remember, cell phones and other electronic devices, other than your approved calculator(s), are not allowed in the testing room. You will spend some time waiting while everyone is seated in the right room for the right test. That's before the test has even begun. With a short break between Section I and Section II, the statistics exam lasts well over 3 hours. Be prepared for a long test time. You don't want to be distracted by hunger pangs.

Be sure to wear comfortable clothes; take along a sweater in case the heating or air-conditioning is erratic. Be sure to wear clothes you like—everyone performs better when they think they look better.

You have been on the fast track. Now go get a 5!

TAKING THE AP® STATISTICS EXAMINATION

The AP® Statistics exam has two sections: Section I consists of 40 multiple-choice questions; Section II contains six free-response questions. You will have 90 minutes to complete the multiple-choice portion. The exam is then collected, and you will be given a short break. Then, you have 90 minutes for the free-response questions. You should answer all six questions. Some AP® exams allow you to choose among the free-response questions, but statistics is *not* one of them. Keep an eye on your watch and devote about 13 minutes to each of questions 1–5 and about 25 minutes on question number 6. Since question number 6 carries more weight on your overall score, you want to be sure to at least try the first couple of parts of this question. Please note that watch alarms are *not* allowed.

Below is a chart to help you visualize the breakdown of the exam:

Section	Multiple-Choice Questions	Six Free-Response Questions	
Weight	50% of the exam	50% of the exam (weighted as follows):	
		37.5% of exam	12.5% of exam
Number of Questions	40	Questions 1–5	Question 6
Time Allowed	90 minutes	90 minutes	
Suggested Pace	2 minutes per question	13 minutes per question	25 minutes for this question

STRATEGIES FOR THE MULTIPLE-CHOICE SECTION

Here are some rules of thumb to help you work your way through the multiple-choice questions:

SCORING OF MULTIPLE CHOICE There are five possible answers for each question. There is no penalty on the AP® Statistics exam for wrong answers. You will simply not get credit for the wrong answer. Since there is no penalty for guessing, be sure to answer every question prior to the end of the

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90 minutes allotted. This means, fill in a bubble for each of the 40 questions even if you have to guess to answer a question.

FIND QUESTIONS YOU KNOW FIRST Find questions you are confident of and work those first. (Generally, the easier questions appear first on the exam.) Then, return to the questions you skipped. Make a mark in the booklet on questions you are unsure of, then return to those questions later.

READ EACH QUESTION CAREFULLY Pressed for time, many students make the mistake of reading the questions too quickly or merely skimming them. By reading each question carefully, you may already have some idea about the correct answer. You can then look for that answer in the responses. Careful reading is especially important in EXCEPT questions (see the next section that describes the types of multiple-choice questions).

ELIMINATE ANY ANSWER YOU KNOW IS WRONG You can write on the multiple-choice questions in the test book. As you read through the responses, draw a line through every answer you know is wrong. This will help you in choosing correct solutions on questions you aren't sure about.

READ EACH RESPONSE, THEN CHOOSE THE MOST ACCURATE ONE AP® examinations are written to test your precise knowledge of a subject. Sometimes there are a few answers that seem correct, but one of them is more specific and therefore the correct response.

AVOID ABSOLUTE RESPONSES These answers often include the words "always" or "never." For example, the statement "the data **are** normal" is an absolute answer. Instead, look for the phrase, "the data appear to be approximately normal."

MARK AND SKIP TOUGH QUESTIONS If you are hung up on a question, mark it in the margin of the question book. You can come back to it later if you have time. Make sure you skip that question on your answer sheet as well. In the end, be sure to answer ALL questions prior to the end of the 90 minutes.

TYPES OF MULTIPLE-CHOICE QUESTIONS

There are various kinds of multiple-choice questions. Here are some suggestions for how to approach each one.

CLASSIC/BEST-ANSWER QUESTIONS

This is the most common type of multiple-choice question. It simply requires you to read the question and select the correct answer. For example:

1. A firm claims that the percentage of workers who express job satisfaction is higher than the 58% under the previous supervisors. Which of the following are the correct hypotheses to test this claim?
   (A) $H_0 : \mu = 0.58, H_a : \mu > 0.58$
   (B) $H_0 : p = 0.58, H_a : p > 0.58$
   (C) $H_0 : \mu = 0.58, H_a : \mu < 0.58$
   (D) $H_0 : p = 0.58, H_a : p < 0.58$
   (E) $H_0 : p > 0.58, H_a : p < 0.58$

ANSWER: B. This is the only correct answer as the data are categorical. The claim is about a population percentage, which is equivalent to a claim about a population proportion. The null is written as an equality statement and the alternative is a greater than statement since they claim the percentage has gone up since the change in supervisors.

EXCEPT QUESTIONS

In EXCEPT style questions, you will notice all of the answer choices but one are correct. The best way to approach these questions is to treat them as true/false questions. Mark a T or an F in the margin next to each possible answer. There should be only one false answer, and that is the answer you should select. For example:

1. A random sample selected from a population is helpful for all of the following reasons except
   (A) it tends to produce a group that is representative of the population.
   (B) it avoids selection bias.
   (C) it ensures that all members of the population have an equal chance of selection.
   (D) it allows generalization from the sample to the population.
   (E) it eliminates response bias.

ANSWER: E. Response bias is a type of bias that comes about because of the way a survey question is written or the way in which it is asked, leading the subjects to a certain response. Selecting a random sample will not eliminate this type of bias.

ANALYSIS/APPLICATION QUESTIONS

These questions will require you to apply your knowledge of statistics to a given situation or problem. For example:

1. A farmer wants to see which of two types of corn seed (seed A and seed B) will yield more corn. He has 52 plots marked off and he can plant either type of seed in any of the plots. Half of the plots (those on the west side) are bordered by a forest. The plots on the east side are not bordered by forest. Which of the following methods is the best way to decide how the two seed types should be assigned to the 52 plots?
   (A) Number the plots 01–52 and put these numbers in a hat. Pull out 26 numbers to determine the plots used for seed A. The remaining plots get seed B.

(B) Number the plots 01–52 and go to a random digits table and locate two-digit numbers. The plots corresponding to the first 26 numbers get seed A and the rest will get seed B.
(C) Plant the 26 plots on the west side with seed A and the 26 east side plots with seed B.
(D) Divide the 52 plots into two groups consisting of the 26 near the forest and the 26 not near the forest. Number the plots near the forest 00–25 and put these numbers in a hat. Pull out 13 numbers to determine which plots would be planted with seed A; the remaining 13 plots would be planted with seed B. Repeat this process with those plots not near forest.
(E) Pair up a plot near the forest with one not near the forest. Number them 1 and 2 and put numbers in a hat. First number out gets assigned seed A and the other seed B. Repeat for all pairs.

ANSWER: D. This is the only correct solution, since the forest may influence the results. So in this case, half of the plots near the forest will get seed A and half will get seed B. The same will occur for those away from the forest. Answer E might seem like a reasonable approach at first, but it is possible that most of the plots near the forest could have the same seed type with this method.

FREE-RESPONSE QUESTIONS

There are six free-response questions that should all be answered. These six questions account for 50% of the final score you receive on this exam and are weighted as follows. The first five free-response questions combine to make up 75% of your free-response score and the sixth question, the investigative task, will account for the remaining 25% of the grade. This means the first five make up 37.5% and the investigative task makes up 12.5% of the entire test. So it is important to answer all questions as completely as possible.

These questions can cover multiple content areas. Each of the four major content areas of the AP® syllabus will be found in the free- response section. The following hints may help you prepare for this half of the exam.

You should start by quickly reading the six questions. As you are reading, you may want to make a quick note as to an idea you have on the subject of each question. Once you have done this, you should go to the easiest question you find in the first five questions. Answer it as completely as you can and then jump to question number 6, the investigative task.

Now spend a little time, but no more than about 15 minutes, working on the investigative task. Since this carries 25% of the weight for this portion of the test, it is very important that you take the time to at least attempt this task. While this task is intended to stretch you beyond the course, typically it will begin with one or two parts that should be familiar to an AP® Statistics student.

You should then go back and answer the remaining four questions. If time permits, you should reread and note any key phrases or points that are made in a given question. Once you have answered the questions, be sure you read the question again to ensure you have actually answered the question asked. Examination readers comment that sometimes students don't actually answer

the question that is asked. While the information you give may be correct, if it doesn't answer the question, you won't get credit.

Don't assume any question is asking for a "cookie cutter" type response. The AP® readers who will review your answer will be reading for a correct answer in the context of the question, and not just a memorized phrase or explanation. In that light, also be sure to use statistical vocabulary correctly. If you are not sure about the correct vocabulary, it is permissible to use a short phrase in place of the word you are unsure about. Correct notation is also important. It won't hurt to define your notation for clarity, but be sure you are using the notation correctly. For example, students may lose credit for using notation for a statistic when they should be using parameter notation and vice versa.

You will have 90 minutes for this section of the exam, so watch your time. As a recommendation from the College Board, you should allow about 12 minutes for each of the first five questions and 25 minutes for the investigative task. Then, use the remaining 5 minutes to read over your responses. However, earlier we recommended only about 15 minutes to begin with for the investigative task. This allows you to plan once you have begun answering the last question. In either case, it is important you take a watch and keep a close eye on your time. You want to be sure you have enough time to answer the questions you know and that you don't get bogged down on any one question.

KEY POINTS TO ANSWERING FREE-RESPONSE QUESTIONS

In answering the free-response questions, it is important to note the word choices used in the questions. Focus your writing for the AP® Statistics Exam with these points in mind.

READ Carefully read the question and circle key phrases and comments you are to address. Watch for the specific wording and don't make assumptions about what you are being asked before completely reading the question.

CONTEXT Be sure to answer in the context of the problem. For a complete answer, you are required to write the conclusions and interpretations in context.

DEFINE You are expected to define any nonstandard symbols you use.

CORRECT NOTATION Be clear on parameter versus statistic notation when answering. For example, when discussing a mean value, use the correct population and sample notation in your written responses. A sample mean notation $\bar{x}$ will be considered incorrect if you are supposed to use a population mean notation μ.

VOCABULARY Use statistical vocabulary correctly. If you are unsure of the meaning of a statistical term, write a couple of sentences and either define the term or—better yet—let the sentences describe the concept and don't use the word.

CHECK ASSUMPTIONS Unless the question states that all assumptions are reasonable or have been checked, you should state and check assumptions whenever possible. Assumptions need to be checked or referred to as

uncheckable when carrying out any hypothesis test or constructing any confidence interval.

ANSWER Did you actually answer the question? Be sure you have answered the question that was asked.

INTERPRET Be ready to justify your work in a variety of statistical ways. Know how to read printouts, graphical displays, and tables. Provide correct analysis and comparisons as required.

SCORING FREE-RESPONSE QUESTIONS

All six free-response questions will be scored using a holistic four-point scale. However, as stated earlier, question 6 will be weighted more heavily than questions 1 through 5. The four-point score is holistic in nature. This means the readers will consider your entire solution in addition to each of the parts. Therefore, it is important that you answer the question and not contradict yourself. You should NOT attempt more than one solution; the reader will read each solution and your score will be that of your weakest solution.

Keep in mind that both statistical knowledge and verbal communication are essential on the AP® Statistics exam. To score a 4 on a question, you must demonstrate that you are able to both correctly compute statistical values as well as properly interpret those values in the context of the question. The table on the next page provides some general guidelines regarding the differences between the scores of 0 to 4 on any individual free-response question. More specific guidelines can be found on the College Board website (https://apstudent.collegeboard .org/apcourse/ap-statistics) where you can download the PDF file of the course description.

	Statistical Knowledge	Communication
Score	(Be able to correctly use the statistical ideas and techniques.)	(Demonstrate a clear and concise explanation of what work you performed and why.)
4	Demonstrates a complete understanding of the statistics and is able to perform correct statistical calculations. Even if you make minor arithmetic errors, the solution is plausible.	Your thoughts and explanations are correct, with all aspects of the explanation utilizing correct procedures, terminology, and appropriate conclusions, etc.
3	Able to demonstrate clear understanding of appropriate techniques but may have some minor gaps. Overall, this solution is substantially correct even if there are some mathematical errors.	Overall, the rationale in this solution is correct but there may be some missing assumptions, caveats, or even a bit unfinished in the final work. While there is a conclusion, it may be incomplete.
2	Has some parts correct but others have either misused or even possibly unreasonable answers. There is some understanding of the pieces yet little relationship demonstrated between them.	Vague or inappropriate explanations. May be missing components or diagrams needed for the explanation to be complete. Conclusions that are drawn are not complete.
1	Misuses the statistical components and develops unreasonable solutions. Very limited knowledge of statistics given. *(A score of 1 may be awarded if the reader can identity something relevant to the question posed even if you have not answered the question.)*	Response is jumbled, messy, unclear, or difficult to follow. It may not match the statistical work provided by the student. Fails to provide a conclusion or answer the question posed. Incorrect diagrams or displays.
0	Very little, if any, understanding of the statistical pieces needed for the problem	No strategy that will lead to a solution is communicated.

FREE-RESPONSE SAMPLE QUESTION

Free-response questions can differ in the number of parts as well as how much each part contributes to the overall question. Carefully analyze your final answer to make sure you have made a complete response by answering all of the parts of the question.

Be careful **not** to include parallel solutions (or two different answers to the same question). The AP® readers are instructed to score the weakest solution, so try not to lose points you have already scored because you doubt or contradict yourself. Be confident in your choice and cross out any dual answers that you don't want graded.

Here is an example of a free-response question that addresses hypothesis testing.

1. A party rental company rents out tents for large parties. These tents must be setup prior to the party. The company usually allows 28 minutes for set up but is now wondering if the mean time required to set up a tent is actually greater than 28 minutes. To answer this question, the company selects 34 past rentals at random from all its tent rentals and notes the time required to setup the tent for each of the selected rentals. The

average set up time for the sample of rentals was 35 minutes and the sample standard deviation was 6 minutes. Do these data provide convincing evidence that the mean tent setup time is greater than the 28 minutes that the company allows?

Hypothesis test questions can usually be answered in four parts.

PART I—STATE THE HYPOTHESIS.

H_0: μ = 28 minutes, μ = average tent setup time
H_a : μ > 28 minutes
α = .05 Since no alpha level given, we will use .05

PART II—IDENTIFY TEST AND ANY CONDITIONS OR ASSUMPTIONS THAT MUST BE MET.

Because the hypotheses are about a population mean and the population standard deviation is unknown, we consider a one-sample *t* test.

Assumptions

RANDOM SAMPLE—The 34 rentals were selected at random from all of the company's past tent rentals.

LARGE SAMPLE OR NORMAL POPULATION DISTRIBUTION—the sample size is large (n = 34).

PART III—CALCULATIONS

$$t = \frac{35 - 28}{\frac{6}{\sqrt{34}}} = 6.802, \text{ with } df = 33$$

$$p = 4.64 \times 10^{-8} \approx 0$$

PART IV—CONCLUSION: GIVE YOUR CONCLUSION BOTH IN CONTEXT AND LINKED TO ALPHA.

Because 0 < .05, the null hypothesis is rejected. There is convincing evidence that the mean setup time for a party tent is greater than the 28 minutes allowed by the company.

The usual scoring guidelines for a hypothesis test question classify each of the four parts in the test as essentially correct, partially correct, or incorrect. A response that is judged to be essentially correct on all four parts would receive a score of 4.

More examples of free-response type questions and scoring guidelines are included in the sample exams and review sections that appear later in this book.

A DIAGNOSTIC TEST

This diagnostic test will give you some indication of how you might score on the AP® Statistics Exam. Of course, the exam changes every year, so it is never possible to predict a student's score with certainty. This test will also help to pinpoint strengths and weaknesses on the key content areas covered by the exam.

AP® STATISTICS EXAMINATION
Section I: Multiple-Choice Questions
Time: 90 minutes
Number of Questions: 40

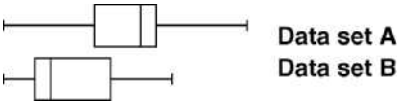
DIRECTIONS: Each of the following questions or incomplete statements is accompanied by five suggested answers or completions. Select the one that best answers the question or completes the statement.

1. If the average test score for one class of 30 students is 75.6 and the average test score for another class of 24 students is 68.4, what is the overall average for this test for all 54 students?
   (A) 71.5
   (B) 72
   (C) 72.4
   (D) 72.8
   (E) 74

2. A snake's length is approximately normal with a mean of 50 cm. What standard deviation would be necessary to ensure that 80% of the snake lengths are within 12 cm of the mean?
   (A) 4.687
   (B) 9.375
   (C) 2.344
   (D) 7.129
   (E) 14.259

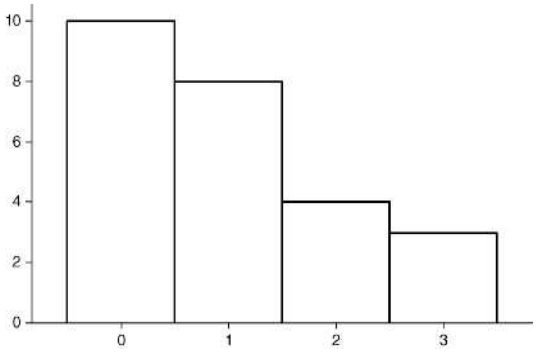
3. A simple random sample of 150 students at a local high school was taken to estimate the proportion who like strawberry-flavored licorice. Ninety-five of the students in the sample liked strawberry licorice. What would be an appropriate setup for a 90% confidence interval? Assume conditions for inferences are met.
   (A) $0.63 \pm 1.96\sqrt{\frac{0.63(0.37)}{150}}$
   (B) $0.63 \pm 1.96\sqrt{\frac{0.63(0.37)}{95}}$
   (C) $0.63 \pm 1.645\sqrt{\frac{0.63(0.37)}{150}}$
   (D) $0.63 \pm 1.645\sqrt{\frac{0.63(0.37)}{95}}$
   (E) $0.63 \pm 1.645\sqrt{\frac{0.63(0.37)}{149}}$

4. Amy is graduating in the spring from Howard University with a degree in accounting. AmeriGroup has offered her a job with a starting salary of $48,000 per year. How many standard deviations below or above the mean is her starting salary if the mean and standard deviation for intro level accounting positions are $47,500 and $1,470, respectively?
   (A) 0.17
   (B) 0.45
   (C) 0.34
   (D) 0.61
   (E) cannot be determined

5. 

   Which of the following must be true for the two boxplots shown? (Although the scale is not shown, the two boxplots are drawn using the same numerical scale.)
   (A) The IQR of data set A is smaller than the IQR of data set B.
   (B) The lower quartile of data set A is greater than the upper quartile of data set B.
   (C) The ranges of data set A and data set B are equal.
   (D) The median of data set B is greater than the median of data set A.
   (E) There are more data in data set A than in data set B.

6. The given histogram was constructed using data on X = number of pets for a sample of 25 students. Which of the following is closest to the value of the mean of this data set?



   (A) 0.5
   (B) 1.0
   (C) 1.5
   (D) 2.0
   (E) 3.0

7. To determine how students at a particular college feel about cigarette smoking in public places, all students at the college who chose to have their email address published in the college directory were sent an email with a link to an online survey. What is wrong with this sampling method?
   (A) Nothing, since students could go online to give their opinion.
   (B) Only smokers should have been surveyed.
   (C) They should have only sent the email to every 12th student in the directory.
   (D) This sampling method would result in a sample size that is too large.
   (E) Not all students would have an email listed in the student directory.

8. A cell phone company wants to know how happy their customers are with their service. The company sent a text message with a survey to every customer's phone. Out of the 100,000 customers, 42,000 replied. Based on the 42,000 responses, they concluded that their customers were highly satisfied. What type of bias should the company be worried about?
   (A) Selection bias
   (B) Response bias
   (C Nonresponse bias
   (D) Measurement bias
   (E) There is no need to worry since all customers received the text message.

9. For employees of a large company, the correlation between x = years of experience and y = the pay increase is found to be $r = 0.74$. What would the correlation be if the y variable was years of experience and pay increase was the x variable?
   (A) –0.74
   (B) –0.28
   (C) 0.28
   (D) 0.74
   (E) The answer cannot be determined from the given information.

10. The following computer output was taken from a data set where the adult height was used to predict the wrist circumference.

	Coefficients	Standard Error	*t* Stat	*P*-value
Intercept	–2.13	0.4836	–4.40	0.048
Height	0.13	0.0073	17.3	0.003

R Square 0.993

Standard Error 0.082

Which of the following is the equation of the least squares regression line for this data set? Let $\hat{y}$ be the predicted wrist circumference.

(A) $\hat{y} = 0.13 - 2.13$ (height)

(B) $\hat{y} = -2.13 + 0.13$ (height)

(C) $\hat{y} = 0.08 - 2.13$ (height)

(D) $\hat{y} = 0.08 + 0.13$ (height)

(E) $\hat{y} = 0.99 + 0.13$ (height)

11. A study found the correlation between the heights of men and the heights of their biological sons to be $r = 0.71$. What is the approximate value of r^2 and what is its meaning?
    (A) $r^2 = 0.71$, it describes how well the least squares regression line fits the data.
    (B) $r^2 = 0.50$, it says that a son's height should be equal to $0.49 \times$ father's height
    (C) $r^2 = 0.84$, it is the ratio of father's height to son's height.
    (D) $r^2 = 0.50$, it is the proportion of the variability in sons' heights that can be explained by fathers' heights.
    (E) $r^2 = 0.84$, it is the proportion the son's height that is caused by father's height.

12. All but one of the following statements contain an error. Which of the following statements is correct?
    (A) A social scientist found a correlation of $r = -1.23$ between the weight of monkeys and their height.
    (B) The correlation coefficient for x = political affiliation and y = income was computed to be $r = 0.73$.
    (C) A psychology graduate student doing research found the correlation coefficient between gender and race to be $r = -0.81$.
    (D) The correlation coefficient for x = amount of fertilizer and y = yield was found to be $r = 0.58$.
    (E) The correlation coefficient between x = the speed of a racing boat and y = fuel consumption is found to be $r = 5.0$ mpg.

13. A new type of flame retardant created for clothing is ready for testing. There are two types of fabric that this retardant is to be tested on to see if it is better than the current substance used on these fabrics. There are 100 pieces of each type of fabric available for testing. Which of the following is the best method for assigning retardants to pieces of fabric?
    (A) Assign 100 pieces of each fabric to be tested with the new material.
    (B) Take one type of fabric first and number the 100 pieces 00–99. Using a random number table, find 50 different two-digit random numbers. The pieces of fabric corresponding to these numbers would get the new retardant and the remaining 50 get the old retardant. Repeat this process for the other fabric.
    (C) Take one type of fabric first and place the pieces of fabric in a stack. The first 50 pieces in the stack get the old retardant and the rest get the new retardant. Repeat this for the other fabric as well.
    (D) Put all 200 pieces of fabric in a stack with all of the pieces of the first type of fabric on the top of the stack. Select a piece and flip a coin. Heads get the old material and tails get the new material. Do this until 100 pieces have been assigned to one of the retardants. The rest of the pieces would get the other retardant.
    (E) Select one of the types of fabric (all 100 pieces) and flip a coin. If it comes up heads, then assign the old flame retardant to this fabric and the new to the other fabric.

14. Why would double-blinding be used in a study?
    (A) To make sure the researcher does not know who is getting which treatment.
    (B) To keep the subjects from knowing which treatment they are receiving.
    (C) To keep the subjects from communicating with each other since they don't know which treatment they are getting.
    (D) To keep the subjects from telling the researcher which treatment they received.
    (E) To keep the subjects and person measuring the response from influencing the outcome.

15. A lottery ticket is sold for $2 with the promise that someone will win this particular jackpot of $500. Only 1,000 tickets are sold. What are the expected winnings for someone who purchases a single ticket?
    (A) $500.00
    (B) $1.00
    (C) $0.50
    (D) −$1.00
    (E) −$1.50

16. Every year, 50% of all children miss at least 3 school days due to illness. Which of the following is closest to the probability that 216 or more children out of a random sample of 400 would miss at least 3 school days this year?
    (A) 0.00
    (B) 0.03
    (C) 0.05
    (D) 0.50
    (E) 0.95

17. Scores on a standardized test have a normal distribution with a mean of 20 and a standard deviation of 6. What is the approximate interquartile range of the test scores?
    (A) 4
    (B) 6
    (C) 8
    (D) 10
    (E) 24

18. A 90% confidence interval has been computed to estimate the mean height in centimeters of newborn babies. Which of the following is a correct interpretation of the confidence interval? Assume conditions for inferences are met.
    (A) 90% of all babies' heights would be within the interval.
    (B) The sample mean will be in this interval 90% of the time.
    (C) 90% of the time, the method used to construct the interval results in an interval that includes the true mean height of newborns.
    (D) Any baby with a height not contained within the interval is an outlier.
    (E) The true mean height of newborns is contained in this interval 90% of the time.

19. Each person in a random sample of 300 elementary school children in New York City was asked if he or she preferred outside recess in the morning. A 98% confidence interval for the proportion of New York elementary school children who prefer outside recess is (0.32, 0.46). Which of the following would be the 95% confidence interval computed from this sample data?
    (A) (0.30, 0.48)
    (B) (0.32, 0.42)
    (C) (0.31, 0.47)
    (D) (0.32, 0.50)
    (E) (0.33, 0.45)

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20. A city official in a storm-damaged region of the United States believes that the percentage of homes with contaminated water is higher than the recently reported value of 9%. The city inspected 168 homes and found 23 homes with contaminated water. Is there enough evidence to conclude that the initial report of 9% is too low at the 0.05 significance level? Assume conditions for inference are met.
    (A) No, because the P-value = 0.017, which is smaller than α.
    (B) No, because the P-value = 0.034, which is bigger than α.
    (C) Yes, because the P-value = 0.017, which is smaller than α.
    (D) Yes, because the P-value = 0.034, which is bigger than α.
    (E) No, because the P-value = 0.14, which is larger than α.

21. In a study of a random sample of 100 popular songs, the average length was found to be 3.2 minutes and the sample standard deviation was 0.04 minutes. Which of the following would be a true statement?
    (A) If we took another random sample of 100 popular songs, the average length for this sample would be 3.2 minutes and the standard deviation would be 0.04 minutes.
    (B) The sampling distribution of the sample mean song length would be approximately normal with a larger variance than that of the population.
    (C) The population standard deviation is likely to be larger than 0.04 minutes and the mean for the population will probably be smaller than 3.2 minutes.
    (D) The population standard deviation is likely to be smaller than 0.04 minutes and the population mean will probably be greater than 3.2 minutes.
    (E) The sampling distribution of sample mean song length is approximately normal, with a standard deviation that is likely to be smaller than 0.04.

Questions 22–24 refer to the following table, which is the probability distribution of x = the number of times a copy machine needs repair in a given month.

x	0	1	2	3	4	5
$P(x)$	0.12	0.18	0.23	0.20	0.14	0.13

22. A corporation must pay a service person at a rate of $50 per visit. On average, about how much should the company expect to pay per month for copy machine repairs?
    (A) $50.00
    (B) $59.75
    (C) $75.25
    (D) $100.00
    (E) $122.50

23. What's the probability the machine will need to be repaired at least once in a month?
    (A) 0.12
    (B) 0.18
    (C) 0.23
    (D) 0.70
    (E) 0.88

24. What is the standard deviation for the number of repairs the machine will need in a given month?
    (A) 1
    (B) 2.38
    (C) 2.45
    (D) 2.5
    (E) 5

25. Which of the following is not a property of a binomial experiment?
(A) All trials are independent.
(B) The outcome of each trial can be classified as success or failure.
(C) The probability of success is the same for each trial.
(D) There are a fixed number of trials.
(E) Trials continue until a success occurs.

26. Dequarius decides to take a simple random sample from a population that is normally distributed. However, σ is not known. If his sample size is 20, and Dequarius wishes to compute a 95% confidence interval for the population mean, which formula would be correct? Assume conditions for inference are met.
(A) $\bar{x} \pm 2.093\frac{s}{\sqrt{20}}$
(B) $\bar{x} \pm 2.093\frac{s}{\sqrt{19}}$
(C) $\bar{x} \pm 1.960\frac{s}{\sqrt{20}}$
(D) $\bar{x} \pm 1.960\frac{s}{\sqrt{19}}$
(E) $\bar{x} \pm 1.725\frac{s}{\sqrt{20}}$

27. Marvin is planning to use a simple random sample of 30 to estimate a population mean. What would happen to the margin of error if he were to increase the sample size to 150?
(A) The margin of error will increase.
(B) The margin of error will decrease.
(C) The margin of error will not be affected.
(D) The margin of error will be multiplied by five.
(E) There is not enough information to determine what will happen to the margin of error.

28. A video game company is interested in the proportion of people who currently play one of their online games who would be willing to pay for an enhanced version of the game. They plan to market the enhanced game if they are convinced that more than 40% of the current users would pay for the enhanced version. Which of the following correctly describes the company making a type I error?
(A) Determining over 40% of users would pay for the enhanced version when they would not.
(B) Determining that over 40% of users would not pay for the enhanced version when they would.
(C) Failing to take a random sample.
(D) Failing to enhance the video game.
(E) Determining exactly 40% of users would buy the enhanced version.

29. A newspaper claims that the proportion of people using public transportation is 0.39. An environmental group disagrees, stating the proportion is smaller than what the newspaper claims. The environmental group plans to conduct a survey to support its position. What hypotheses should the environmental group test?
(A) H_0:$p = 0.50$, H_a:$p > 0.50$
(B) H_0:$p = 0.39$, H_a:$p \neq 0.39$
(C) H_0:$P = 0.39$, H_a:$p > 0.39$
(D) H_0:$P = 0.39$, H_a:$p < 0.39$
(E) H_0:$P = 0.50$, H_a:$p \neq 0.50$

30. A scientist wants to use data from a survey of 1,000 randomly selected registered voters to determine whether there is a relationship between gender and whether or not a person voted in the last election. What is an appropriate test to use in this situation?
(A) Chi-square goodness-of-fit test
(B) Chi-square test of independence
(C) Two-sample *t*-test
(D) Two-sample *z*-test
(E) One proportion *z*-test

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31. A researcher wants to study the effectiveness of two different medications for ADHD in children. Fifty boys and 50 girls who are diagnosed with ADHD have volunteered to participate in the study. Which of the following could cause the introduction of a confounding variable?
    (A) The subjects were not randomly selected.
    (B) For each child, a coin flip will determine which medication the child will receive.
    (C) The 50 girls will be given medication 1 and the 50 boys will be given medication 2.
    (D) Double blinding is used in the study.
    (E) No control group is used in the study.

32. The population {4, 6, 8, 10} has mean $\mu = 7$ and standard deviation $\sigma = 2.24$. If sampling is done with replacement, there are 16 different possible samples of size 2 that can be selected from this population. Each of these samples has a sample mean. For example, one of the samples is (8, 10), which has a mean of 9. The mean and standard deviation of the sampling distribution of the sample means are denoted by $\mu_{\bar{x}}$ and $\sigma_{\bar{x}}$, respectively. Which of the following statements is true?
    (A) $\mu_{\bar{x}} = 7$ and $\sigma_{\bar{x}} = 2.24$
    (B) $\mu_{\bar{x}} = 7$ and $\sigma_{\bar{x}} > 2.24$
    (C) $\mu_{\bar{x}} = 7$ and $\sigma_{\bar{x}} < 2.24$
    (D) $\mu_{\bar{x}} > 7$ and $\sigma_{\bar{x}} > 2.24$
    (E) $\mu_{\bar{x}} < 7$ and $\sigma_{\bar{x}} < 2.24$

33. A local storeowner wants to know if a new line of souvenir glass figurines is a better sales product than a line he has carried for years. To compare sales of the two products, he decides to keep track of sales of each item for a period of 1 month. He randomly assigns one item to the checkout lane and the other to the second aisle in the store. The new item is placed to the left of the checkout lane and the old item is randomly assigned to the second aisle. Is this a good study design?
    (A) Yes, because he has assigned the locations at random.
    (B) Yes, but the new item should be placed in the aisle and the old item by the register.
    (C) No, because a confounding variable of location within the store has been introduced.
    (D) Yes, because the new item will be seen more because it is by the register.
    (E) No, because 1 month is too short of a time to compare sales.

34. A weight loss group wants to see if a new program seems to be effective in helping individuals who want to lose weight. Nine individuals have been weighed before the program and then after 2 months on the program. The results are in the table below.

Subject	1	2	3	4	5	6	7	8	9
Before	150	182	118	197	208	215	134	107	168
After	151	180	118	203	206	216	133	105	170

What would be an appropriate set of hypotheses to use if the group wants to see if the program was effective for weight loss? Let μ_d = the true mean change in weight (before – after)
(A) $H_0: \mu_d = 0$, $H_a: \mu_d < 0$, $df = 8$
(B) $H_0: \mu_d > 0$, $H_a: \mu_d < 0$, $df = 17$
(C) $H_0: \mu_d = 0$, $H_a: \mu_d < 0$, $df = 9$
(D) $H_0: \mu_d = 0$, $H_a: \mu_d > 0$, $df = 8$
(E) $H_0: \mu_d > 0$, $H_a: \mu_d \neq 0$, $df = 17$

35. Which of the following actions will increase the power of a test?
I Increasing the sample size
II Decreasing the sample size
III Increasing the significance level
IV Decreasing the significance level

(A) I only
(B) III only
(C) IV only
(D) I and III only
(E) II and IV only

36. In a particular town, 40% of the registered voters are registered as Democrats, 35% are registered as Republicans, and 25% are registered as Independents. What is the expected number of Independents in a random sample of 200 registered voters from this town?
(A) 20
(B) 25
(C) 40
(D) 50
(E) 75

37. A newspaper reported that based on a recent survey of reality show watchers, 58% of the people preferred the reality show *The Bachelor* to the reality show *Survivor*. The margin of error reported was ±4%. What does this ±4% mean?
(A) 4% of the reality TV watchers don't know what show they prefer.
(B) There is a 4% chance of error in these results from this particular sample.
(C) The results are based on 4% of the reality TV show watchers.
(D) The actual percentage who prefer *The Bachelor* to *Survivor* is probably somewhere between 54% and 62%.
(E) 54% to 62% of the population watches *The Bachelor*.

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38. Each person in a random sample of high school students was asked whether he or she takes vitamin C on a regular basis and whether he or she had a cold in the last 6 months. A chi-square test of independence resulted in a *P*-value of 0.37. What conclusion is reasonable based on the *P*-value? Assume conditions for inference are met.
    (A) There is an association between taking vitamin C and whether or not a person gets a cold.
    (B) The data prove that taking vitamin C and whether or not a person gets a cold are independent.
    (C) There is convincing evidence that there is an association between taking vitamin C and whether or not a person gets a cold.
    (D) There is convincing evidence that taking vitamin C and whether or not a person gets a cold are independent.
    (E) There is not convincing evidence that there is an association between taking vitamin C and whether or not a person gets a cold.

39. If a 95% confidence interval for the slope of a regression line were computed, what would it mean if the interval contained zero? Assume conditions for inference are met.
    (A) There is sufficient evidence to conclude that the slope of the true regression line is zero.
    (B) There is sufficient evidence to conclude that the slope of the true regression line is not zero.
    (C) There is insufficient evidence to conclude that the slope of the regression line is zero.
    (D) There is insufficient evidence to conclude that the slope of the regression line is not zero.
    (E) The slope of the population regression line is equal to zero.

40. A recent poll of 1,000 adults included 540 people who said they would be willing to give up television for the summer if they could be sure that doing so would result in weight loss. Assuming it is reasonable to regard this sample of 1,000 as a random sample of adult Americans, is there convincing evidence that a majority of adult Americans would be willing to do this? Assume conditions for inference are met.
    (A) Yes, since P-value < 0.01, we reject the null hypothesis.
    (B) Yes, since P-value > 0.01, we reject the null hypothesis.
    (C) Yes, since P-value > 0.05, we fail to reject the null hypothesis.
    (D) No, since P-value = 0.54, we fail to reject the null hypothesis.
    (E) No, because 0.54 is not enough larger than 0.50 to be convinced.

STOP

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.

SECTION II: FREE-RESPONSE QUESTIONS

Part A
Questions 1–5
Spend about 65 minutes on this part of the exam
Percent of Section II grade—75

DIRECTIONS: Show all your work. Clearly indicate the methods you use, as you will be graded on the correctness of the methods as well as the accuracy of your results and explanation.

1. Strep throat is a common infection among teenagers. It must be treated quickly to avoid serious complications. The Rapid Strep Test (RST) is a diagnostic test that may be performed by a doctor in his or her office. RST gives a false positive in about 4% of the healthy students and gives a negative result in about 20% of students who do have strep throat. Suppose there is a lot of strep throat going around, and 5% of the student body has been infected.
   (a) What is the probability that a student selected at random would test positive for strep throat if the RST is used? Show your work.
   (b) What is the probability that a child selected at random who tests positive for strep throat using the RST does not have the strep throat? Show your work.

2. *Aunt Pearl's Produce* grows fruits and vegetables for distribution to local grocery stores. The tomato field is located next to the trees in the apple orchard, meaning part of the tomato field gets more shade (the shady side) than the rest of the field (the sunny side). Sun and shade might affect tomato growth. The tomato field can accommodate 600 tomato plants, with 200 placed in the shady side and 400 placed in the sunny side. Larger tomatoes (greater than 2.5 inches in diameter) are considered more valuable since they can be sold for higher prices. Two brands of fertilizer are being considered for use in growing tomatoes and it is not known if one brand of fertilizer might produce larger tomatoes than the other brand of fertilizer.
   (a) You are asked to design an experiment to decide if there is a difference in the proportion of larger tomatoes produced for the two regions of the field. You can use 600 tomato plants that have been planted in the field described. Explain why it would be a good idea to incorporate blocking and describe the blocks you would use.
   (b) Describe the method you would use to assign a brand of fertilizer to each of the 600 tomato plants in the field using the table of random digits.
   (c) Using the random digits table provided below, pick the first two tomato plants for your study and tell where you are placing them.

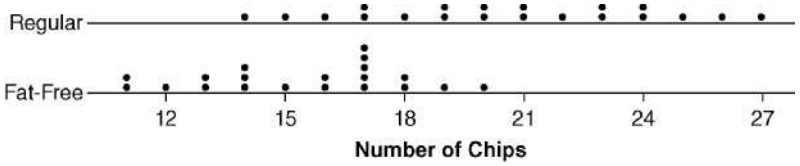
75690	50177	50467	73999	60573	58156
06205	44401	01052	41856	75562	60464
05596	22931	85521	03730	12804	76697

3. A local barbecue-cooking event consists of professional barbecue teams preparing three different types of meat: beef brisket, pork ribs, and chicken. The teams receive a score for each category of meat (on a scale of 1–25) and you can assume that team scores are independent across categories. The distributions of scores for each category are approximately normal.

	μ	σ
Beef Brisket	18.8	0.72
Pork Ribs	18.6	0.85
Chicken	19.4	0.78

   (a) What are the mean and standard deviation for the score of a team competing in all three categories?
   (b) What proportion of teams competing in all three categories score higher than 58.8 overall?
   (c) What is the probability that two out of five teams competing in all three categories will score higher than 58.8 overall?
   (d) What is the probability that a random sample of five teams competing in all three categories have a mean overall score higher than 58.8?

4. A cookie manufacturer sells two types of chocolate chip cookies, regular and fat free. The manufacturer claims that the fat-free cookies have, on average, the same number of chocolate chips as the regular cookies. A group of students wanted to test this claim. They counted the number of chips in a random sample of 20 regular cookies and in a random sample of 20 fat-free cookies. The data are summarized in the following dotplots.



   (a) Compare the distributions of number of chips for regular and fat-free cookies.
   (b) What test should the students perform if they want to determine if there is convincing evidence against the manufacturer's claim? State the appropriate hypotheses.
   (c) Would it be reasonable to test the hypotheses in part (b)? Explain why or why not.

5. LeRhonda and Nick want to consider the weights of *Snickers* fun-size candy bars to see if the advertised weight of 1 ounce is accurate. Eight candy bars are weighed. The weights (in ounces) were as follows:

   0.99 0.97 0.98 0.96 1.01 1.03 0.99 1.02

   (a) Assume that it is reasonable to consider this sample of eight bars as a random sample of all Snickers fun-size bars. Estimate the mean weight for Snickers fun-size bars using a 90% confidence interval.
   (b) Based on your confidence interval from part (a), do you think that the manufacturer's advertised weight of 1 ounce is reasonable? Why or why not?
   (c) Explain which error— a type I or type II error—could have occurred in part (b) and comment on the consequence of making this error.

SECTION II
Part B
Question 6
Spend about 25 minutes on this part of the exam
Percent of Section II grade—25

DIRECTIONS: Show all your work. Clearly indicate the methods you use, as you will be graded on the correctness of the methods as well as the accuracy of your results and explanation.

6. The Federal Bureau of Investigation (FBI) handles requests by law enforcement officers to gain top-secret clearance status. In years past, the requests were rarely granted. However, in recent years, more requests have been granted. The data below show the number of top-secret clearances granted by year.

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009
# Top-Secret Clearances	8	57	102	136	258	317	489	743	1,823

Computer software was used to fit the least-squares regression line to these data, resulting in the output below.

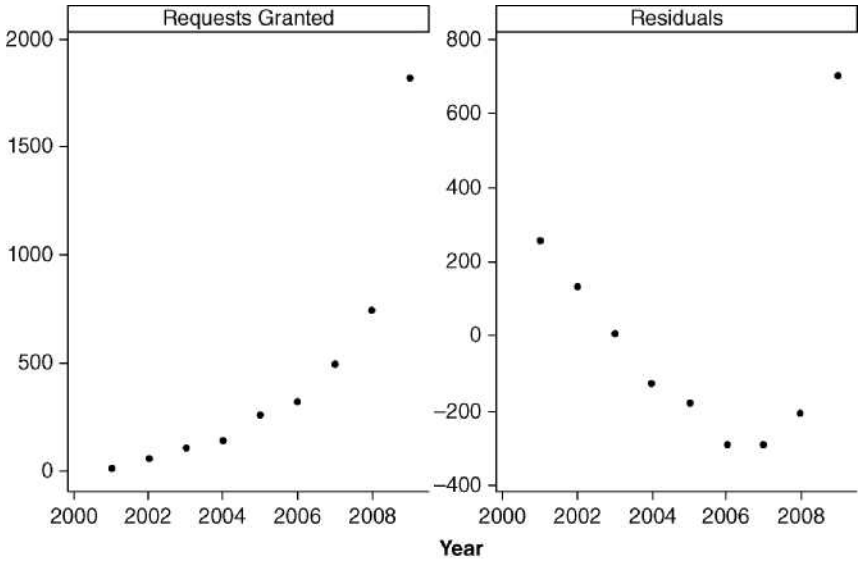
```
Predictor      Coef          SE Coef       T             P
Constant       -342852       89460         -3.83         0.006
Year           171.22        44.62         3.84          0.006

S = 345.612          R - Sq = 67.8%     R - Sq(adj) = 63.2%
```

(a) What is the equation of the least-squares regression line?
(b) What is the residual value for the year 2006? Interpret this value.
(c) Based on the regression line, the predicted number of requests granted in the year 2020 is 3,012. Is this a good estimate to use? Explain.

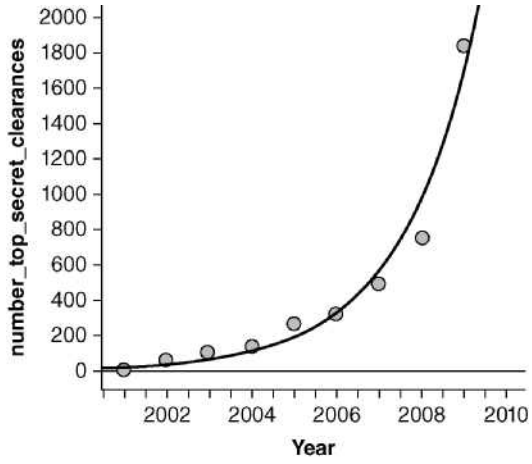
GO ON TO NEXT PAGE

(d) Below are a scatter diagram and a residual plot from the linear regression for these data. Based on these plots, an exponential model has been recommended as a better way to describe the relationship between number of requests granted and year. What aspect of these plots supports this recommendation?



(e) The recommended exponential model is given below.
$\hat{y} = 11.82(1.74)x$, where $\hat{y}$ is the predicted number of top-secret clearances and x is the number of years since 2000.
Use this model to find the residual in 2006. Interpret and compare this value to the value found in part (b).

(f) Here is the exponential model plotted with the data.



Explain why the exponential model is better than the linear model.

(g) Since the exponential model is better, can we use it to predict the number of requests granted in the year 2020? Why or why not?

END OF EXAMINATION

ANSWERS TO DIAGNOSTIC TEST

MULTIPLE-CHOICE ANSWERS

Using the table below, score your test.

Determine how many questions you answered correctly and how many you answered incorrectly. You will find explanations of the answers on the following pages.

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

ANSWERS AND EXPLANATIONS

MULTIPLE-CHOICE ANSWERS

1. (C) The combined average is calculated by $\frac{30(75.6)+24(68.4)}{54}=72.4$

   (*Introduction to Statistics & Data Analysis*, 5th ed., p. 154/6th ed., p. 150).

2. (B) The upper *z*-score for a central area of 80% is 1.28. Values of snake lengths that are within 12 cm of the mean are those between 38 and 62.

   Using the upper value of 62, we get $z=\frac{62-50}{\sigma}=1.28$ and solve for the value of σ. This results in $1.28=\frac{62-50}{\sigma}$; $\sigma=\frac{62-50}{1.28}=9.375$.

   (*Introduction to Statistics & Data Analysis*, 5th ed., pp. 401-404/6th ed., pp. 392-395)

3. (C) The *z** for a 90% interval is 1.645 and the sample size of 150 is the denominator for the standard error calculation (*Introduction to Statistics & Data Analysis*, 5th ed., pp. 472-473/6th ed., p. 465).

4. (C) Using $z=\frac{x-\mu}{\sigma}$, Amy can solve for her *z*-score. This would give $z=\frac{48000-47500}{1470}=0.34.$

   (*Introduction to Statistics & Data Analysis*, 5th ed., p. 182/6th ed., p. 179)

5. (A) The IQR is equal to the width of the box in the boxplot, so the IQR for data set A is smaller than the IQR for data set B (*Introduction to Statistics & Data Analysis*, 5th ed., pp. 173-176/6th ed., pp. 169-172).

6. (B) Visually, you can estimate the mean of this data set to be close to 1 from the histogram, or you could also compute the mean if you wanted to by adding the 10 zeros, 8 ones, 4 twos, and 3 threes and then dividing by 25 (*Introduction to Statistics & Data Analysis*, 5th ed., p. 158/6th ed., p. 154).

7. (E) The use of the emails included in the directory would mean that only those who chose to be in the directory would be able to respond. This plan excludes students who are not in the directory and these students may be different in some way. The fact that they are not included in the survey may significantly alter the results (*Introduction to Statistics & Data Analysis*, 5th ed., pp. 36-37/6th ed., pp. 34-36).

8. (C) They should worry about nonresponse bias because the survey was returned by only 42% of the customers. The remaining 58% did not respond and if they had, the results may have been quite different since those 58% could differ in a specific way to the 42% (*Introduction to Statistics & Data Analysis*, 5th ed., pp. 36-37/6th ed., pp. 34-36).

9. (D) The interchanging of the x and y variables will not change the correlation (*Introduction to Statistics & Data Analysis*, 5th ed., pp. 207-208/6th ed., pp. 202-203).

10. (B) The slope of the line is found in the first column in the row with the named variable, height. The other coefficient value is the y-intercept (*Introduction to Statistics & Data Analysis*, 5th ed., p. 219/6th ed., p. 215).

11. (D) r^2 is calculated by squaring the correlation coefficient. It is defined as the proportion of the variability in the response variable that can be explained by the explanatory variable (*Introduction to Statistics & Data Analysis*, 5th ed., p. 232/6th ed., p. 228).

12. (D) Correlation has no units, so this will remove choice E. Also, the correlation must be between –1 and +1, which eliminates choice A. B and C both have at least one categorical variable and the correlation coefficient is for two numerical values (*Introduction to Statistics & Data Analysis*, 5th ed., pp. 207-208/6th ed., p. 202-203).

13. (B) For the method in A, only the new fire retardant will be used. For the method described in C, there is no random assignment and if the first 50 pieces in the stack differ from the last 50 in the stack in some important way, this would be a problem. The method described in D will tend to produce an uneven distribution of fabric types for the two retardants. The method in part E results in retardant being confounded with fabric type. The method described in B is the best choice (*Introduction to Statistics & Data Analysis*, 5th ed., pp. 50-51/6th ed., pp. 49-50).

14. (E) The subject as well as the person measuring the response would not know which treatment the subject is getting in order to keep this knowledge from influencing the study results (*Introduction to Statistics & Data Analysis*, 5th ed., pp. 63-64/6th ed., pp. 61-62).

15. (E) The probability of winning with a single ticket is 1/1000. Because the ticket costs \$2, the possible amounts won are \$498 (with probability 0.001) and –\$2 (with probability 0.999). The expected amount won is then (498)(0.001) + (–2)(0.999) = –1.50 (*Introduction to Statistics & Data Analysis*, 5th ed., p. 370/6th ed., p. 361).

16. (C) This is a binomial probability with $n = 400$ and $p = 0.5$. This means we want $1 - P(x \leq 215)$. You can evaluate this using the following calculator command: 1 – binomcdf (400, 0.5, 215) or you can use the normal approximation to the binomial since $np > 10$ and $n(1 - p) \geq 10$ (*Introduction to Statistics & Data Analysis*, 5th ed., pp. 386-387/6th ed., p. 377).

17. (C) The z-scores for a central area of 0.50 are $z = \pm 0.67$. The upper quartile is approximately 0.67 standard deviations above the mean and the lower quartile is about 0.67 standard deviations below the mean. The IQR is then about 2(0.67) – 1.34 standard deviations or $(1.34 \times 6) = 8.04$ (*Introduction to Statistics & Data Analysis*, 5th ed., pp. 401-404/6th ed., pp. 392-395).

18. (C) A confidence interval uses a point estimate to generate an interval of plausible values for the true height of babies. Since it was a 90% interval, a method was used that will result in intervals that include the true mean height about 90% of the time (*Introduction to Statistics & Data Analysis*, 5th ed., pp. 484-485/6th ed., pp. 476-477).

19. (E) The 95% confidence interval will be narrower than the 98% confidence interval. It will also be centered in the same place as the 98% confidence interval, so the correct answer must be E (*Introduction to Statistics & Data Analysis*, 5th ed., pp. 472-473/6th ed., p. 465).

20. (C) This will give a z test statistic of 2.12 and P-value = 0.017. Since $0.017 < 0.05$, we reject the null hypothesis and have strong evidence that the earlier claim of only 9% is too low (*Introduction to Statistics & Data Analysis*, 5th ed., pp. 523-525/6th ed., pp. 524-526).

21. (E) For large samples, the sampling distribution is approximately normal with standard deviation equal to the population standard deviation divided by the square root of the sample size (*Introduction to Statistics & Data Analysis*, 5th ed., pp. 446-447/6th ed., pp. 435-437).

22. (E) The expected number of service calls is 2.45. This would mean that, on average, they should expect to pay (2.45)(50) = \$122.50 per month (*Introduction to Statistics & Data Analysis*, 5th ed., p. 370/6th ed., p. 361).

23. (E) $P(x \geq 1) = 1 - P(x = 0) = 1 - 0.12 = 0.88$ (*Introduction to Statistics & Data Analysis*, 5th ed., pp. 298-299/6th ed., pp. 291-292).

24. (B) $\sigma = \sqrt{\sum(x_i - \mu)^2 p_i} = 2.38$ (*Introduction to Statistics & Data Analysis*, 5th ed., pp. 298-299/6th ed., pp. 291-292).

25. (E) Continuing trials until a success occurs is the property of a geometric situation *(Introduction to Statistics & Data Analysis*, 5th ed., p. 388/6th ed., p. 379).

26. (A) Because the population standard deviation is not known, a *t* interval should be used. The appropriate *t** value is based on 19 *df* and a central area of 0.95. (*Introduction to Statistics & Data Analysis*, 5th ed., p. 484/6th ed., p. 476).

27. (B) Increasing sample size decreases margin of error *(Introduction to Statistics & Data Analysis*, 5th ed., p. 495/6th ed., p. 487).

28. (A) A type I error is rejecting the null hypothesis when it is true. The null hypothesis would be that 40% of users would buy the enhanced version of the game and the alternative would be that over 40% of users would buy the enhanced version of the game. (*Introduction to Statistics & Data Analysis*, 5th ed., p. 510/6th ed., p. 512).

29. (D) The alternative hypothesis is $p < 0.39$, as the group wants to determine if the actual proportion is less than the claimed proportion of 0.39 (*Introduction to Statistics & Data Analysis*, 5th ed., pp. 508 and 523/6th ed., pp. 510 and 524).

30. (B) The chi-square test for independence is designed to decide if there is an association between two categorical variables (*Introduction to Statistics & Data Analysis*, 5th ed., pp. 642-644/6th ed., pp. 672-673).

31. (C) If all the girls received medication 1 and all the boys received medication 2, we would not be able to distinguish the effect of the medication from a gender effect (*Introduction to Statistics & Data Analysis*, 5th ed., pp. 31-32/6th ed., pp. 30-31).

32. (C) The mean of the sampling distribution will be the same as the population mean but the standard deviation of the sampling distribution will be smaller than the population standard deviation because the standard deviation of the sampling distribution is the population standard deviation divided by the square root of the sample size (*Introduction to Statistics & Data Analysis*, 5th ed., pp. 446-447/6th ed., pp. 435-437).

33. (C) Since each is in a different location, the study has now introduced a confounding variable. A person may be more prone to last-minute shopping, for example, and thus choose the ones by the register more often (*Introduction to Statistics & Data Analysis*, 5th ed., pp. 31-32 and 47-48/6th ed., pp. 30-31 and 46).

34. (D) If the program is effective, the after weight should be less than the before weight. This would mean the before – after differences should tend to be greater than 0. Also, since this is a matched-pairs design, $df = n - 1 = 8$ (*Introduction to Statistics & Data Analysis*, 5th ed., p. 584/6th ed., p. 598).

35. (D) Increasing sample size is one way to increase power. Increasing the significance level decreases the probability of a type II error and increases power. So, both I and III increase power *(Introduction to Statistics & Data Analysis*, 5th ed., p. 540/6th ed., pp. 541-542).

36. (D) The expected number is 200(0.25) = 50 (*Introduction to Statistics & Data Analysis*, 5th ed., pp. 625-628/6th ed., pp. 655-658).

37. (D) The margin of error tells us that the sample percentage is expected to be within 4% of the actual population percentage. Therefore, the population percentage is probably between 54% and 62% (*Introduction to Statistics & Data Analysis*, 5th ed., p. 493/6th ed., p. 485).

38. (E) With a *P*-value as large as 0.37, we fail to reject the null hypothesis. There is no evidence of an association (*Introduction to Statistics & Data Analysis*, 5th ed., pp. 642-644/6th ed., pp. 672-673).

39. (D) Since the interval contains 0, it is plausible that the slope of the population least-squares regression line could be 0 (*Introduction to Statistics & Data Analysis*, 5th ed., pp. 676-678/6th ed., pp. 703-705).

40. (A) A one-proportion *z* test is appropriate for testing H_o: $p = 0.50$ versus H_a: $p > 0.50$. The *P*-value for this test is 0.006, which is very small and indicates that the null hypothesis should be rejected (*Introduction to Statistics & Data Analysis*, 5th ed., pp. 523-525/6th ed., pp. 524-526).

FREE-RESPONSE ANSWERS

1. (a) Those who test positive will consist of those who have strep and test positive and those who do not have strep but still test positive.

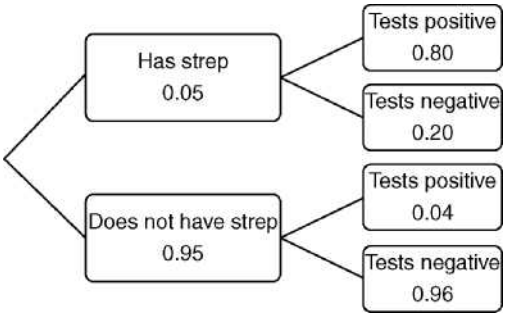
P(have strep $\cap$ test positive) + P(don't have strep n test positive)

$= P$(strep)P(test positive | strep) + P(no strep)P(test positive | no strep)

$= 0.05(0.80) + 0.95(0.04) = 0.078$

This means that 7.8% of the students would test positive.

It is helpful to diagram the probability as shown on the following page. This will also demonstrate that you are familiar with all the correct probabilities.



(b) This is the conditional probability that a student doesn't have strep even though the student tested positive. The solution can be found as follows

P(does not have strep | B)

$$= \frac{P(\text{does not have strep} \cap B)}{P(B)} = \frac{P(\text{does not have strep})P(B)}{0.078} = \frac{0.95(0.04)}{0.078}$$

$= 0.487$

This means that 48.7% of those who test positive don't actually have strep. (*Introduction to Statistics & Data Analysis*, 5th ed., pp. 307, 310-311, and 326-328/6th ed., pp. 300, 302-303, and 317-319).

Scoring Question 1:

Each part of this problem can be scored as essentially correct (E), partially correct (P), or incorrect (I).

Part (a) is scored

E if the probability is correctly computed and supporting work is shown.

P if a correct probability is given but no supporting work is shown OR if the probability computed only considers one of the two possible cases (testing positive and has strep or testing positive and does not have strep).

Part (b) is scored

E if the probability is correctly computed and supporting work is shown.

P if a correct probability is given but no supporting work is shown OR if the numerator in the conditional probability calculation is not correct but the computed probability is still reasonable (a number between 0 and 1).

Question 1 is scored a

4 if both parts are E
3 if one part is E and the other is P
2 if one part is E and one part is I OR if both parts are P
1 if one part is P and one part is I
0 if both parts are I

2. (a) Whether tomato plants are grown in the sunny side or the shady side might affect the proportion of larger tomatoes produced. Because the field consists of a sunny side and a shady side, we should use sides to create blocks. One block would consist of the 200 tomato plants planted on the shady side and the other block would consist of the 400 tomato plants planted on the sunny side.

   (b) First assign fertilizer brand to each of the 200 tomato plants on the shady side. Number the tomato plants from 001 to 200. Read the table three digits at a time until you have 100 tomato plants chosen. Ignore duplicate numbers and the numbers 201–999 and 000. The 100 tomato plants chosen would get fertilizer brand A. The other 100 tomato plants would get fertilizer brand B. Repeat this process to assign a fertilizer brand to the 400 tomato plants on the sunny side. Number the tomato plants from 001 to 400. Read the table three digits at a time until you have 200 tomato plants chosen. Ignore duplicate numbers and the numbers 401–999 and 000. The 200 tomato plants chosen would get fertilizer brand A. The other 200 tomato plants would get fertilizer brand B.

   (c) The tomato plants numbered 017 and 467 will be the first two assigned to fertilizer A in the shady area. 756, 905, and 750 are ignored.

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

(*Introduction to Statistics & Data Analysis*, 5th ed., pp. 38-39, 57-58, 62, 340-342/6th ed., pp. 36-38, 56-57, 60, 331-333).

Scoring Question 2:

Each part of this problem can be scored as essentially correct (E), partially correct (P), or incorrect (I).

Part (a) is scored

E if the sides are chosen as the blocks and the response states that the side may affect the proportion of larger tomatoes produced.

P if sides are chosen as blocks but the response is unclear in stating that the sides (shady or sunny) might be related to the proportion of larger tomatoes produced.

Part (b) is scored

E if a correct method of assigning fertilizer brand at random to tomato plants is described and it is clear that this is done separately for each block (shady side and sunny side).

P if a correct method of assigning fertilizer brand at random to tomato plants is described but it is not clear that this is done separately for each block OR if the blocking is clear but method does not include ignoring unused numbers and repeated numbers.

Part (c) is scored

E if a correct method of selecting tomato plants is performed and this tomato plant is assigned a fertilizer brand and a field side.

P if a correct method of selecting tomato plants is performed but the tomato plants are not assigned a fertilizer brand and a field side.

Question 2 is scored a

4 if three parts are E
3 if two parts are E and one part is P
2 if two parts are E and one part is I OR one part is E and two parts are P OR if one part is E and one part is P and one part is I
1 if three parts are P OR one part is E and two parts are I OR two parts are P and one part is I
0 if one part is P and two parts are I OR three parts are I

3. (a) $\mu_{B+P+C} = \mu_B + \mu_P + \mu_C = 18.8 + 18.6 + 19.4 = 56.8$ points

$\sigma_{B+P+C} = \sqrt{\sigma_B^2 + \sigma_P^2 + \sigma_C^2} = \sqrt{0.72^2 + 0.85^2 + 0.78^2} = \sqrt{1.8493} = 1.3599$ points

(b) The desired probability is the area to the right of 58.8 under the normal curve with $\mu_{B+P+C} = 56.8$ and $\sigma_{B+P+C} = 1.3599$. The z-score is $z = \dfrac{58.8 - 56.8}{1.3599} = 1.47$. The area to the right of 1.47 under the standard normal curve is 0.0707. [Full credit can be awarded if the mean and standard deviation in (a) are incorrect but used in this calculation.]

(c) This is a binomial situation where $n = 5$ and $p = .0707$.

$p(x = 2) = \binom{5}{2}(0.0707)^2(1 - 0.0707)^{5-2} = 0.0401$

(d) This refers to the sampling distribution of the sample mean. The desired probability is the area to the right of 58.8 under the normal curve with $\mu_{\bar{x}} = 56.8$ and $\sigma_{\bar{x}} = \dfrac{1.3599}{\sqrt{5}} = 0.6082$.

The z-score is $z = \dfrac{58.8 - 56.8}{0.6082} = 3.289$. The area to the right of 3.289 under the standard normal curve is 0.0005.

(*Introduction to Statistics & Data Analysis*, 5th ed., pp. 375-377, 383-384, 401-404, and 446-447/6th ed., pp. 365-367, 373-375, 392-395, and 435-436).

Scoring Question 3:

Each part of this problem can be scored as essentially correct (E), partially correct (P), or incorrect (I).

Part (a) is scored

E if the mean and standard deviation are calculated correctly and supporting work is shown.

P if the mean and standard deviation are calculated correctly but no supporting work is shown, OR if the mean is calculated correctly but the standard deviation is not calculated correctly.

Part (b) is scored

E if the normal distribution is used to compute a correct probability and supporting work is shown. Note: Supporting work can consist of showing the computation of the z-score or of a sketch of the standard normal distribution with the appropriate area shaded.

P if the normal distribution is used to compute a correct probability but no supporting work is shown.

Part (c) is scored

E if a binomial situation is identified and correct probability is computed and supporting work is shown.

P if a binomial situation is identified and correct probability is computed but no supporting work is shown.

Part (d) is scored

E if a correct probability is computed using the standard deviation of the sampling distribution and supporting work is shown.

P if a correct probability is computed using the standard deviation of the sampling distribution but no supporting work is shown OR an incorrect probability is computed using the incorrect standard deviation and supporting work is shown.

Note: For parts (b) through (d), if the mean and standard deviation are incorrect in (a) but all work and answers for (b), (c), and (d) are correct based on the incorrect mean and standard deviation, (b), (c), and (d) are scored as correct.

Question 3 is scored a

4 if four parts are E

3 if three parts are E and one is P OR three parts are E and one is I OR two parts are E and two parts are P

2 if two parts are E and one part is P and one part is I OR two parts are E and two parts are I OR one part is E and three parts are P OR one part is E and two parts are P and one part is I OR if four parts are P

1 if one part is E and one part is P and two parts are I OR one part is E and three parts are I OR three parts are P and one part is I OR two parts are P and two parts are I

0 if one part is P and three parts are I OR four parts are I

4. (a) Both of the distributions are approximately symmetric. The variability appears to be a little bit greater for regular cookies than for fat-free cookies (the range for regular cookies is 13 and the range for fat-free cookies is 11). The number of chips for regular cookies is centered at a higher value than number of chips for fat-free cookies. Neither distribution appears to have unusual observations.

   (b) We would perform a two-sample *t* test for population means. The claim is that the mean number of chips is the same for both types of cookies. Since no direction is implied, this would be a two-sided test with hypotheses
   $H_0: \mu_r = \mu_f$
   $H_a: \mu_r \neq \mu_f$
   where μ_r is the true mean number of chips for regular cookies and μ_f is the true mean number of chips for fat-free cookies.

   (c) The samples are independent random samples from their respective populations of cookies. The other condition required for the two-sample *t* test is that the samples sizes are large or that the population distributions are approximately normal. Because both sample sizes are less than 30, we need to look at the distributions. Both of the dotplots show distributions that are approximately symmetric and there are no outliers, so this condition is reasonable and it would be appropriate to carry out the two-sample *t* test.
   (*Introduction to Statistics & Data Analysis*, 5th ed., pp. 173-176, and 565/6th ed., pp. 169-172 and 580).

Scoring Question 4:

Each part of this problem can be scored as essentially correct (E), partially correct (P), or incorrect (I).

Part (a) is scored

E if the two distributions are compared on the basis of all three of shape, center, and spread.

P if the distributions are compared on only two of shape, center, and spread OR if shape, center, and spread are described for both distributions, but no comparative statements are made.

Part (b) is scored

E if the correct test is identified and correct hypotheses are given and if symbols other than μ_R and μ_F are used, they are correctly defined. Note: It is also correct to write the hypotheses in terms of the difference in means:

$H_o : \mu_R - \mu_F = 0$ and $H_a : \mu_R - \mu_F \neq 0$.

P if the correct test is identified and the null hypothesis is correct but the alternative hypothesis is one-sided.

Part (c) is scored

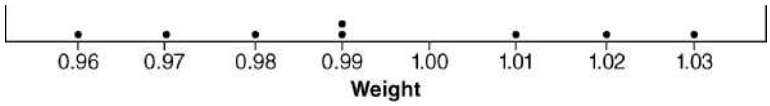
E if the response says use of the *t* test is appropriate and mentions that independent random samples is reasonable and judges the normality conditions to be reasonable based on the given dotplot or on some other appropriate graphical display that is constructed and included in the response.

P if the response says use of the *t* test is appropriate and mentions that independent random samples are given and judges the normality conditions to be reasonable but does not link this judgment to a graphical display.

Question 4 is scored a
4 if all three parts are E
3 if two parts are E and the one is P
2 if two parts are E and one part is I OR one part is E and two parts are P
1 if three parts are P OR two parts are P and one part is I OR if one part is E and two parts are I
0 if one or no parts are P

5. (a) Because we need to estimate a population mean and the population standard deviation is not known, we will use a one-sample *t* confidence interval.

Check Assumptions
1. We are told that it is reasonable to regard the sample as a random sample from the population of interest, so this condition is met.
2. The sample size is not large, so we need to check to see if it is reasonable to assume the population distribution is approximately normal. A dotplot of the sample is



The dotplot is approximately symmetric and there are no outliers, so it is reasonable to use the *t* confidence interval.
Calculations:
$\bar{x} = 0.994$
$s = 0.024$
$df = 8 - 1 = 7$

$$\bar{x} \pm t \bullet \frac{s}{\sqrt{n}} = (\mathbf{0.833},\ \mathbf{1.155})$$

Interpretation:
We can be 90% confident that the true mean weight of *Snickers* fun-size bars is between 0.833 ounces and 1.155 ounces.

(b) Because 1 ounce is in the confidence interval, it is a plausible value for the population mean. There is no reason to think that the manufacturer's claim is not reasonable.

(c) Based on the above interval, we have no evidence to conclude that the manufacturer's advertised weight is unreasonable. This is equivalent to the conclusion of failing to reject the null hypothesis of $\mu = 1$ ounce in a hypothesis test. Since we failed to reject the null hypothesis, we could have made a type II error in which the eight bars do not have a mean weight of 1 ounce but our test does not detect this fact. If the mean weight of candy bars is less than advertised, the company could lose customers for not giving them the advertised weight. If the mean weight of candy bars is more than advertised, the company loses money by including more chocolate than necessary. In either consequence, the company is losing money.
(*Introduction to Statistics & Data Analysis*, 5th ed., pp. 484-485/6th ed., pp. 476-477).

Scoring Question 5:

Each part of this problem can be scored as essentially correct (E), partially correct (P), or incorrect (I).

Part (a) is scored as three parts

E if the *t* confidence interval is identified by name or by formula and both conditions are verified.

P if the *t* confidence interval is identified by name or by formula but it is not clear that both conditions are verified.

E if the correct interval is given and supporting work is shown.

P if the correct interval is given and supporting work is not shown OR the incorrect interval is given but correct supporting work is shown.

E if a correct interpretation of the interval is given in context.

P if a correct interpretation of the interval is given without context.

Part (b) is scored

E if the response says that the manufacturer's claim is reasonable and justifies this based on the fact that 1 is in the computed interval.

P if the response says the claim is reasonable but does not explicitly state that this is because 1 is in the interval.

Note: If the interval in part (a) is incorrectly computed, the response in part (b) must be consistent with the interval in part (a). Part (b) should be scored based on the interval in (a).

Question 5 is scored a

4 if four parts are E

3 if three parts are E and one is P OR three parts are E and one is I OR two parts are E and two parts are P

2 if two parts are E and one part is P and one part is I OR two parts are E and two parts are I OR one part is E and three parts are P OR one part is E and two parts are P and one part is I OR if four parts are P

1 if one part is E and one part is P and two parts are I OR one part is E and three parts are I OR three parts are P and one part is I OR two parts are P and two parts are I

0 if one part is P and three parts are I OR four parts are I

6. (a) $\hat{y} = -342{,}852 + 171.2x$

where $\hat{y}$ = predicted number of requests granted and x = year.

(b) Predicted value for year 2006: $\hat{y} = -342852 + 171.22(2006) = 615.32$

residual = $y - \hat{y} = 317 - 615.32 = -298.32$

The least-squares regression line overpredicted the number of requests granted for 2006. The predicted number of requests granted was quite a bit larger than the actual number of requests granted.

(c) 2020 is far outside the range of the data (which only goes up to 2009). This is extrapolation; it would be unwise to use the line to predict number of requests granted for 2020.

(d) Both the scatter diagram and the residual plot show strong curved patterns, indicating that a linear model is not the best way to describe the relationship between number of requests granted and year. The pattern in the scatter diagram looks like an exponential curve, so it is reasonable to consider an exponential model.

(e) Predicted value for year 2006: $\hat{y} = 11.82(1.74)^6 = 328.03$

residual = $y - \hat{y} = 317 - 328.03 = -11.03$

The exponential model still overpredicts the number of requests granted for 2006, but the predicted number of requests granted is much closer to the actual number of requests granted than the prediction from the linear model.

(f) The exponential model does a better job of describing the relationship between number of requests granted and year in the scatter diagram than a line. The points in the scatter diagram fall much closer to the fitted exponential model than to any line.

(g) No. Even though the exponential model does a better job of describing the relationship for 2001 to 2009 than the least-squares regression line, it is still not a good idea to extrapolate this far outside the range of the data.

(*Introduction to Statistics & Data Analysis*, 5th ed., pp. 218-219, 225, 227-228, 254-256/6th ed., pp. 214-215, 221, 224, 251-253).

Scoring Question 6:

Part (a) is scored

E if a correct equation for the least-squares regression line is given and variables are identified.

P if a correct equation for the least-squares regression line is given but variables are not identified.

Part (b) is scored

E if the predicted value and residual are correctly computed using the line from part (a) and the prediction is identified as an overprediction.

P if the predicted value and residual are correctly computed using the line from part (a) but the prediction is identified as an underprediction OR the predicted value and residual are not correctly computed using the line from part (a) but the prediction is correctly identified as an over/underprediction based on the value calculated.

Part (c) is scored

E if the response says it is not a good idea to use the least-squares regression line to make a prediction for 2020 and identifies extrapolation as the reason.

P if the response says it is not a good idea to use the least-squares regression line to make a prediction for 2020 but does not identify extrapolation as the reason.

Part (d) is scored

E if the response comments on the curved (or nonlinear) pattern in both plots.

I otherwise

Part (e) is scored

E if the predicted value and residual are correctly computed using the given exponential model and it is noted that the predicted value is closer to the actual value than the prediction from part (b).

P if the predicted value and residual are correctly computed using the given exponential model but it is not noted that the predicted value is closer to the actual value than the prediction from part (b).

Part (f) is scored

E if the exponential model is identified as providing a better fit with an appropriate explanation.

P if the exponential model is identified as providing a better fit with an incomplete or missing explanation.

Part (g) is scored

E if the response notes that even with the better exponential model, it is still not a good idea to predict outside the range of the data.

I otherwise

Each part scored as E counts as 1 point and each part scored as P counts as ½ point to compute an overall score. Then Question 6 is scored a

4 if the overall score is 7 or 6.5
3 if the overall score is 6, 5.5, or 5
2 if the overall score is 4.5, 4, 3.5, or 3
1 if the overall score is 2.5, 2, 1.5, or 1
0 if the overall score is 0 or 0.5

CALCULATING YOUR SCORE

SECTION I: MULTIPLE-CHOICE QUESTIONS

[_____] × 1.25 = _____
Number Correct (out of 40) — Weighted Section I Score (do not round)

SECTION II: FREE-RESPONSE QUESTIONS

Question 1 _____ × (1.875) = _____
(out of 4) (Do not round)

Question 2 _____ × (1.875) = _____
(out of 4) (Do not round)

Question 3 _____ × (1.875) = _____
(out of 4) (Do not round)

Question 4 _____ × (1.875) = _____
(out of 4) (Do not round)

Question 5 _____ × (1.875) = _____
(out of 4) (Do not round)

Question 6 _____ × (3.1255) = _____
(out of 4) (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)

Composite Score Range	Approximate AP® Grade
68–100	5
53–67	4
40–52	3
29–39	2
0–28	1