

## Chapter 2/ Exercises

- 2.1 List the elements of each of the following sample spaces: (a) the set of integers between 1 and 50 divisible by 8; (b) the set  $S = \{x \mid x^2 + 4x - 5 = 0\}$ ; (c) the set of outcomes when a coin is tossed until a tail or three heads appear; (d) the set  $S = \{x \mid x \text{ is a continent}\}$ ; (e) the set  $S = \{x \mid 2x - 4 > 0 \text{ and } x < 1\}$ .
- 2.2 Use the rule method to describe the sample space  $S$  consisting of all points in the first quadrant inside a circle of radius 3 with center at the origin.
- 2.3 Which of the following events are equal? (a)  $A = \{1, 3\}$ ; (b)  $B = \{x \mid x \text{ is a number on a die}\}$ ; (c)  $C = \{x \mid x^2 - 4x + 3 = 0\}$ ; (d)  $D = \{x \mid x \text{ is the number of heads when six coins are tossed}\}$ .
- 2.4 An experiment involves tossing a pair of dice, 1 green and 1 red, and recording the numbers that come up. If  $x$  equals the outcome on the green die and  $y$  the outcome on the red die, describe the sample space  $S$  (a) by listing the elements  $\{x, y\}$  (b) by using the rule method.
- 2.5 An experiment, consists of tossing a die and then flipping a coin once if the number on the die is even. If the number on the die is odd, the coin is flipped twice. Using the notation  $4//$ , for example, to denote the outcome that the die comes up 4 and then the coin comes up heads, and  $3HT$  to denote the outcome that the die comes up 3 followed by a head and then a tail on the coin, construct a tree diagram to show the 18 elements of the sample space  $S$ .
- 2.6 Two jurors are selected from 4 alternates to serve at a murder trial. Using the notation  $4IA;J$ , for example, to denote the simple event that alternates 1 and 3 are selected, list the 6 elements of the sample space  $S$ .
- 2.7 Four students are selected at random from a chemistry class and classified as male or female. List the elements of the sample space  $S_1$  using the letter M for "male" and F for "female." Define a second sample space  $S_2$  where the elements represent the number of females selected.
- 2.8 For the sample space of Exercise 2.4:
- (a) list the elements corresponding to the event  $A$  that the sum is greater than 8;
  - (b) list the elements corresponding to the event  $B$  that a 2 occurs on either die;
  - (c) list the elements corresponding to the event  $C$  that a number greater than 4 comes up on the green die
  - (d) list the elements corresponding to the event  $A \cap C$
  - (e) list the elements corresponding to the event  $A \cap B$
  - (f) list the elements corresponding to the event  $B \cap C$
  - (g) Construct a Venn diagram to illustrate the intersections and unions of the events  $A$ ,  $B$ , and  $C$ .
- 2.9 For the sample space of Exercise 2.5, (a) list the elements corresponding to the event  $A$  that a number less than 3 occurs on the die; (b) list the elements corresponding to the event  $B$  that 2 tails occur; (c) list the elements corresponding to the event  $A'$ ; (d) list the elements corresponding to the event  $A' \cap B$ ; (e) list the elements corresponding to the event  $A \cup B$ .
- 2.10 An engineering firm is hired to determine if certain waterways in Virginia are safe for fishing. Samples are taken from three rivers. (a) List the elements of a sample space  $S$ , using the letters F for "safe to fish" and N for "not safe to fish." (b) List the elements of  $S$  corresponding to event  $E$  that at least two of the rivers are safe for fishing. (c) Define an event that has as its elements the points  $\{FFF, NFF, FFN, NFN\}$ .

2.11 The resumes of 2 male applicants for a college teaching position in chemistry are placed in the same file as the resumes of 2 female applicants. Two positions become available and the first, at the rank of assistant professor, is filled by selecting 1 of the 4 applicants at random. The second position, at the rank of instructor, is then filled by selecting at random one of the remaining 3 applicants. Using the notation  $M_2F_1$ , for example, to denote the simple event that the first position is filled by the second male applicant and the second position is then filled by the first female applicant,

(a) list the elements of a sample space  $S$ ; (b) list the elements of  $S$  corresponding to event  $A$  that the position of assistant professor is filled by a male applicant; (c) list the elements of  $S$  corresponding to event  $B$  that exactly 1 of the 2 positions was filled by a male applicant; (d) list the elements of  $S$  corresponding to event  $C$  that neither position was filled by a male applicant; (e) list the elements of  $S$  corresponding to the event  $AH_5$ ; (f) list the elements of  $S$  corresponding to the event  $A_{DC}$ ; (g) construct a Venn diagram to illustrate the intersections and unions of the events  $A$ ,  $B$ , and  $C$ .

2.12 Exercise and diet are being studied as possible substitutes for medication to lower blood pressure. Three groups of subjects will be used to study the effect of exercise. Group one is sedentary while group two walks and group three swims for 1 hour a day. Half of each of the three exercise groups will be on a salt-free diet. An additional group of subjects will not exercise nor restrict their salt, but will take the standard medication. Use  $Z$  for sedentary,  $W$  for walker,  $S$  for swimmer,  $Y$  for salt,  $M$  for medication and  $F$  for medication free.

(a) Show all of the elements of the sample space  $S$ .

(b) Given that  $A$  is the set of nonmedicated subjects and  $B$  is the set of walkers, list the elements of  $A \cup B$ .

(c) List the elements of  $A \cap B$ .

2.13 Construct a Venn diagram to illustrate the possible intersections and unions for the following events relative to the sample space consisting of all automobiles made in the United States.  $F$ : Four door,  $S$ : Sun roof,  $P$ : Power steering.

2.14 If  $S = \{0,1,2,3,4,5,6,7,8,9\}$  and  $A = \{0,2,4,6,8\}$ ,  $B = \{1,3,5,7,9\}$ ,  $C = \{2,3,4,5\}$ , and  $D = \{1,6, 7\}$ , list the elements of the sets corresponding to the following events: (a)  $A \cup C$ ;

(b)  $A \cap B$ ;

(c)  $C'$

(d)  $(C \cap D) \cup B$

(e)  $(S \cap C)'$ ;

(f)  $A \cap C \cap D'$ .

2.15 Consider the sample space  $S = \{\text{copper, sodium, nitrogen, potassium, uranium, oxygen, zinc}\}$ , and the events

$A = \{\text{copper, sodium, zinc}\}$ ,  $B = \{\text{sodium, nitrogen, potassium}\}$ ,  $C = \{\text{oxygen}\}$ .

List the elements of the sets corresponding to the following events: (a)  $A'$ ; (b)  $A \cup C$ ; (c)  $(A \cap B') \cup C$ ; (d)  $B' \cap C'$ ; (e)  $A \cap B \cap C$ ; (f)  $(A \cup B') \cap (A' \cap C)$ .

2.16 If  $S = \{x \mid 0 < x < 12\}$ ,  $M = \{x \mid 1 < x < 9\}$ , and  $N = \{x \mid 0 < x < 5\}$ , find (a)  $M \cup N$ ; (b)  $M \cap N$ ; (c)  $M' \cap N'$ .

2.17 Let  $A$ ,  $B$ , and  $C$  be events relative to the sample space  $S$ . Using Venn diagrams, shade the areas representing the following events:

- (a)  $(A \cap B)'$ ;
- (b)  $(A \cup B)'$ ;
- (c)  $(A \cap C) \cup B$ .

2.18 Which of the following pairs of events are mutually exclusive? (a) A golfer scoring the lowest 18-hole round in a 72-hole tournament and losing the tournament. (b) A poker player getting a flush (all cards in the same suit) and 3 of a kind on the same 5-card hand. (c) A mother giving birth to a baby girl and a set of twin daughters on the same day. (d) A chess player losing the last game and winning the match.

2.19 Suppose that a family is leaving on a summer vacation in their camper and that  $M$  is the event that they will experience mechanical problems,  $T$  is the event that they will receive a ticket for committing a traffic violation, and  $V$  is the event that they will arrive at a campsite with no vacancies. Referring to the Venn diagram of Figure 2.5, state in words the events represented by the following regions:

- (a) region 5;
- (b) region 3;
- (c) regions 1 and 2 together ;
- (c) regions 4 and 7 together ;
- (e) regions 3, (i. 7. and 8 together).

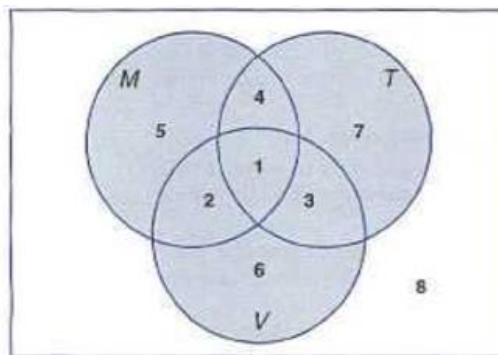


Figure 2.5: Venn diagram for Exercises 2.19 and 2.20.

2.20 Referring to Exercise 2.19 and the Venn diagram of Figure 2.5, list the numbers of the regions that represent, the following events: (a) The family will experience no mechanical problems and

commit no traffic violation but will arrive at a campsite with no vacancies. (b) The family will experience both mechanical problems and trouble in locating a campsite with a vacancy but will not receive a ticket for a traffic violation. (c) The family will either have mechanical trouble or arrive at a campsite with no vacancies but will not receive a ticket for committing a traffic violation. (d) The family will not arrive at a campsite with no vacancies.

2.21 Registrants at a large convention are offered 6 sightseeing tours on each of 3 days. In how many ways can a person arrange to go on a sightseeing tour planned by this convention?

2.22 In a medical study patients are classified in 8 ways according to whether they have blood type AB+, AB~, A+, A~, B+, B~, O+, or O~, and also according to whether their blood pressure is low, normal, or high. Find the number of ways in which a patient can be classified.

2.23 If an experiment consists of throwing a die and then drawing a letter at random from the English alphabet, how many points are there in the sample space?

2.24 Students at a private liberal arts college are classified as being freshmen, sophomores, juniors, or seniors, and also according to whether they are male or female. Find the total number of possible classifications for the students of that college.

2.25 A certain shoe conies in 5 different styles with each style available in 4 distinct colors. If the store wishes to display pairs of these shoes showing all of its various styles and colors, how many different pairs would the store have on display?

2.26 A California study concluded that by following 7 simple health rules a man's life can be extended by 11 years on the average and a woman's life by 7 years. These 7 rules are as follows: no smoking, regular exercise, use alcohol moderately, get, 7 to 8 hours of sleep, maintain proper weight, eat. breakfast, and do not eat between meals. In how many ways can a person adopt five of these rules to follow (a) If the person presently violates all 7 rules?  
(b) If the person never drinks and fast?

2.27 A developer of a new subdivision offers a prospective home buyer a choice of 4 designs, 3 different heating systems, a garage or carport, and a patio or screened porch. How many different plans are available to this buyer?

2.28 A drug for the relief of asthma can be purchased from 5 different, manufacturers in liquid, tablet, or capsule form, all of which come in regular and extra strength. How many different ways can a doctor prescribe the drug for a patient suffering from asthma?

2.29 In a fuel economy study, each of 3 race cars is tested using 5 different brands of gasoline at 7 test sites located in different regions of the country. If 2 drivers are used in the study, and test runs are made once under each distinct set of conditions, how many tost, runs are needed?

2.30 In how many different ways can a true-false test consisting of 9 questions be answered?

2.31 If a multiple-choice test consists of 5 questions each with 4 possible answers of which only 1 is correct, (a) In how many different ways can a student check off one answer to each question? (b) In how many ways can a student, check off one answer to each question and get all the answers wrong ?

(a) How many distinct permutations can be made from the letters of the word columns? (b) How many of these permutations start with the letter m?

2.33 A witness to a hit-and-run accident told the police that the license number contained the letters RLH followed by 3 digits, the first of which is a 5. If the witness cannot recall the last 2 digits, but is certain that all 3 digits are different, find the maximum number of automobile registrations that the police may have to check.

2.34 (a) In how many ways can 6 people be lined up to get on a bus? (b) If 3 specific persons, among 6, insist on following each other, how many ways are possible? (c) If 2 specific persons, among 6, refuse to follow each other, how many ways are possible?

2.35 A contractor wishes to build 9 houses, each different in design. In how many ways can he place these houses on a street if 6 lots are on one side of the street and 3 lots are on the opposite side?

2.36 (a) How many three-digit numbers can be formed from the digits 0, 1, 2, 3, 4, 5, and 6, if each digit can be used only once? (b) How many of these are odd numbers? (c) How many are greater than 330?

2.37 In how many ways can 4 boys and 5 girls sit in a row if the boys and girls must alternate?

2.38 Four married couples have bought 8 seats in the same row for a concert. In how many different ways can they be seated (a) With no restrictions? (b) If each couple is to sit together? (c) If all the men sit together to the right of all the women?

2.39 In a regional spelling bee, the 8 finalists consist of 3 boys and 5 girls. Find the number of sample points in the sample space  $S$  for the number of possible orders at the conclusion of the contest for (a) all 8 finalists;  
(b) the first 3 positions.

2.40 In how many ways can 5 starting positions on a basketball team be filled with 8 men who can play any of the positions?

2.41 Find the number of ways that 6 teachers can be assigned to 4 sections of an introductory psychology course if no teacher is assigned to more than one section.

2.42 Three lottery tickets for first, second, and third prizes are drawn from a group of 40 tickets. Find the number of sample points in  $S$  for awarding the 3 prizes if each contestant holds only 1 ticket.

2.43 In how many ways can 5 different trees be planted in a circle?

2.44 In how many ways can a caravan of 8 covered wagons from Arizona be arranged in a circle?

2.45 How many distinct permutations can be made from the letters of the word infinity?

2.46 In how many ways can 3 oaks, 4 pines, and 2 maples be arranged along a property line if one does not distinguish among trees of the same kind?

2.47 A college plays 12 football games during a season. In how many ways can the team end the season with 7 wins, 3 losses, and 2 ties?

2.48 Nine people are going on a skiing trip in 3 cars that hold 2, 4, and 5 passengers, respectively. In how many ways is it possible to transport the 9 people to the ski lodge, using all cars?

2.49 How many ways are there to select 3 candidates from 8 equally qualified recent graduates for openings in an accounting firm?

2.50 How many ways are there that no two students will have the same birth date in a size of 60 class?

2.51 Find the errors in each of the following statements: (a) The probabilities that an automobile salesperson will sell 0, 1, 2, or 3 cars on any given day in February are, respectively, 0.19, 0.38, 0.29, and 0.15. (b) The probability that it will rain tomorrow is 0.40 and the probability that it will not rain tomorrow is 0.52. (c) The probabilities that a printer will make 0, 1, 2, 3, or 4 or more mistakes in setting a document are, respectively, 0.19, 0.34, -0.25, 0.43, and 0.29. (d) On a single draw from a deck of playing cards the probability of selecting a heart is  $1/4$ , the probability of selecting a black card is  $1/2$ , and the probability of selecting both a heart and a black card is  $1/8$ .

2.52 Assuming that all elements of  $S$  in Exercise 2.8 on page 38 are equally likely to occur, find (a) the probability of event  $A$ ; (b) the probability of event  $C$ ; (c) the probability of event  $A \cap C$ .

2.53 A box contains 500 envelopes of which 75 contain \$100 in cash, 150 contain \$25, and 275 contain \$10. An envelope may be purchased for \$25. What is the sample space for the different amounts of money? Assign probabilities to the sample points and then find the probability that the first envelope purchased contains less than \$100.

2.54 Suppose that in a senior college class of 500 students it is found that 210 smoke, 258 drink alcoholic beverages, 216 eat between meals, 122 smoke and drink alcoholic beverages, 83 eat between meals and drink alcoholic beverages, 97 smoke and eat between meals, and 52 engage in all three of these bad health practices. If a member of this senior class is selected at random, find the probability that the student (a) smokes but does not drink alcoholic beverages; (b) eats between meals and drinks alcoholic beverages but does not smoke; (c) neither smokes nor eats between meals.

2.55 The probability that an American industry will locate in Shanghai, China is 0.7, the probability that it will locate in Beijing, China is 0.4, and the probability that it will locate in either Shanghai

or Beijing or both is 0.8. What is the probability that the industry will locate (a) in both cities? (b) in neither city?

2.56 From past experiences a stockbroker believes that under present economic conditions a customer will invest in tax-free bonds with a probability of 0.6, will invest in mutual funds with a probability of 0.3, and will invest in both tax-free bonds and mutual funds with a probability of 0.15. At this time, find the probability that a customer will invest (a) in either tax-free bonds or mutual funds: (b) in neither tax-free bonds nor mutual funds.

2.57 If a letter is chosen at random from the English alphabet, find the probability that the letter (a) is a vowel exclusive of y; (b) is listed somewhere ahead of the letter j\ (c) is listed somewhere after the letter g.

2.58 An automobile manufacturer is concerned about a possible recall of its best-selling four-door sedan. If there were a recall, there is 0.25 probability that a defect is in the brake system, 0.18 in the transmission, 0.17 in the fuel system, and 0.40 in some other area. (a) What is the probability that the defect is the brakes or the fueling system if the probability of defects in both systems simultaneously is 0.15? (b) What is the probability that there are no defects in either the brakes or the fueling system?

2.59 If each coded item in a catalog begins with 3 distinct letters followed by 4 distinct nonzero digits, find the probability of randomly selecting one of these coded items with the first letter a vowel and the last digit even.

2.60 A pair of fair dice is tossed. Find the probability of getting (a) a total of 8; (b) at most a total of 5.

2.61 Two cards are drawn in succession from a deck without replacement. What is the probability that both cards are greater than 2 and less than 8?

2.62 If 3 books are picked at random from a shelf containing 5 novels, 3 books of poems, and a dictionary, what is the probability that (a) the dictionary is selected?  
b) 2 novels and 1 book of poems are selected?

2.63 In a poker hand consisting of 5 cards, find the probability of holding (a) 3 aces;  
(b) 4 hearts and 1 club.

2.64 In a game of Yahtzee, where 5 dice are tossed simultaneously, find the probability of getting 4 of a kind.

2.65 In a high school graduating class of 100 students, 54 studied mathematics, 69 studied history, and 35 studied both mathematics and history. If one of these students is selected at random, find the probability that (a) the student took mathematics or history; (b) the student did not take either of these subjects; (c) the student took history but not mathematics.

2.66 Dom's Pizza Company uses taste testing and statistical analysis of the data prior to marketing any new product. Consider a study involving three types of crusts (thin, thin with garlic and oregano, and thin with bits of cheese). Dom's is also studying three sauces, (standard, a new sauce with more garlic, and a new sauce with fresh basil). (a) How many combinations of crust and sauce are involved? (b) What is the probability that a judge will get a plain thin crust with a standard sauce for his first taste test?

2.67 According to Consumer Digest (July/August 1996), the probable location of personal computers (PC) in the home is as follows: Adult bedroom: 0.03 Child bedroom: 0.15 Other bedroom: 0.14 Office or den: 0.40 Other rooms: 0.28 (a) What is the probability that a PC is in a bedroom? (b) What is the probability that it is not in a bedroom? (c) Suppose a household is selected at random from households with a PC; in what room would you expect to find a PC?

2.68 Interest centers around the life of an electronic component. Suppose it is known that the probability that the component survives for more than 6000 hours is 0.42. Suppose also that the probability that the component survives no longer than 4000 hours is 0.04.  
(a) What is the probability that the life of the component is less than or equal to 6000 hours? (b) What is the probability that the life is greater than 4000 hours?

2.69 Consider the situation of Exercise 2.68. Let A be the event that the component fails a particular test and B be the event that the component displays strain but does not actually fail. Event A occurs with probability 0.20 and event B occurs with probability 0.35. (a) What is the probability that the component does not fail the test? (b) What, is the probability that a component works perfectly well (i.e., neither displays strain nor fails the test)? (c) What is the probability that the component either fails or shows strain in the test?

2.70 Factory workers are constantly encouraged to practice zero tolerance when it comes to accidents in factories. Accidents can occur because the working environment or conditions themselves are unsafe. On the other hand, accidents can occur due to carelessness or so-called human error. In addition, the worker's shift 7:00 A.M.-3:00 P.M. (day shift), 3:00 P.M.-11:00 P.M. (evening shift), and 11:00 P.M.-7:00 A.M. (graveyard shift) may be a factor. During the last year, 300 accidents have occurred. The percentages of the accidents for the condition combinations are as follows:

Shift	Unsafe Conditions	Human Error
Day	5%	32%
Evening	6%	25%
Graveyard	2%	30%

If an accident report is selected randomly from the 300 reports, (a) What is the probability that the accident occurred on the graveyard shift? (b) What is the probability that the accident occurred due to human error? (c) What is the probability that the accident occurred due to unsafe conditions? (d) What is the probability that the accident occurred on either the evening or graveyard shift?



2.71 Consider the situation of Example 2.31 on page 54. (a) What is the probability that no more than 4 cars will be serviced by the mechanic? (b) What is the probability that he will service fewer than 8 cars? (c) What is the probability that he will service either 3 or 4 cars?

2.72 Interest centers around the nature of an oven purchased at a particular department store. It can be either a gas or electric oven. Consider the decision made by six distinct customers. (a) Suppose that the probability is 0.40 that at most, two of these individuals purchase an electric oven. What is the probability that at least three purchase the electric oven? (b) Suppose it is known that the probability that all six purchase the electric oven is 0.007 while 0.104 is the probability that all six purchase the gas oven. What is the probability that at least one of each type is purchased?

2.73 It is common in many industrial areas to use a filling machine to fill boxes full of product. This occurs in the food industry as well as other areas in which the product is used in the home, for example, detergent. These machines are not perfect, and, indeed they may A, fill to specification, B, underfill, and C, overfill. Generally, the practice of underfilling is that which one hopes to avoid. Let  $P(B) = 0.001$  while  $P(A) = 0.990$ . (a) Give  $P(C)$ . (b) What is the probability that the machine does not underfill? (c) What is the probability that the machine either overfills or underfills?

2.74 Consider the situation of Exercise 2.73. Suppose 50,000 boxes of detergent are produced per week and suppose also that those underfilled are "sent back" with customers requesting reimbursement of purchase price. Suppose also that the "cost" of production is known to be \$4.00 per box while the purchase price is \$4.50 per box. (a) What is the weekly profit under the condition of no defective boxes? (b) What is the loss in profit expected due to underfilling?

2.75 As the situation of Exercise 2.73 might suggest, statistical procedures are often used for control of quality (i.e., industrial quality control). At times, the weight of a product is an important variable to control. Specifications are given for the weight, of a certain packaged product and a package is rejected if it is either too light or too heavy. Historical data suggest that 0.95 is the probability that the product meets weight specifications whereas 0.002 is the probability that the product is too light. For each single packaged product the manufacturer invests \$20.00 in production and the purchase price by the consumer is \$25.00.

(a) What is the probability that a package chosen randomly from the production line is too heavy? (b) For each 10,000 packages sold, what profit is received by the manufacturer if all packages meet weight specification? (c) Assuming that all "defective" packages are rejected and rendered worthless, how much is the profit reduced on 10,000 packages due to failure to meet weight specification?

2.76 Prove that  $P(A' \cap B') = 1 - P(A) - P(B)$ .

2.77 If R is the event that a convict committed armed robbery and D is the event that the convict pushed dope, state in words what probabilities are expressed by (a)  $P(R \cap D)$ ; (b)  $P(D \cap R)$ ; (c)  $P(R \cap D')$ .

2.78 A class in advanced physics is comprised of 10 juniors, 30 seniors, and 10 graduate students. The final grades show that 3 of the juniors, 10 of the seniors, and 5 of the graduate students received an A for the course. If a student is chosen at random from this class and is found to have earned an A, what is the probability that he or she is a senior?

2.79 A random sample of 200 adults are classified below by sex and their level of education attained.

<b>Education</b>	<b>Male</b>	<b>Female</b>
Elementary	38	45
Secondary	28	50
College	22	17

If a person is picked at random from this group, find the probability that (a) the person is a male, given that the person has a secondary education;

(b) the person does not have a college degree, given that the person is a female.

2.80 In an experiment to study the relationship of hypertension and smoking habits, the following data are collected for 180 individuals:

	<b>Nonsmokers</b>	<b>Moderate Smokers</b>	<b>Heavy Smokers</b>
<i>H</i>	21	36	30
<i>NH</i>	48	26	19

where H and NH in the table stand for Hypertension and Nonhypertension, respectively. If one of these individuals is selected at random, find the probability that the person is (a) experiencing hypertension, given that the person is a heavy smoker; (b) a nonsmoker, given that the person is experiencing no hypertension.

2.81 In the senior year of a high school graduating class of 100 students, 42 studied mathematics, 68 studied psychology, 54 studied history, 22 studied both mathematics and history, 25 studied both mathematics and psychology, 7 studied history but neither mathematics nor psychology, 10 studied all three subjects, and 8 did not take any of the three. If a student is selected at random, find the probability that (a) a person enrolled in psychology takes all three subjects; (b) a person not taking psychology is taking both history and mathematics.

2.82 A manufacturer of a flu vaccine is concerned about the quality of its flu serum. Batches of serum are processed by three different departments having rejection rates of 0.10, 0.08, and 0.12, respectively. The inspections by the three departments are sequential and independent. (a) What is the probability that a batch of serum survives the first departmental inspection but is rejected by the second department? (b) What is the probability that a batch of serum is rejected by the third department?

2.83 In USA Today (Sept. 5, 1996) the results of a survey involving the use of sleepwear while traveling were listed as follows: Male Female Total Underwear Nightgown Nothing Pajamas T-shirt Other 0.220 0.002 0.160 0.102 0.046 0.084 0.024 0.180 0.018 0.073 0.088 0.003 0.244 0.182 0.178 0.175 0.134 0.087 (a) What is the probability that a traveler is a female who sleeps in the nude? (b) What is the probability that a traveler is male? (c) Assuming the traveler is a male, what is the probability that he sleeps in pajamas? (d) What is the probability that a traveler is male if he sleeps in pajamas or a T-shirt?

2.84 The probability that an automobile being filled with gasoline will also need an oil change is 0.25; the probability that it needs a new oil filter is 0.40; and the probability that both the oil and filter need changing is 0.14. (a) If the oil had to be changed, what is the probability that a new oil filter is needed? (b) If a new oil filter is needed, what is the probability that the oil has to be changed?

2.85 The probability that a married man watches a certain television show is 0.4 and the probability that a married woman watches the show is 0.5. The probability that a man watches the show, given that his wife does, is 0.7. Find the probability that (a) a married couple watches the show; (b) a wife watches the show given that her husband does; (c) at least 1 person of a married couple will watch the show.

2.86 For married couples living in a certain suburb, the probability that the husband will vote on a bond referendum is 0.21, the probability that his wife will vote in the referendum is 0.28, and the probability that both the husband and wife will vote is 0.15. What is the probability that (a) at least one member of a married couple will vote? (b) a wife will vote, given that her husband will vote? (c) a husband will vote, given that his wife does not vote?

2.87 The probability that a vehicle entering the Luray Caverns has Canadian license plates is 0.12; the probability that it is a camper is 0.28; and the probability that it is a camper with Canadian license plates is 0.09. What is the probability that (a) a camper entering the Luray Caverns has Canadian license plates? (b) a vehicle with Canadian license plates entering the Luray Caverns is a camper? (c) a vehicle entering the Luray Caverns does not have Canadian plates or is not a camper?

2.88 The probability that the head of a household is home when a telemarketing representative calls is 0.4. Given that the head of the house is home, the probability that goods will be bought from the company is 0.3. Find the probability that the head of the house is home and goods being bought from the company.

2.89 The probability that a doctor correctly diagnoses a particular illness is 0.7. Given that the doctor makes an incorrect diagnosis, the probability that the patient enters a law suit is 0.9. What is the probability that the doctor makes an incorrect diagnosis and the patient sues?

2.90 In 1970, 11% of Americans completed four years of college; 43% of them were woman. In 1990, 22% of Americans completed four years of college; 53% of them were women (Time, Jan. 19, 1996). (a) Given that a person completed four years of college in 1970, what is the probability

that the person was a women? (b) What is the probability that a woman would finish four years of college in 1990? (c) What is the probability that in 1990 a man would not finish college?

2.91 A real estate agent has 8 master keys to open several new homes. Only 1 master key will open any given house. If 40% of these homes are usually left unlocked, what is the probability that the real estate agent can get into a specific home if the agent selects 15 master keys at random before leaving the office'.

2.92 Before the distribution of certain statistical software every fourth compact disk (CD) is tested for accuracy. The testing process consists of running four independent programs and checking the results. The failure rate for the 4 testing programs are. respectively, 0.01, 0.03, 0.02, and 0.01. (a) What is the probability that a CD was tested and failed any test? (b) Given that a CD was tested, what is the probability that it failed program 2 or 3? (c) In a sample of 100, how many CDs would you expect to be rejected? (d) Given a CD was defective, what is the probability that it. was tested?

2.93 A town has 2 fire engines operating independently. The probability that a specific engine is available when needed is 0.96. (a) What is the probability that neither is available when needed? (li) What is the probability that a fire: engine is available when needed?

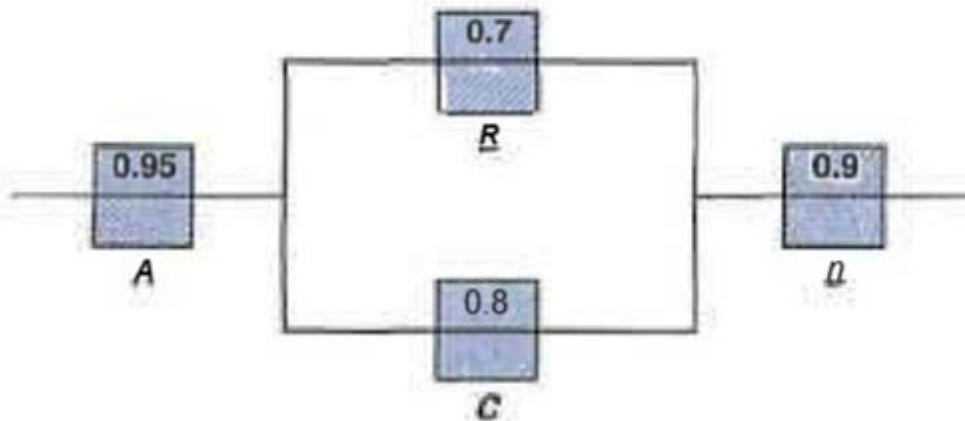
2.94 The probability that Tom will be alive in 20 years is 0.7, and the probability that Nancy will be alive in 20 years is 0.9. If we assume independence for both, what is the probability that neither will be alive hi 20 years?

2.95 One overnight case contains 2 bottles of aspirin and 3 bottles of thyroid tablets. A second tote bag contains 3 bottles of aspirin, 2 bottles of thyroid tablets, and I bottle of laxative tablets. If 1 bottle of tablets is taken at random from each piece of luggage, find the probability that (a) both bottles contain thyroid tablets: (b) neither bottle contains thyroid tablets; (c) the 2 bottles contain different tablets.

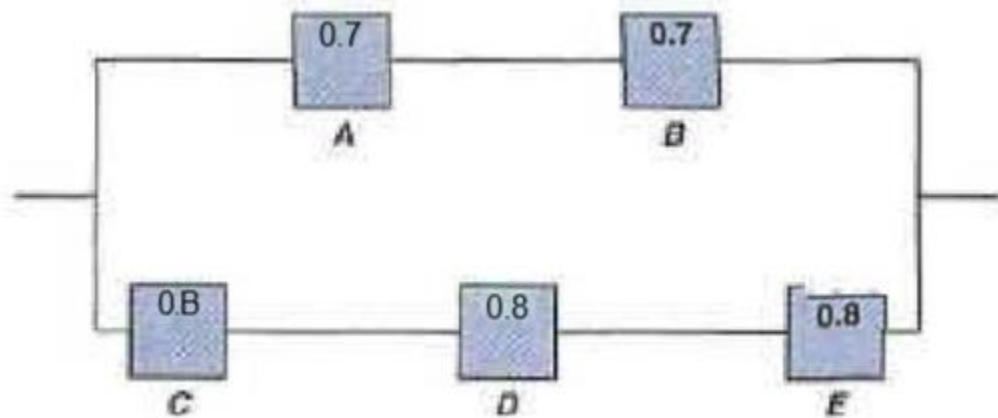
2.96 The probability that a person visiting his dentist will have an X-ray is 0.6; the probability that a person who has an X-ray will also have a cavity filled is 0.3; and the probability that a person who has had an X-ray and a cavity filled will also have a tooth extracted is 0.1. What is the probability that a person visiting his dentist, will have an X-ray, a cavity filled, and a tooth extracted?

2.97 Find the probability of randomly selecting 4 good quarts of milk in succession from a cooler containing 20 quarts of which 5 have spoiled, by using (a) the first formula of Theorem 2.15 on page 64; (b) the formulas of Theorems 2.8 and 2.9 on pages 46' and 50, respectively.

2.98 Suppose the diagram of an electrical system is given in Figure 2.10. What is the probability that the system works? Assume the components fail independently.



2.99 A circuit system is given in Figure 2.11. Assume the components fail independently. (a) What is the probability that the entire system works? (b) Given that the system works, what is the probability that the component A is not working?



2.100 In the situation of Exercise 2.99, it is known that the system does not work. What is the probability that the component A also does not work?

2.101 In a certain region of the country it is known from (last, experience that the: probability of selecting an adult over 40 years of age: with cancer is 0.05, If the probability of a doctor correctly diagnosing a person with cancer as having the disease is 0.78 and the: probability of incorrectly diagnosing a person without cancer as having the disease is 0.1)6, what is the probability that, a person is diagnosed as having cancer?

2.102 Police plan to enforce speed limits by using radar traps at 4 different locations within the city limits. The radar traps at each of the locations  $L_1$ ,  $L_2$ ,  $L_3$  and  $L_4$  are operated 40%, 30%, 20%, and 30% of the time, and if a person who is speeding on his way to work has probabilities of 0.2, 0.1, 0.5, and 0.2, respectively, of passing through these locations, what is the probability that he will receive a speeding ticket?

2.103 Referring to Exercise 2.101, what, is the probability that a person diagnosed as having cancer actually has the disease?

2.104 If in Exercise 2.102 the person received a speeding ticket on his way to work, what is the probability that he passed through the radar trap located at L2?

2.105 Suppose that the four inspectors at a film factory are supposed to stamp the expiration date on each package of film at the end of the assembly line. John, who stamps 20% of the packages, fails to stamp the expiration date once in every 200 packages; Tom, who stamps 60% of the packages, fails to stamp the expiration date once in every 100 packages; Jeff, who stamps 15% of the packages, fails to stamp the expiration date once in every 90 packages; and Pat, who stamps 5% of the packages, fails to stamp the expiration date once in every 200 packages. If a customer complains that her package of film does not show the expiration date, what is the probability that it was inspected by John?

2.106 A regional telephone company operates three identical relay stations at different locations. During a one year period, the number of malfunctions reported by each station and the causes are shown below.

<u>Station</u>	<u>A</u>	<u>B</u>	<u>C</u>
Problems with electricity supplied	2	1	1
Computer malfunction	4	3	2
Malfunctioning electrical equipment	5	4	2
Caused by other human errors	7	7	5

2.107 Pollution of the rivers in the United States has been a problem for many years. Consider the following events:

A= {The river is polluted.}

B= {A sample of water tested detects pollution.}

C= {Fishing permitted.}

Assume  $P(A) = 0.3$ ,  $P(B|A) = 0.75$ ,  $P(P|A') = 0.20$ ,  $P(C/A \cap B) = 0.20$ ,  $P(C|A' \cap B) = 0.15$ ,  $P(C|A \cap B') = 0.80$ , and  $P(C|A' \cap B') = 0.90$ .

(a) Find  $P(A \cap B \cap C)$ . (b) Find  $P(B' \cap C)$ . (c) Find  $P(C)$ . (d) Find the probability that the river is polluted, given that fishing is permitted and the sample tested did not detect pollution.

2.108 A paint-store chain produces and sells latex and semigloss paint. Based on long-range sales, the probability that a customer will purchase latex paint is 0.75. Of those that purchase latex paint, 60% also purchase rollers. But only 30% of semigloss paint buyers purchase rollers. A randomly selected buyer purchases a roller and a can of paint. What is the probability that the paint is latex?

2.109 A truth serum has the property that 90% of the guilty suspects are properly judged while, of course, 10% of guilty suspects are improperly found innocent. On the other hand, innocent

suspects are misjudged 1% of the time. If the suspect was selected from a group of suspects of which only 5% have ever committed a crime, and the serum indicates that he is guilty, what is the probability that he is innocent?

2.110 An allergist, claims that 50% of the patients she tests are allergic to some type of weed. What, is the probability that (a) exactly 3 of her next 4 patients are allergic to weeds? (b) none of her next 4 patients is allergic to weeds?

2.111 By comparing appropriate regions of Venn diagrams, verify that (a)  $(A \cap B) \cup (A \cap B') = A$ ; (b)  $A' \cap (B' \cup C) = (A' \cap B') \cup (A' \cap C)$ .

2.112 The probabilities that a service station will pump gas into 0, 1, 2, 3, 4, or 5 or more cars during a certain 30-minute period are 0.03, 0.18, 0.24, 0.28, 0.10, and 0.17, respectively. Find the probability that in this 30-minute period (a) more than 2 cars receive gas; (b) at most 4 cars receive gas; (c) 4 or more cars receive gas.

2.113 How many bridge hands are possible containing 4 spades, 6 diamonds, 1 club, and 2 hearts?

2.114 If the probability is 0.1 that a person will make a mistake on his or her state income tax return, find the probability that (a) four totally unrelated persons each make a mistake; (b) Mr. Jones and Ms. Clark both make a mistake, and Mr. Roberts and Ms. Williams do not make a mistake.

2.115 A large industrial firm uses 3 local motels to provide overnight accommodations for its clients. From past experience it is known that 20% of the clients are assigned rooms at the Ramada Inn, 50% at the Sheraton, and 30% at the Lakeview Motor Lodge. If the plumbing is faulty in 5% of the rooms at the Ramada Inn, in 4% of the rooms at the Sheraton, and in 8% of the rooms at the Lakeview Motor Lodge, what, is the probability that (a) a client will be assigned a room with faulty plumbing? (b) a person with a room having faulty plumbing was assigned accommodations at the Lakeview Motor Lodge?

2.116 From a group of 4 men and 5 women, how many committees of size 3 are possible (a) with no restrictions? (b) with 1 man and 2 women? (c) with 2 men and 1 woman if a certain man must be on the committee?

2.117 The probability that a patient recovers from a delicate heart operation is 0.8. What is the probability that (a) exactly 2 of the next 3 patients who have this operation survive? (b) all of the next 3 patients who have this operation survive?

2.118 In a certain federal prison it is known that  $\frac{2}{3}$  of the inmates are under 25 years of age. It is also known that  $\frac{3}{5}$  of the inmates are male and that  $\frac{5}{8}$  of the inmates are female or 25 years of age or older. What is the probability that a prisoner selected at random from this prison is female and at least 25 years old?

2.119 From 4 red, 5 green, and 6 yellow apples, how many selections of 9 apples are possible if 3 of each color are to be selected?

2.120 From a box containing 6 black balls and 4 green balls, 3 balls are drawn in succession, each ball being replaced in the box before the next draw is made. What is the probability that (a) all 3 are the same color? (b) each color is represented?

2.121 A shipment of 12 television sets contains 3 defective sets. In how many ways can a hotel purchase 5 of these sets and receive at least 2 of the defective sets?

2.122 Electrical, chemical, industrial, and mechanical engineering curricula were studied. It was found that some students took no statistics, some took one semester, and others took two semesters. Consider the following events: A: Some statistics is taken B: Electrical and industrial engineers C: Chemical engineers Use Venn diagrams and shade the areas representing the following events: (a)  $(A \cap B)'$ ;

(b)  $(A \cup B)$ ;

(c)  $(A \cap C) \cup B$ .

2.123 A certain federal agency employs three consulting firms (A, B, and C) with probabilities 0.40, 0.35, and 0.25, respectively. From past experience it is known that the probability of cost overruns for the firms are 0.05, 0.03, and 0.15, respectively. Suppose a cost overrun is experienced by the agency. (a) What is the probability that the consulting firm involved is company C? (b) What is the probability that it is company A?

2.124 A manufacturer is studying the effects of cooking temperature, cooking time, and type of cooking oil for making potato chips. Three different temperatures, 4 different cooking times, and 3 different oils are to be used. (a) What is the total number of combinations to be studied? (b) How many combinations will be used for each type of oil? (c) Discuss why permutations are not an issue in this exercise.

2.125 Consider the situation in Exercise 2.124, and suppose that the manufacturer can try only two combinations in a day.

(a) What is the probability that any given set of 2 runs is chosen?

(b) What is the probability that the highest temperature is used in either of these 2 combinations?

2.126 A certain form of cancer is known to be found in women over 60 with probability 0.07. A blood test exists for the detection of the disease but the test is not infallible. In fact, it is known that 10% of the time the test gives a false negative (i.e., the test incorrectly gives a negative result) and 5% of the time the test, gives a false positive (i.e., incorrectly gives a positive result). If a woman over 60 is known to have taken the test and received a favorable (i.e., a negative result), what is the probability that she has the disease?

2.127 A producer of a certain type of electronic component ships to suppliers in lots of twenty. Suppose that 60% of all such lots contain no defective components, 30% contain one defective



component, and 10% contain two defective components. A lot is selected and two components from the lot are randomly selected and tested and neither is defective. (a) What is the probability that zero defective components exist in the lot? (b) What is the probability that one defective exists in the lot? (c) What is the probability that two defectives exist in the lot?

2.128 A rare disease exists in which only 1 in 500 are affected. A test for the disease exists but of course it is not infallible. A correct positive result (patient actually has the disease) occurs 95% of the time while a false positive result (patient does not have the disease) occurs 1% of the time. If a randomly selected individual is tested and the result is positive, what is the probability that the individual has the disease?

2.129 A construction company employs 2 sales engineers. Engineer 1 does the work in estimating cost for 70% of jobs bid by the company. Engineer 2 does the work for 30% of jobs bid by the company. It is known that the error rate for engineer 1 is such that 0.02 is the probability of an error when he does the work, whereas the probability of an error in the work of engineer 2 is 0.04. Suppose a bid arrives and a serious error occurs in estimating cost. Which engineer would you guess did the work? Explain and show all work.

2.130 In the field of quality control the science of statistics is often used to determine if a process is "out of control." Suppose the process is, indeed, out of control and 20% of items produced are defective. (a) If three items arrive off the process line in succession, what is the probability that all three are defective? (b) If four items arrive in succession, what is the probability that three are defective?

2.131 An industrial plant is conducting a study to determine how quickly injured workers are back on the job following injury. Records show that 10% of all injured workers are admitted to the hospital for treatment and 15% are back on the job the next day. In addition, studies show that 2% are both admitted for hospital treatment and back on the job the next day. If a worker is injured, what is the probability that the worker will either be admitted to a hospital or back on the job the next day or both?

2.132 A firm is accustomed to training operators who do certain tasks on a production line. Those operators who attend the training course are known to be able to meet their production quotas 90% of the time. New operators who do not take the training course only meet their quotas 65% of the time. Fifty percent of new operators attend the course. Given that a new operator meets his production quota, what is the probability that he (or she) attended the program?

2.133 A survey of those using a particular statistical software system indicated that 10% were dissatisfied. Half of those dissatisfied purchased the system from vendor A. It is also known that 20% of those surveyed purchased from vendor A. Given that the software package was purchased from vendor A, what is the probability that that particular user is dissatisfied?

2.134 During bad economic times, industrial workers are dismissed and are often replaced by machines. The history of 100 workers whose loss of employment is attributable to technological advances is reviewed. For each of these individuals, it was determined if he or she was given an alternative job within the same company, found a job with another company but is working in the same field, found a job in a new field, or has been unemployed for 1 year. In addition, the union status of each worker is recorded. The following table summarizes the results.

	<u>Union</u>	<u>Nonunion</u>
Same Company	<b>40</b>	<b>15</b>
New Company (same field)	<b>13</b>	<b>10</b>
New Field	<b>4</b>	<b>11</b>
Unemployed	<b>2</b>	<b>5</b>

- (a) If the selected workers found a job with a new company in the same field, what is the probability that the worker is a union member? (b) If the worker is a union member, what is the probability that the worker has been unemployed for a year.

2.135 There is a 50-50 chance that the queen carries the gene of hemophilia. If she is a carrier, then each prince has a 50-50 chance of having hemophilia independently. If the queen is not a carrier, the prince will not have the disease. Suppose the queen has had three princes without the disease, what is the probability the queen is a carrier?

2.136 What is the probability that no two students will have the same birth date in a size of 60 class? (See Exercise 2.50.)