

2. The effective rate of interest is the _____ interest rate that would produce the same accumulated amount in _____ as the _____ rate compounded _____ times a year. The formula for calculating the effective rate is _____.
3. A sequence of payments made at regular time intervals is called an _____. If the payments are made at the end of each payment period, then it is called a/an _____. If the payment period coincides with the interest conversion period, then it is called a/an _____.
4. The formula for the future value of an annuity is $S_n = P \cdot \frac{(1+i)^n - 1}{i}$. The formula for the present value of an annuity is $P = \frac{R}{i} \left[1 - \frac{1}{(1+i)^n} \right]$.
5. The periodic payment R on a loan of P dollars to be amortized over n periods with interest charged at the rate of i per period is $R = \frac{P \cdot i}{1 - (1+i)^{-n}}$.

6. A sinking fund is an account that is set up for a specific purpose at some _____ date. The periodic payment R required to accumulate a sum of S dollars over n periods with interest charged at the rate of i per period is $R = \frac{S \cdot i}{(1+i)^n - 1}$.
7. An arithmetic progression is a sequence of numbers in which each term after the first is obtained by adding a /an _____ to the preceding term. The n th term of an arithmetic progression is $a_n = a_1 + (n-1)d$. The sum of the first n terms of an arithmetic progression is $S_n = \frac{n}{2} [2a_1 + (n-1)d]$.
8. A geometric progression is a sequence of numbers in which each term after the first is obtained by multiplying the preceding term by a /an _____. The n th term of a geometric progression is $a_n = a_1 r^{n-1}$. If $r \neq 1$, the sum of the first n terms of a geometric progression is $S_n = \frac{a_1 (1-r^n)}{1-r}$.

CHAPTER 4 Review Exercises

- Find the accumulated amount after 4 years if \$5000 is invested at 5%/year compounded (a) annually, (b) semi-annually, (c) quarterly, and (d) monthly.
- Find the accumulated amount after 8 years if \$12,000 is invested at 3.5%/year compounded (a) annually, (b) semi-annually, (c) quarterly, and (d) monthly.
- Find the effective rate of interest corresponding to a nominal rate of 6%/year compounded (a) annually, (b) semi-annually, (c) quarterly, and (d) monthly.
- Find the effective rate of interest corresponding to a nominal rate of 5.5%/year compounded (a) annually, (b) semi-annually, (c) quarterly, and (d) monthly.
- Find the present value of \$41,413 due in 5 years at an interest rate of 4.5%/year compounded quarterly.
- Find the present value of \$64,540 due in 6 years at an interest rate of 4%/year compounded monthly.
- Find the amount (future value) of an ordinary annuity of \$150/quarter for 7 years at 5%/year compounded quarterly.
- Find the future value of an ordinary annuity of \$120/month for 10 years at 4.5%/year compounded monthly.
- Find the present value of an ordinary annuity of 36 payments of \$250 each made monthly and earning interest at 4.5%/year compounded monthly.
- Find the present value of an ordinary annuity of 60 payments of \$5000 each made quarterly and earning interest at 3.5%/year compounded quarterly.

- Find the payment R needed to amortize a loan of \$22,000 at 3.5%/year compounded monthly with 36 monthly installments over a period of 3 years.
- Find the payment R needed to amortize a loan of \$10,000 at 4.6%/year compounded monthly with 36 monthly installments over a period of 3 years.
- Find the payment R needed to accumulate \$18,000 with 48 monthly installments over a period of 4 years at an interest rate of 3%/year compounded monthly.
- Find the payment R needed to accumulate \$15,000 with 60 monthly installments over a period of 5 years at an interest rate of 3.6%/year compounded monthly.
- Find the effective rate of interest corresponding to a nominal rate of 3.6%/year compounded monthly.
- Find the effective rate of interest corresponding to a nominal rate of 4.8%/year compounded monthly.
- Find the present value of \$119,346 due in 4 years at an interest rate of 5%/year compounded continuously.
- COMPANY SALES** JCN Media had sales of \$1,750,000 in the first year of operation. If the sales increased by 7%/year thereafter, find the company's sales in the fourth year and the total sales over the first 4 years of operation.
- CDs** The manager of a money market fund has invested \$4.2 million in certificates of deposit that pay interest at the rate of 5.4%/year compounded quarterly over a period of 5 years. How much will the investment be worth at the end of 5 years?

20. **SAVINGS ACCOUNTS** Emily deposited \$2000 into a bank account 5 years ago. The bank paid interest at the rate of 3.2%/year compounded weekly. What is Emily's account worth today?
21. **SAVINGS ACCOUNTS** Kim invested a sum of money 4 years ago in a savings account that has since paid interest at the rate of 3.5%/year compounded monthly. Her investment is now worth \$19,440.31. How much did she originally invest?
22. **SAVINGS ACCOUNTS** Andrew withdrew \$5470.87 from a savings account, which he closed this morning. The account had earned interest at the rate of 3%/year compounded continuously during the 3-year period that the money was on deposit. How much did Andrew originally deposit into the account?
23. **MUTUAL FUNDS** Juan invested \$24,000 in a mutual fund 5 years ago. Today his investment is worth \$34,616. Find the effective annual rate of return on his investment over the 5-year period.
24. **COLLEGE SAVINGS PROGRAM** The Blakes have decided to start a monthly savings program to provide for their son's college education. How much should they deposit at the end of each month in a savings account earning interest at the rate of 3.5%/year compounded monthly so that, at the end of the tenth year, the accumulated amount will be \$40,000?
25. **RETIREMENT ACCOUNTS** Mai Lee has contributed \$200 at the end of each month into her company's employee retirement account for the past 10 years. Her employer has matched her contribution each month. If the account has earned interest at the rate of 5%/year compounded monthly over the 10-year period, determine how much Mai Lee now has in her retirement account.
26. **AUTOMOBILE LEASING** Maria has leased an auto for 4 years at \$300/month. If money is worth 5%/year compounded monthly, what is the equivalent cash payment (present value) of this annuity? (Assume that the payments are made at the end of each month.)
27. **INSTALLMENT FINANCING** Peggy made a down payment of \$400 toward the purchase of new furniture. To pay the balance of the purchase price, she has secured a loan from her bank at 6%/year compounded monthly. Under the terms of her finance agreement, she is required to make payments of \$75.32 at the end of each month for 24 months. What was the purchase price of the furniture?
28. **HOME FINANCING** The Turners have purchased a house for \$150,000. They made an initial down payment of \$30,000 and secured a mortgage with interest charged at the rate of 4.5%/year on the unpaid balance. (Interest computations are made at the end of each month.) Assume that the loan is amortized over 30 years.
- What monthly payment will the Turners be required to make?
 - What will be their total interest payment?
 - What will be their equity (disregard depreciation) after 10 years?
29. **HOME FINANCING** Refer to Exercise 28. If the loan is amortized over 15 years:
- What monthly payment will the Turners be required to make?
 - What will be their total interest payment?
 - What will be their equity (disregard depreciation) after 10 years?
30. **SINKING FUNDS** The management of a corporation anticipates a capital expenditure of \$500,000 in 5 years for the purpose of purchasing replacement machinery. To finance this purchase, a sinking fund that earns interest at the rate of 5%/year compounded quarterly will be set up. Determine the amount of each (equal) quarterly installment that should be deposited in the fund. (Assume that the payments are made at the end of each quarter.)
31. **SINKING FUNDS** The management of a condominium association anticipates a capital expenditure of \$120,000 in 2 years for the purpose of painting the exterior of the condominium. To pay for this maintenance, a sinking fund will be set up that will earn interest at the rate of 5.8%/year compounded monthly. Determine the amount of each (equal) monthly installment the association will be required to deposit into the fund at the end of each month for the next 2 years.
32. **CREDIT CARD PAYMENTS** The outstanding balance on Bill's credit card account is \$3200. The bank issuing the credit card is charging 9.3%/year compounded monthly. If Bill decides to pay off this balance in equal monthly installments at the end of each month for the next 18 months, how much will be his monthly payment? What is the effective rate of interest the bank is charging Bill?
33. **FINANCIAL PLANNING** Matt's parents have agreed to contribute \$250/month toward the rent for his apartment in his junior year in college. The plan is for Matt's parents to deposit a lump sum in Matt's bank account on August 1 and then have Matt withdraw \$250 on the first of each month starting on September 1 and ending on May 1 the following year. If the bank pays interest on the balance at the rate of 5%/year compounded monthly, how much should Matt's parents deposit into his account?

$$28. \left[\begin{array}{cc|c} 1 & 2 & 1 \\ 2 & 3 & -1 \end{array} \right] \xrightarrow{R_2 - 2R_1} \left[\begin{array}{cc|c} 1 & 2 & 1 \\ \cdot & \cdot & \cdot \end{array} \right] \xrightarrow{-R_2}$$

$$\left[\begin{array}{cc|c} 1 & 2 & 1 \\ \cdot & \cdot & \cdot \end{array} \right] \xrightarrow{R_1 - 2R_2} \left[\begin{array}{cc|c} 1 & 0 & -5 \\ 0 & 1 & 3 \end{array} \right]$$

$$29. \left[\begin{array}{ccc|c} 1 & 3 & 1 & 3 \\ 3 & 8 & 3 & 7 \\ 2 & -3 & 1 & -10 \end{array} \right] \xrightarrow{\begin{array}{l} R_2 - 3R_1 \\ R_3 - 2R_1 \end{array}} \left[\begin{array}{ccc|c} 1 & 3 & 1 & 3 \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \end{array} \right] \xrightarrow{-R_2}$$

$$\left[\begin{array}{ccc|c} 1 & 3 & 1 & 3 \\ \cdot & \cdot & \cdot & \cdot \\ 0 & -9 & -1 & -16 \end{array} \right] \xrightarrow{\begin{array}{l} R_1 - 3R_2 \\ R_3 + 9R_2 \end{array}}$$

$$\left[\begin{array}{ccc|c} \cdot & \cdot & \cdot & \cdot \\ 0 & 1 & 0 & 2 \\ \cdot & \cdot & \cdot & \cdot \end{array} \right] \xrightarrow{\begin{array}{l} R_1 + R_1 \\ -R_3 \end{array}} \left[\begin{array}{ccc|c} 1 & 0 & 0 & -1 \\ 0 & 1 & 0 & 2 \\ 0 & 0 & 1 & -2 \end{array} \right]$$

$$30. \left[\begin{array}{ccc|c} 0 & 1 & 3 & -4 \\ 1 & 2 & 1 & 7 \\ 1 & -2 & 0 & 1 \end{array} \right] \xrightarrow{R_1 \leftrightarrow R_2} \left[\begin{array}{ccc|c} \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ 1 & -2 & 0 & 1 \end{array} \right]$$

$$\xrightarrow{R_3 - R_1} \left[\begin{array}{ccc|c} 1 & 2 & 1 & 7 \\ 0 & 1 & 3 & -4 \\ \cdot & \cdot & \cdot & \cdot \end{array} \right] \xrightarrow{\begin{array}{l} R_1 - 2R_2 \\ R_3 + 4R_2 \end{array}} \left[\begin{array}{ccc|c} \cdot & \cdot & \cdot & \cdot \\ 0 & 1 & 3 & -4 \\ \cdot & \cdot & \cdot & \cdot \end{array} \right]$$

$$\xrightarrow{\frac{1}{11}R_3} \left[\begin{array}{ccc|c} 1 & 0 & -5 & 15 \\ 0 & 1 & 3 & -4 \\ \cdot & \cdot & \cdot & \cdot \end{array} \right] \xrightarrow{\begin{array}{l} R_1 + 5R_3 \\ R_2 - 3R_3 \end{array}} \left[\begin{array}{ccc|c} 1 & 0 & 0 & 5 \\ 0 & 1 & 0 & 2 \\ 0 & 0 & 1 & -2 \end{array} \right]$$

31. Write a system of linear equations for the augmented matrix of Exercise 27. Using the results of Exercise 27, determine the solution of the system.

32. Repeat Exercise 31 for the augmented matrix of Exercise 28.

33. Repeat Exercise 31 for the augmented matrix of Exercise 29.

34. Repeat Exercise 31 for the augmented matrix of Exercise 30.

In Exercises 35–56, solve the system of linear equations using

$$45. \begin{cases} 2x + y - 2z = 4 \\ x + 3y - z = -3 \\ 3x + 4y - z = 7 \end{cases}$$

$$47. \begin{cases} 2x + 2y + z = 9 \\ x + z = 4 \\ 4y - 3z = 17 \end{cases}$$

$$49. \begin{cases} -x_2 + x_3 = 2 \\ 4x_1 - 3x_2 + 2x_3 = 16 \\ 3x_1 + 2x_2 + x_3 = 11 \end{cases}$$

$$51. \begin{cases} x_1 - 2x_2 + x_3 = 6 \\ 2x_1 + x_2 - 3x_3 = -3 \\ x_1 - 3x_2 + 3x_3 = 10 \end{cases}$$

$$53. \begin{cases} 2x + 3z = -1 \\ 3x - 2y + z = 9 \\ x + y + 4z = 4 \end{cases}$$

$$55. \begin{cases} x_1 - x_2 + 3x_3 = 14 \\ x_1 + x_2 + x_3 = 6 \\ -2x_1 - x_2 + x_3 = -4 \end{cases}$$

$$56. \begin{cases} 2x_1 - x_2 - x_3 = 0 \\ 3x_1 + 2x_2 + x_3 = 7 \\ x_1 + 2x_2 + 2x_3 = 5 \end{cases}$$

57. Determine the value(s) of k such that the following system of linear equations has a unique solution, and then find the solution in terms of k :

$$4x + 5y = 3$$

$$3x + ky = 10$$

58. Determine the value(s) of k such that the following system of linear equations has a unique solution:

$$x + 3y + z = 8$$

$$3x + 2y - 2z = 5$$

$$4x - 3y + kz = 0$$

The problems in Exercises 59–80 correspond to those in Exercises 23–44, Section 5.1. Use the results of your previous work to help you solve these problems.

$$46. \begin{cases} x + y + z = 0 \\ 2x - y + z = 1 \\ x + y - 2z = 2 \end{cases}$$

$$48. \begin{cases} 2x + 3y - 2z = 10 \\ 3x - 2y + 2z = 0 \\ 4x - y + 3z = -1 \end{cases}$$

$$50. \begin{cases} 2x + 4y - 6z = 38 \\ x + 2y + 3z = 7 \\ 3x - 4y + 4z = -19 \end{cases}$$

$$52. \begin{cases} 2x + 3y - 6z = -11 \\ x - 2y + 3z = 9 \\ 3x + y = 7 \end{cases}$$

$$54. \begin{cases} 2x_1 - x_2 + 3x_3 = -4 \\ x_1 - 2x_2 + x_3 = -1 \\ x_1 - 5x_2 + 2x_3 = -3 \end{cases}$$

... units of each type of... Find how
A ball and a hat cost a total of \$110. The hat costs \$100
more than the ball. How much does the ball cost?

INVESTMENTS Josh has invested \$70,000 in two projects.
The amount invested in project A exceeds that invested in
project B by \$20,000. How much has Josh invested in
each project?

INVESTMENT PLANNING The annual returns on Sid Car-
lington's three investments amounted to \$21,600: 6%
on a savings account, 8% on mutual funds, and 12% on
bonds. The amount of Sid's investment in bonds was
twice the amount of his investment in the savings ac-
count, and the interest earned from his investment in
bonds was equal to the dividends he received from his
investment in mutual funds. Find how much money he
placed in each type of investment.

INVESTMENT RISK AND RETURN A private investment club has
\$200,000 earmarked for investment in stocks. To arrive at
an acceptable overall level of risk, the stocks that man-
agement is considering have been classified into three
categories: high-risk, medium-risk, and low-risk. Manage-
ment estimates that high-risk stocks will have a rate of
return of 15%/year; medium-risk stocks, 10%/year; and
low-risk stocks, 6%/year. The members have decided that
the investment in low-risk stocks should be equal to the
sum of the investments in the stocks of the other two cat-
egories. Determine how much the club should invest in

71. **Lawn Fertilizers**
Commercial fertilizer
contains 18 lb of nu-
trient potassium, A
20 lb of nitroge-
num, A 100 lb
nitrogen, 3 lb
many 100 lb
should have
of phosphorus
all the nu-

72. **Box-Office**
900 and
for ad-
there
comb
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73. **Bu**
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b
i

17. $x - 2y = -3$
 $2x + y = 3$
 $x - 2y = -5$
19. $3x - 2y = 5$
 $x + 3y = -4$
 $2x - 4y = 6$
21. $x - 2y = 2$
 $7x - 14y = 14$
 $3x - 6y = 6$
23. $x + 2y + z = -2$
 $-2x - 3y - z = 1$
 $2x + 4y + 2z = -4$
25. $3x + 2y = 4$
 $-\frac{1}{2}x - y = -2$
 $6x + 4y = 8$
27. $x + y - 2z = -3$
 $2x - y + 3z = 7$
 $x - 2y + 5z = 0$
29. $x - 2y + 3z = 4$
 $2x + 3y - z = 2$
 $x + 2y - 3z = -6$
31. $4x + y - z = 4$
 $8x + 2y - 2z = 8$
33. $2x + y - 3z = 1$
 $x - y + 2z = 1$
 $5x - 2y + 3z = 6$
35. $x + 2y - z = -4$
 $2x + y + z = 7$
 $x + 3y + 2z = 7$
 $x - 3y + z = 9$
18. $2x + 3y = 2$
 $x + 3y = -2$
 $x - y = 3$
20. $4x + 6y = 8$
 $3x - 2y = -7$
 $x + 3y = 5$
22. $3x - y + 2z = 5$
 $x - y + 2z = 1$
 $5x - 2y + 4z = 12$
24. $3y + 2z = 4$
 $2x - y - 3z = 3$
 $2x + 2y - z = 7$
26. $2x_1 - x_2 + x_3 = -4$
 $3x_1 - \frac{3}{2}x_2 + \frac{3}{2}x_3 = -6$
 $-6x_1 + 3x_2 - 3x_3 = 12$
28. $2x_1 + 6x_2 - 5x_3 = 5$
 $x_1 + 3x_2 + x_3 + 7x_4 = -1$
 $3x_1 + 9x_2 - x_3 + 13x_4 = 1$
30. $x_1 - 2x_2 + x_3 = -3$
 $2x_1 + x_2 - 2x_3 = 2$
 $x_1 + 3x_2 - 3x_3 = 5$
32. $x_1 + 2x_2 + 4x_3 = 2$
 $x_1 + x_2 + 2x_3 = 1$
34. $3x - 9y + 6z = -12$
 $x - 3y + 2z = -4$
 $2x - 6y + 4z = 8$
36. $3x - 2y + z = 4$
 $x + 3y - 4z = -3$
 $2x - 3y + 5z = 7$
 $x - 8y + 9z = 10$

37. **MANAGEMENT DECISIONS** The management of Hartman Rent-A-Car has allocated \$1,512,000 to purchase 60 new automobiles to add to the existing fleet of rental cars. The company will choose from compact, mid-sized, and full-sized cars costing \$18,000, \$28,800, and \$39,600 each, respectively. Find formulas giving the options available to the company. Give two specific options. (Note: Your answers will not be unique.)

38. **DIET PLANNING** A dietitian wishes to plan a meal around three foods. The meal is to include 8800 units of vitamin A, 3380 units of vitamin C, and 1020 units of calcium. The number of units of the vitamins and calcium in each ounce of the foods is summarized in the following table:

	Food I	Food II	Food III
Vitamin A	400	1200	800
Vitamin C	110	570	340
Calcium	90	30	60

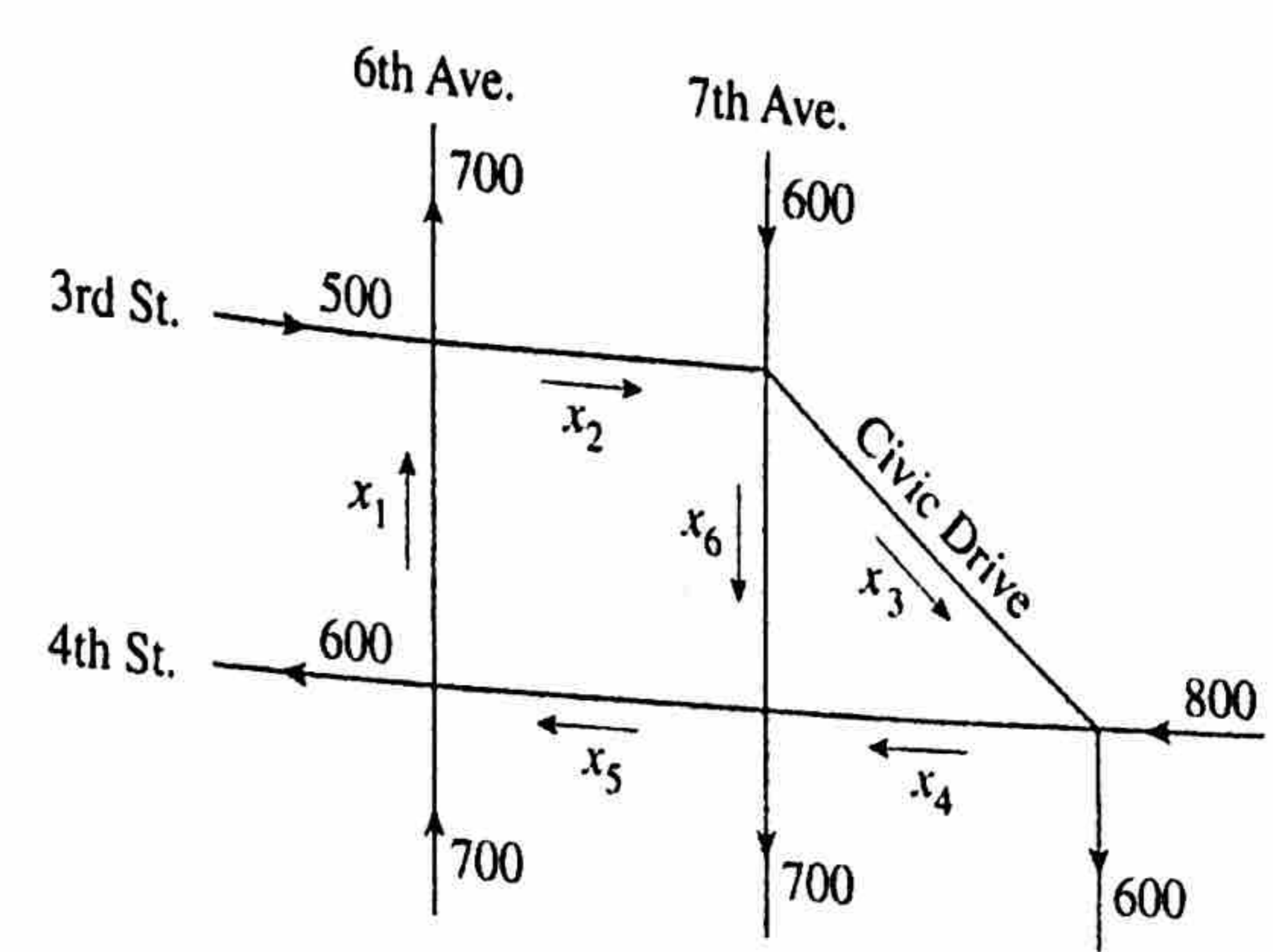
Determine the amount of each food the dietitian should include in the meal to meet the vitamin and calcium requirements.

39. **DIET PLANNING** Refer to Exercise 38. In planning for another meal, the dietitian changes the requirement of vitamin C from 3380 units to 2160 units. All other requirements remain the same. Show that such a meal cannot be planned around the same foods.

40. **PRODUCTION SCHEDULING** Ace Novelty manufactures Giant Pandas, Saint Bernards, and Big Birds. Each Giant Panda requires 1.5 yd² of plush, 30 ft³ of stuffing, and 5 pieces of trim; each Saint Bernard requires 2 yd² of plush, 35 ft³ of stuffing, and 8 pieces of trim; and each Big Bird requires 2.5 yd² of plush, 25 ft³ of stuffing, and 15 pieces of trim. If 4700 yd² of plush, 65,000 ft³ of stuffing, and 23,400 pieces of trim are available, how many of each of the stuffed animals should the company manufacture if all the material is to be used? Give two specific options.

41. **ASSET ALLOCATION** Mr. and Mrs. Garcia have a total of \$100,000 to be invested in stocks, bonds, and a money market account. The stocks have a rate of return of 6%/year, while the bonds and the money market account pay 4%/year and 2%/year, respectively. The Garcias have stipulated that the amount invested in stocks should be equal to the sum of the amount invested in bonds and 3 times the amount invested in the money market account. How should the Garcias allocate their resources if they require an annual income of \$5,000 from their investments? Give two specific options.

42. **TRAFFIC CONTROL** The accompanying figure shows the flow of traffic near a city's Civic Center during the rush hours on a typical weekday. Each road can handle a maximum of 1000 cars/hr without causing congestion. The flow of traffic is controlled by traffic lights at each of the five intersections.



- Set up a system of linear equations describing the traffic flow.
- Solve the system devised in part (a), and suggest two possible traffic-flow patterns that will ensure no traffic congestion.
- Suppose 7th Avenue between 3rd and 4th Streets is soon to be closed for road repairs. Find one possible traffic-flow pattern that will result in a smooth flow of traffic.