1. An urn contains 5 red, 5 blue and 5 white marbles, each exactly alike except for color:
   a) If one marble is withdrawn, what is the expected probability that it will be blue?
   b) The marble in part (a) is not replaced and another marble is withdrawn. What is the probability that the second marble is white?
   c) Both marbles are replaced and another marble is withdrawn. What is the probability that it will be red or blue?

2. An ordinary coin is flipped 5 times and lands heads up each time. What is the probability that it will land heads up on the 6th flip?

3. A pair of dice, one green and one red, is tossed.
   a) Make a sample space for this experiment by listing the possible outcomes of each die. (Hint: this sample space contains 36 sample points.)
   b) What is the expected probability of each simple event? (A simple event contains one sample point.)
   c) What is the sum of the probabilities of the simple events?

4. An organization conducts a raffle to raise money and sells 250 tickets. Donna purchased 10 tickets. What is the probability that she will win the prize?

5. A coin is flipped and a die is tossed.
   a) Make a sample space for this experiment by listing all possible outcomes. (Hint: there will be 12 sample points.)
   b) What is the probability of getting a head on the coin and a number greater than 3 on the die?
   c) What is the probability of getting a tail on the coin and a prime number on the die?

6. A letter is chosen at random from the word "chosen."
   a) What is the probability that the letter "n" is chosen?
   b) What is the probability that the letter is a vowel?

7. A card is drawn at random from an ordinary deck of 52 playing cards. What is the probability that the card:
   a) is a queen?
   b) is a red card?
   c) is a heart or a club?
   d) is a spade and a diamond?
   e) is a king or a spade?
   f) is a heart or a face card?

8. The names of Susan, Kathy, Richard and Bill are written on slips of paper and placed in a box. Two names are to be drawn as representatives of a club.
   a) Make a sample space for the experiment.
   b) What is the probability that the names drawn were Susan and Bill?
   c) What is the probability that Kathy was one of the two?
   d) What is the probability that both were male?
   e) What is the probability that neither Susan nor Richard were selected?

9. A student has a choice of 4 foreign languages and 5 sciences. In how many ways can he choose one of each?

10. In how many ways can two different prizes be awarded among nine contestants if both prizes:
    a) may not be given to the same person?
    b) may be given to the same person?

11. How many committees consisting of a junior, a senior and a graduate student can be chosen from 15 juniors, 17 seniors and 12 graduates?

12. In how many ways can 8 books be arranged on a shelf having spaces for exactly 8 books if a particular book must be on the extreme left?

13. How many positive even integers of three digits each can be formed from the digits 1, 2, 3, 4, 5, 6, 7, 8 if no repetitions are allowed?

14. Out of 9 pictures available, 3 are being hung in a row. In how many ways can this be done?

15. In how many ways can 6 people be seated in 11 vacant chairs that are arranged in a row?

16. How many numbers can be formed by using four digits from the digits 1, 2, 3, 4, 5, 6 if:
    a) the digits may not be repeated in any number?
    b) the digits may be repeated?

17. A woman buys 4 sweaters, 5 blouses and 6 skirts. How many "outfits" that includes one of each can she wear assuming any garment can be worn with any other?

18. How many groups of 4 people can be chosen from 12 people?

19. How many different "hands" of 5 cards each can be dealt from a deck of 52 cards?

20. A committee consists of 5 Democrats and 3 Republicans.
    a) How many sub-committees of 3 Democrats and 2 Republicans can be selected.
    b) What is the probability the committee will consist of 3 Democrats and 2 Republicans?

21. What is the probability of drawing 3 spades from an ordinary deck of 52 cards without replacement?

22. Four cards are drawn from an ordinary deck of 52 cards. What is the probability that:
    a) all will be hearts, without replacement?
    b) all will be kings, with replacement?
    c) all will be red, without replacement?

23. Three coins are tossed. What is the probability that:
    a) all three fall heads up?
    b) exactly 2 fall heads up?

24. The probability that it will snow in Lincoln on Easter is 1/10 and the probability that it will snow on Christmas is 3/10. What is the probability that it will snow:
    a) on both days?
    b) on at least one of the days?

25. Find the odds <u>in favor</u> of obtaining:
    a) an ace when drawing one card from an ordinary deck of 52 cards.
    b) two tails when an ordinary coin is thrown twice.
    c) a vowel when one letter is chosen at random from among the 26 letters in the English alphabet.

26. Find the odds <u>against</u> obtaining:
    a) a 4 in one throw of a single die.
    b) an odd number in one throw of a single die.
    c) one of the picture cards (jack, queen, king) when drawing one card from an ordinary deck of 52 cards.

(Answers are on the reverse side.)

ANSWERS NOTE: An alternative method is sometimes given in brackets [ ].

1. a) $P(E) = \frac{5}{15} = \frac{1}{3}$ b) $P(E) = \frac{5}{14}$ c) $P(E) = \frac{10}{15} = \frac{2}{3}$

2. $P(E) = \frac{1}{2}$ Since a coin has no memory, we have a sequence of independent trials. The probability remains constant for each flip.

3. a)

Outcome of the green die \ Outcome of the red die	1	2	3	4	5	6
1	1,1	1,2	1,3	1,4	1,5	1,6
2	2,1	2,2	2,3	2,4	2,5	2,6
3	3,1	3,2	3,3	3,4	3,5	3,6
4	4,1	4,2	4,3	4,4	4,5	4,6
5	5,1	5,2	5,3	5,4	5,5	5,6
6	6,1	6,2	6,3	6,4	6,5	6,6

b) $P(E) = \frac{1}{36}$ c) 1

4. $P(E) = \frac{10}{250} = \frac{1}{25}$

5. a) S = {(h,1), (h,2), (h,3), (h,4), (h,5), (h,6), (t,1), (t,2), (t,3), (t,4), (t,5), (t,6)}

b) $P(E) = \frac{3}{12} = \frac{1}{4}$ c) $P(E) = \frac{3}{12} = \frac{1}{4}$

6. a) $P(E) = \frac{1}{6}$ b) $P(E) = \frac{2}{6} = \frac{1}{3}$

7. a) $\frac{4}{52} = \frac{1}{13}$ b) $\frac{26}{52} = \frac{1}{2}$ c) $\frac{13}{52} + \frac{13}{52} = \frac{26}{52} = \frac{1}{2}$

d) $\frac{0}{52} = 0$ e) $\frac{4}{52} + \frac{13}{52} - \frac{1}{52} = \frac{16}{52} = \frac{4}{13}$ f) $\frac{13}{52} + \frac{12}{52} - \frac{3}{52} = \frac{22}{52} = \frac{11}{26}$

8. a) S = {(S,K), (S,R), (S,B), (K,R), (K,B), (R,B)} Drawing Susan and Kathy is the same as drawing Kathy and Susan, etc.

b) $P(E) = \frac{1}{6}$ c) $P(E) = \frac{3}{6} = \frac{1}{2}$ d) $P(E) = \frac{1}{6}$ e) $P(E) = \frac{1}{6}$

9. $4 \bullet 5 = 20$

10. a) $9 \bullet 8 = 72$ $\left[{}_9P_2 = \frac{9!}{(9-2)!} \right]$ b) $9 \bullet 9 = 81$

11. $15 \bullet 17 \bullet 12 = 3060$

12. $7! = 7 \bullet 6 \bullet 5 \bullet 4 \bullet 3 \bullet 2 \bullet 1 = 5040$
[$1 \bullet 7 \bullet 6 \bullet 5 \bullet 4 \bullet 3 \bullet 2 \bullet 1$] = 5040

13. $6 \bullet 7 \bullet 4 = 168$ The last digit must be even (2,4,6, or 8) for the number to be even.

14. ${}_9P_3 = \frac{9!}{(9-3)!} = 504$ $\left[9 \bullet 8 \bullet 7 \right]$

15. ${}_{11}P_6 = \frac{11!}{(11-6)!} = 332{,}640$ $\left[11 \bullet 10 \bullet 9 \bullet 8 \bullet 7 \bullet 6 \right]$

16. a) ${}_6P_4 = \frac{6!}{(6-4)!} = 360$ $\left[6 \bullet 5 \bullet 4 \bullet 3 \right]$

b) $6 \bullet 6 \bullet 6 \bullet 6 = 1{,}296$

17. $4 \bullet 5 \bullet 6 = 120$

18. $\binom{12}{4} = \frac{12!}{(12-4)! \bullet 4!} = 495$

19. $\binom{52}{5} = 2{,}598{,}960$

20. a) $\binom{5}{3} \bullet \binom{3}{2} = 30$ b) $P(E) = \frac{\binom{5}{3} \bullet \binom{3}{2}}{\binom{8}{5}} = \frac{30}{56} = \frac{15}{28}$

21. $P(E) = \frac{\binom{13}{3} \bullet \binom{39}{0}}{\binom{52}{3}}$ $\left[\frac{13}{52} \bullet \frac{12}{51} \bullet \frac{11}{50} = \frac{11}{850} \right]$

22. a) $P(E) = \frac{\binom{13}{4} \bullet \binom{39}{0}}{\binom{52}{4}}$ $\left[\frac{13}{52} \bullet \frac{12}{51} \bullet \frac{11}{50} \bullet \frac{10}{49} = \frac{11}{4165} \right]$

b) $P(E) = \frac{4}{52} \bullet \frac{4}{52} \bullet \frac{4}{52} \bullet \frac{4}{52} = \frac{1}{28{,}561}$

c) $P(E) = \frac{\binom{26}{4} \bullet \binom{26}{0}}{\binom{52}{4}}$ $\left[\frac{26}{52} \bullet \frac{25}{51} \bullet \frac{24}{50} \bullet \frac{23}{49} = \frac{46}{833} \right]$

23. a) $P(E) = \frac{1}{8}$ $\left[\frac{1}{2} \bullet \frac{1}{2} \bullet \frac{1}{2} = \frac{1}{8} \right]$

b) $P(E) = \frac{1}{8} + \frac{1}{8} + \frac{1}{8} = \frac{3}{8}$, from sample space

24. a) $P(E) = \frac{1}{10} \bullet \frac{3}{10} = \frac{3}{100}$

b) $P(E) = \frac{1}{10} + \frac{3}{10} - \frac{3}{100} = \frac{37}{100}$

25. a) Odds (E): $\frac{4}{52} \div \frac{48}{52} = \frac{1}{12}$, 1 to 12

b) Odds (E): $\frac{1}{4} \div \frac{3}{4} = \frac{1}{3}$, 1 to 3

c) Odds (E): $\frac{5}{26} \div \frac{21}{26} = \frac{5}{21}$, 5 to 21

26. a) Odds (~E): $\frac{5}{6} \div \frac{1}{6} = 5$, 5 to 1

b) Odds (~E): $\frac{3}{6} \div \frac{3}{6} = 1$, 1 to 1

c) Odds (~E): $\frac{40}{52} \div \frac{12}{52} = \frac{10}{3}$, 10 to 3