showing each of the strategies on 5 days. Do you prefer this experiment or the one in the previous exercise? Give reasons for your answer.

3.11 A different design for online sales of running shoes. Refer to Exercise 3.9. Here is another way in which the experiment could be designed. Suppose that you randomly select a strategy each time a customer visits the website. Discuss this experiment in terms of the principles of experimental design (page 167).

3.12 Randomize the web pages for the running shoes. Refer to Exercise 3.10. Use software or Table B to randomize the treatments. Give a step-by-step detailed description of how you performed the randomization.

3.13 What is needed? Explain what is deficient in each of the following proposed experiments and explain how you would improve the experiment.

(a) A study compares three marketing campaigns to encourage individuals to eat more fruits and vegetables. The first campaign is launched in Florida at the same time that the second campaign is launched in Minnesota. A third campaign is launched in California a month later.

(b) You want to evaluate the effectiveness of a new exercise routine. You try the routine from January to June and the second routine from July to December.

(c) Two product promotions are to be compared. The first, which offers two items for $2, will be used online. The second, which offers three items for $3, will be used in a store.

3.14 The *Madden* curse. Some people believe that individuals who appear on the cover of the football game *Madden NFL* will soon have a serious injury. Can you evaluate this belief with an experiment? Explain your answer.

3.15 Evaluate a new orientation program. Your company runs a two-day orientation program for new employees on Monday and Tuesday each week. A new program is to be compared with the current one. Set up an experiment to compare the new program with the old. Be sure to provide details regarding randomization and what outcome variables you will measure.

3.16 What is wrong? Explain what is wrong with each of the following randomization procedures and describe how you would do the randomization correctly.

(a) Twenty subjects are to be assigned to two treatments, 10 to each. For each subject, a coin is tossed. If the coin comes up heads, the subject is assigned to the first treatment; if the coin comes up tails, the subject is assigned to the second treatment.

(b) An experiment will assign 50 rats to five different treatment conditions. The rats arrive from the supplier in batches of 10, and the treatment lasts two weeks. The first batch of 10 rats is randomly assigned to one of the five treatments, and data for these rats are collected. After a one-week break, another batch of 10 rats arrives and is assigned to one of the four remaining treatments. The process continues until the last batch of rats is given the treatment that has not been assigned to the four previous batches.

(c) Thirty students are to be used to evaluate a new treatment. Fifteen women are assigned to receive the treatment, and 15 men are assigned to be the controls.

3.17 Calcium and vitamin D. The body needs vitamin D in order to use calcium. An experiment is designed to study the effects of calcium and vitamin D supplements on the bones of first-year college students. The outcome measure is the total body bone mineral content (TBBMC), a measure of bone health. Three doses of calcium will be used: 0, 300, and 600 milligrams per day (mg/day). The doses of vitamin D will be 0 and 150 international units (IU) per day. The calcium and vitamin D will be given in a single tablet. All tablets, including those with no calcium and no vitamin D, will look identical. Subjects for the study will be 30 men and 30 women.

(a) What are the factors and the treatments for this experiment?

(b) Draw a picture explaining how you would randomize the 60 college students to the treatments.

(c) Use a spreadsheet to carry out the randomization.

(d) Is there a placebo that serves as a control group in this experiment? Explain your answer.

3.18 Use the *Simple Random Sample* applet. You can use the *Simple Random Sample* applet to choose a group at random once you have labeled the subjects. Example 3.20 (page 168) uses Excel to choose 5 students from a group of 10 to receive a treatment in an experiment. The remaining 5 students will receive a placebo control.

(a) Use the applet to choose 5 students. Which students were selected?

(b) Compare the use of Excel, as in Example 3.20, with the use of the applet for this exercise. Which do you prefer? Give reasons for your answer.

3.19 Use the *Simple Random Sample* applet. The *Simple Random Sample* applet allows you to randomly assign experimental units to more than two groups without difficulty. Consider a randomized comparative experiment in which 90 students are randomly assigned to three groups of 30.

(a) Use the applet to randomly choose 30 out of 90 students to form the first group. Which students are in this group?

(b) There are now 60 students who were not chosen. Use the applet to randomly choose 30 of these remain students to make up the second group. Which student were chosen?

(c) Use the applet to randomly choose the third grou Don't take the time to write this down. Check that th are only 20 students remaining. These students get Treatment 3. Which students are they?

3.23 Calcium and the bones of young girls. Calcium is important to the bone development of young girls. To study how the bodies of young girls process calcium, investigators used the setting of a summer camp. Calcium was given in punch at either a high level or a low level. The camp diet was otherwise the same for all girls. Suppose that there are 40 campers.

(a) Outline a completely randomized design for this experiment.

(b) Use software or Table B to do the randomization. Explain in step-by-step detail how you carried out the randomization.

(c) Make a table giving the treatment that each camper will receive.

3.24 A different design for calcium and the bones of young girls. Refer to the previous exercise.

(a) Outline a matched pairs design in which each girl receives both levels of calcium (with a "washout period" in which no calcium supplementation was given between the two treatment periods).

(b) What is the advantage of the matched pairs design over the completely randomized design?

(c) The same randomization can be used in different ways for both designs. Explain why this is true.

(d) Use software or Table B to do the randomization. Explain what each subject will receive for the matched pairs design.

3.26 How many text messages? You would like to know something about how many text messages you will receive in the next 50 days. Counting the number for each of the 50 days would take more time than you would like to spend on this project, so you randomly select 5 days from the 50 to count.

(a) Describe the population for this setting.

(b) What is the sample?

3.32 What's wrong? Explain what is wrong with each of the following random selection procedures and explain how you would do the randomization correctly.

(a) To determine the reading level of an introductory statistics text, you evaluate all the written material in the third chapter.

(b) You want to sample student opinions about a proposed change in procedures for changing majors. You hand out questionnaires to 100 students as they arrive for class at 7:30 A.M.

(c) A population of subjects is put in alphabetical order, and a simple random sample of size 10 is taken by selecting the first 10 subjects from the list.

3.36 Using GIS to identify mint field conditions. A geographic information system (GIS) is to be used to distinguish different conditions in mint fields. Ground observations will be used to classify regions of each field as either healthy mint, diseased mint, or weed-infested mint. The GIS divides mint-growing areas into regions called pixels. An experimental area contains 100 pixels. For a random sample of 12 pixels, ground measurements will be made to determine the status of the mint, and these observations will be compared with information obtained by the GIS. Select the random sample. If you use Table B, start at line 130 and choose only the first 12 pixels in the sample.

applet **4.6 Use the *Probability* applet.** The idea of probability is that the *proportion* of heads in many tosses of a balanced coin eventually gets close to 0.5. But does the actual *count* of heads get close to one-half the number of tosses? Let's find out. Set the "Probability of Heads" in the *Probability* applet to 0.5 and the number of tosses to 100. You can extend the number of tosses by tossing again to get 100 more. Don't reset the app during this exercise.

(a) After 100 tosses, what is the proportion of heads? What is the count of heads? What is the difference between the count of heads and 50 (one-half the number of tosses)?

(b) Keep going to 200 tosses. Again record the proportion and count of heads and the difference between the count and 100 (half the number of tosses).

(c) Keep going. Stop at 300 tosses and again at 400 tosses and record the same facts. Although it may take a long time, the laws of probability say that the proportion of heads will always get close to 0.5 and also that the difference between the count of heads and half the number of tosses will always grow without limit.

4.27 Universal blood donors. People with type O-negative blood are universal donors. That is, any patient can receive a transfusion of O-negative blood. Only 7% of the American population have O-negative blood. If six people appear at random to give blood, what is the probability that at least one of them is a universal donor?

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(b) You are observing cars at an intersection. You classify the movement of each car as a right turn, a left turn, or straight through the intersection.

(c) For college basketball games, you record the times that the home team wins and the number of times that the home team loses.

(d) The outcome of the next tennis match for Ashleigh Barty is either a win or a loss.

4.14 What's wrong? In each of the following scenarios, there is something wrong. Describe what is wrong and give a reason for your answer.

(a) If we select a digit at random, then the probability of selecting a 4 is 0.4.

(b) If the probability of A is 0.2, the probability of B is 0.3, and the probability of A and B is 0.5, then A and B are independent.

(c) If the sample space consists of four outcomes, then each outcome has probability 0.25.

4.15 Evaluating web page designs. You are a web page designer, and you set up a page with four different links. A user of the page can click on one of the links, or he or she can leave that page. Describe the sample space for the outcome of someone visiting your web page.

4.16 Record the length of time spent on the page. Refer to the previous exercise. You also decide to measure the length of time a visitor spends on your page. Give the sample space for this measure.

4.17 Distribution of blood types. All human blood can be "ABO-typed" as one of O, A, B, or AB, but the distribution of the types varies a bit among groups of people. Here is the distribution of blood types for a randomly chosen person in the United States:[7]

Blood type	A	B	AB	O
U.S. probability	0.42	0.11	0.03	?

(a) What is the probability of type O blood in the United States?

(b) Sasha has type A blood. She can safely receive blood transfusions from people with blood types O and A. What is the probability that a randomly chosen person from the United States can donate blood to Sasha? (This exercise and the one that follows ignore the Rh factor, another classification of blood types that is related to whether one person can donate blood to another.)

4.18 Blood types in Ireland. The distribution of blood types in Ireland differs from the U.S. distribution given in the previous exercise:

Blood type	A	B	AB	O
Ireland probability	0.35	0.10	0.03	0.52

Choose a person from the United States and a person from Ireland at random, independently of each other. What is the probability that both have type O blood? What is the probability that both have the same blood type?

4.19 Are the probabilities legitimate? In each of the following situations, state whether or not the given assignment of probabilities to individual outcomes is legitimate—that is, whether it satisfies the rules of probability. If not, give specific reasons for your answer.

(a) Deal a card from a shuffled deck: $P(\text{clubs}) = 14/52$ $P(\text{diamonds}) = 14/52$, $P(\text{hearts}) = 12/52$, $P(\text{spades}) = 12/52$

(b) Roll a die and record the count of spots on the up-face: $P(1) = 0.2$, $P(2) = 0.1$, $P(3) = 0.3$, $P(4) = 0.1$, $P(5) = 0.1$, $P(6) = 0.2$.

(c) Choose a college student at random and record gender and enrollment status: $P(\text{female full-time}) = 0.45$ $P(\text{female part-time}) = 0.55$, $P(\text{male full-time}) = 0.48$, $P(\text{male part - time}) = 0.52$.

4.20 French and English in Canada. Canada has two official languages, English and French. Choose a Canadian at random and ask, "What is your mother tongue?" Here is the distribution of responses:[8]

Language	English	French	Other
Probability	0.56	0.21	?

(a) What probability should replace "?" in the distribution?

(b) What is the probability that a Canadian's mother tongue is not English? Explain how you computed your answer.

4.21 Education levels of young adults. Choose a young adult (age 25 to 34 years) at random. The probability is 0.12 that the person chosen did not complete high school, 0.31 that the person has a high school diploma but no further education, and 0.29 that the person has at least a bachelor's degree.

(a) What must be the probability that a randomly chosen young adult has some education beyond high school but does not have a bachelor's degree?

(b) What is the probability that a randomly chosen young adult has at least a high school education?

4.22 Loaded dice. There are many ways to produce crooked dice. To *load* a die so that 6 comes up too often and 1 (which is opposite 6) comes up too seldom, add a bit of lead to the spot on the 1 face. Because the spot is solid plastic, this works even with transparent dice. If a die is loaded so that 6 comes up with probability 0.24 and the probabilities of the 2, 3, 4, and 5 faces are not affected, what is the assignment of probabilities to the six faces?

4.23 Rh blood types. Human blood is typed as O, A, B, or AB and also as Rh-positive or Rh-negative. ABO type and Rh-factor type are independent because they are governed by different genes. In the American population, 84% of people are Rh-positive. Use the information about ABO type in Exercise 4.17 to give the probability distribution of blood type (ABO and Rh) for a randomly chosen American.