d. How many hours of production time will be scheduled in each department?
e. What is the slack time in each department?

23. George Johnson recently inherited a large sum of money; he wants to use a portion of this money to set up a trust fund for his two children. The trust fund has two investment options: (1) a bond fund and (2) a stock fund. The projected returns over the life of the investments are 6% for the bond fund and 10% for the stock fund. Whatever portion of the inheritance he finally decides to commit to the trust fund, he wants to invest at least 30% of that amount in the bond fund. In addition, he wants to select a mix that will enable him to obtain a total return of at least 7.5%.
a. Formulate a linear programming model that can be used to determine the percentage that should be allocated to each of the possible investment alternatives.
b. Find the optimal solution using the graphical solution procedure.

24. The Sea Wharf Restaurant would like to determine the best way to allocate a monthly advertising budget of $1000 between newspaper advertising and radio advertising. Management has decided that at least 25% of the budget must be spent on each type of media, and that the amount of money spent on local newspaper advertising must be at least twice the amount spent on radio advertising. A marketing consultant has developed an index that measures audience exposure per dollar of advertising on a scale from 0 to 100, with higher values implying greater audience exposure. If the value of the index for local newspaper advertising is 50 and the value of the index for spot radio advertising is 80, how should the restaurant allocate its advertising budget in order to maximize the value of total audience exposure?
a. Formulate a linear programming model that can be used to determine how the restaurant should allocate its advertising budget in order to maximize the value of total audience exposure.
b. Find the optimal solution using the graphical solution procedure.

25. Blair & Rosen, Inc. (B&R), is a brokerage firm that specializes in investment portfolios designed to meet the specific risk tolerances of its clients. A client who contacted B&R this past week has a maximum of $50,000 to invest. B&R's investment advisor has decided to recommend a portfolio consisting of two investment funds: an Internet fund and a Blue Chip fund. The Internet fund has a projected annual return of 12%, while the Blue Chip fund has a projected annual return of 9%. The investment advisor requires that at most $35,000 of the client's funds should be invested in the Internet fund. B&R services include a risk rating for each investment alternative. The Internet fund, which is the more risky of the two investment alternatives, has a risk rating of 6 per thousand dollars invested. The Blue Chip fund has a risk rating of 4 per thousand dollars invested. For example, if $10,000 is invested in each of the two investment funds, B&R's risk rating for the portfolio would be $6(10) + 4(10) = 100$. Finally, B&R has developed a questionnaire to measure each client's risk tolerance. Based on the responses, each client is classified as a conservative, moderate, or aggressive investor. Suppose that the questionnaire results have classified the current client as a moderate investor. B&R recommends that a client who is a moderate investor limit his or her portfolio to a maximum risk rating of 240.
a. What is the recommended investment portfolio for this client? What is the annual return for the portfolio?
b. Suppose that a second client with $50,000 to invest has been classified as an aggressive investor. B&R recommends that the maximum portfolio risk rating for an aggressive investor is 320. What is the recommended investment portfolio for this aggressive investor? Discuss what happens to the portfolio under the aggressive investor strategy.
c. Suppose that a third client with $50,000 to invest has been classified as a conservative investor. B&R recommends that the maximum portfolio risk rating for a conservative investor is 160. Develop the recommended investment portfolio for the conservative investor. Discuss the interpretation of the slack variable for the total investment fund constraint.

SELF test

29. Consider the following linear program:

$$\begin{aligned} \text{Min} \quad & 3x_1 + 4x_2 \\ \text{s.t.} \quad & \\ & 1x_1 + 3x_2 \geq 6 \\ & 1x_1 + 1x_2 \geq 4 \\ & x_1, x_2 \geq 0 \end{aligned}$$

Identify the feasible region and find the optimal solution using the graphical solution procedure. What is the value of the objective function?

30. Identify the three extreme-point solutions for the M&D Chemicals problem (see Section 2.5). Identify the value of the objective function and the values of the slack and surplus variables at each extreme point.

31. Consider the following linear programming model:

$$\begin{aligned} \text{Min} \quad & x_1 + 2x_2 \\ \text{s.t.} \quad & \\ & x_1 + 4x_2 \leq 21 \\ & 2x_1 + x_2 \geq 7 \\ & 3x_1 + 1.5x_2 \leq 21 \\ & -2x_1 + 6x_2 \geq 0 \\ & x_1, x_2 \geq 0 \end{aligned}$$

a. Find the optimal solution using the graphical solution procedure and the value of the objective function.
b. Determine the amount of slack or surplus for each constraint.
c. Suppose the objective function is changed to max $5x_1 + 2x_2$. Find the optimal solution and the value of the objective function.

50. Expedition Outfitters manufactures a variety of specialty clothing for hiking, skiing, and mountain climbing. They decided to begin production on two new parkas designed for use in extremely cold weather. The names selected for the two models are the Mount Everest Parka and the Rocky Mountain Parka. Their manufacturing plant has 120 hours of cutting time and 120 hours of sewing time available for producing these two parkas. Each Mount Everest Parka requires 30 minutes of cutting time and 45 minutes of sewing time, and each Rocky Mountain Parka requires 20 minutes of cutting time and 15 minutes of sewing time. The labor and material cost is $150 for each Mount Everest Parka and $50 for each Rocky

cont'd

Mountain Parka, and the retail prices through the firm's mail order catalog are $250 for the Mount Everest Parka and $200 for the Rocky Mountain Parka. Because management believes that the Mount Everest Parka is a unique coat that will enhance the image of the firm, they have specified that at least 20% of the total production must consist of this model. Assuming that Expedition Outfitters can sell as many coats of each type as they can produce, how many units of each model should they manufacture to maximize the total profit contribution?