***Introduction to Management Science*, 11e (Taylor)**
Chapter 2 Linear Programming: Model Formulation and Graphical Solution

1) Linear programming is a model consisting of linear relationships representing a firm's decisions given an objective and resource constraints.
Answer: TRUE
Diff: 2 Page Ref: 31
Section Heading: Model Formulation
Keywords: model formulation
AACSB: Analytic skills

2) The objective function always consists of either maximizing or minimizing some value.
Answer: TRUE
Diff: 2 Page Ref: 31
Section Heading: Model Formulation
Keywords: objective function
AACSB: Analytic skills

3) The objective function is a linear relationship reflecting the objective of an operation.
Answer: TRUE
Diff: 1 Page Ref: 31
Section Heading: Model Formulation
Keywords: model formulation
AACSB: Analytic skills

4) A constraint is a linear relationship representing a restriction on decision making.
Answer: TRUE
Diff: 1 Page Ref: 31
Section Heading: Model Formulation
Keywords: model formulation
AACSB: Analytic skills

5) A linear programming model consists of only decision variables and constraints.
Answer: FALSE
Diff: 1 Page Ref: 56
Section Heading: Characteristics of Linear Programming Problems
Keywords: model formulation
AACSB: Analytic skills

6) A parameter is a numerical value in the objective function and constraints.
Answer: TRUE
Diff: 1 Page Ref: 31
Section Heading: Model Formulation
Keywords: parameter
AACSB: Analytic skills

7) A feasible solution violates at least one of the constraints.
Answer: FALSE
Diff: 2 Page Ref: 34
Section Heading: Model Formulation
Keywords: model formulation
AACSB: Analytic skills

8) Proportionality means the slope of a constraint is proportional to the slope of the objective function.
Answer: FALSE
Diff: 2 Page Ref: 56
Section Heading: Characteristics of Linear Programming Problems
Keywords: properties of linear programming models, proportionality
AACSB: Analytic skills

9) The terms in the objective function or constraints are additive.
Answer: TRUE
Diff: 2 Page Ref: 56
Section Heading: Characteristics of Linear Programming Problems
Keywords: properties of linear programming models, additive
AACSB: Analytic skills

10) The terms in the objective function or constraints are multiplicative.
Answer: FALSE
Diff: 2 Page Ref: 56
Section Heading: Characteristics of Linear Programming Problems
Keywords: properties of linear programming models, additive
AACSB: Analytic skills

11) The values of decision variables are continuous or divisible.
Answer: TRUE
Diff: 2 Page Ref: 56
Section Heading: Characteristics of Linear Programming Problems
Keywords: properties of linear programming models, divisible
AACSB: Analytic skills

12) All model parameters are assumed to be known with certainty.
Answer: TRUE
Diff: 2 Page Ref: 56
Section Heading: Characteristics of Linear Programming Problems
Keywords: properties of linear programming models
AACSB: Analytic skills

13) In linear programming models , objective functions can only be maximized.
Answer: FALSE
Diff: 1 Page Ref: 31
Section Heading: Model Formulation
Keywords: properties of linear programming models, objective function
AACSB: Analytic skills

14) All linear programming models exhibit a set of constraints.
Answer: TRUE
Diff: 1 Page Ref: 30
Section Heading: Model Formulation
Keywords: properties of linear programming models, constraints
AACSB: Analytic skills

15) When using the graphical method, only one of the four quadrants of an *xy*-axis needs to be drawn.
Answer: TRUE
Diff: 1 Page Ref: 36
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphical linear programming
AACSB: Analytic skills

16) Linear programming models exhibit linearity among all constraint relationships and the objective function.
Answer: TRUE
Diff: 1 Page Ref: 55
Section Heading: Characteristics of Linear Programming Problems
Keywords: properties of linear prog models, linearity, proportionality
AACSB: Analytic skills

17) The equation $8xy = 32$ satisfies the proportionality property of linear programming.
Answer: FALSE
Diff: 2 Page Ref: 56
Section Heading: Characteristics of Linear Programming Problems
Keywords: graphical solution, proportionality
AACSB: Analytic skills

18) Typically, finding a corner point for the feasible region involves solving a set of three simultaneous equations.
Answer: FALSE
Diff: 2 Page Ref: 46
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphical solution, extreme points, feasible region
AACSB: Analytic skills

19) Objective functions in linear programs always minimize costs.
Answer: FALSE
Diff: 2 Page Ref: 31
Section Heading: Model Formulation
Keywords: properties of linear programming models, objective function
AACSB: Analytic skills

20) The feasible solution area contains infinite solutions to the linear program.
Answer: TRUE
Diff: 1 Page Ref: 38
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: properties of linear programming models, feasible solution area
AACSB: Analytic skills

21) There is exactly one optimal solution point to a linear program.
Answer: FALSE
Diff: 2 Page Ref: 53
Section Heading: Irregular Types of Linear Programming Problems
Keywords: properties of linear programming models, optimal solution pt
AACSB: Analytic skills

22) The following equation represents a resource constraint for a maximization problem: $X + Y \geq 20$.
Answer: FALSE
Diff: 2 Page Ref: 34
Section Heading: A Maximization Model Example
Keywords: properties of linear programming models, constraints
AACSB: Analytic skills

23) The optimal solution for a graphical linear programming problem is the corner point that is the farthest from the origin.
Answer: FALSE
Diff: 2 Page Ref: 41
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: feasibility, constraints
AACSB: Analytic skills

24) A minimization model of a linear program contains only surplus variables.
Answer: FALSE
Diff: 1 Page Ref: 52
Section Heading: A Minimization Model Example
Keywords: properties of linear programming models, surplus variables
AACSB: Analytic skills

25) In the graphical approach, simultaneous equations may be used to solve for the optimal solution point.
Answer: TRUE
Diff: 2 Page Ref: 42
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphical solution
AACSB: Analytic skills

26) Slack variables are only associated with maximization problems.
Answer: FALSE
Diff: 2 Page Ref: 44
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphical solution, slack variables
AACSB: Analytic skills

27) Surplus variables are only associated with minimization problems.
Answer: FALSE
Diff: 2 Page Ref: 52
Section Heading: A Minimization Model Example
Keywords: graphical solution, surplus variable
AACSB: Analytic skills

28) If the objective function is parallel to a constraint, the constraint is infeasible.
Answer: FALSE
Diff: 2 Page Ref: 54
Section Heading: Irregular Types of Linear Programming Problems
Keywords: graphical solution
AACSB: Analytic skills

29) Multiple optimal solutions occur when constraints are parallel to each other.
Answer: FALSE
Diff: 2 Page Ref: 54
Section Heading: Irregular Types of Linear Programming Problems
Keywords: graphical solution
AACSB: Analytic skills

30) Graphical solutions to linear programming problems have an infinite number of possible objective function lines.
Answer: TRUE
Diff: 2 Page Ref: 39
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphical solution, objective function line
AACSB: Analytic skills

31) The first step in formulating a linear programming model is to define the objective function
Answer: FALSE
Diff: 2 Page Ref: 32
Section Heading: Introduction
Keywords: linear programming problems, formulation
AACSB: Analytic skills

32) _____ are mathematical symbols representing levels of activity.
Answer: Decision variables
Diff: 1 Page Ref: 31
Section Heading: Model Formulation
Keywords: decision variables, model formulation
AACSB: Analytic skills

33) The _____ is a linear relationship reflecting the objective of an operation.
Answer: objective function
Diff: 1 Page Ref: 31
Section Heading: Model Formulation
Keywords: objective function, model formulation
AACSB: Analytic skills

34) A _____ is a linear relationship representing a restriction on decision making.
Answer: constraint
Diff: 1 Page Ref: 31
Section Heading: Model Formulation
Keywords: constraint, model formulation
AACSB: Analytic skills

35) A manufacturer using linear programming to decide the best product mix to maximize profit typically has a(n) _____ constraint included in the model.
Answer: nonnegativity
Diff: 1 Page Ref: 34
Section Heading: A Maximization Model Example
Keywords: nonnegativity
AACSB: Analytic skills

36) If at least one constraint in a linear programming model is violated, the solution is said to be _____.
Answer: infeasible
Diff: 1 Page Ref: 54
Section Heading: Irregular Types of Linear Programming Problems
Keywords: constraint, infeasible solution
AACSB: Analytic skills

37) A graphical solution is limited to solving linear programming problems with _____ decision variables
Answer: two
Diff: 1 Page Ref: 35
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphical solution
AACSB: Analytic skills

38) The _____ solution area is an area bounded by the constraint equations.
Answer: feasible
Diff: 1 Page Ref: 38
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphical solution
AACSB: Analytic skills

39) Multiple optimal solutions can occur when the objective function line is _____ to a constraint line.
Answer: parallel
Diff: 2 Page Ref: 44
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphical solution, multiple optimal solutions
AACSB: Analytic skills

40) When a maximization problem is _____, the objective function can increase indefinitely without reaching a maximum value.
Answer: unbounded
Diff: 2 Page Ref: 55
Section Heading: Irregular Types of Linear Programming Problems
Keywords: graphical solution, unbounded problem
AACSB: Analytic skills

41) A linear programming problem that results in a solution that is _____ usually indicates that the linear program has been incorrectly formulated.
Answer: infeasible
Diff: 2 Page Ref: 54
Section Heading: Irregular Types of Linear Programming Problems
Keywords: graphical solution, infeasible solution
AACSB: Analytic skills

42) The best feasible solution is _____.
Answer: optimal
Diff: 1 Page Ref: 40
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: optimal solutions
AACSB: Analytic skills

43) In a constraint, the _____ variable represents unused resources.
Answer: slack
Diff: 1 Page Ref: 44
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphical solution, surplus variable
AACSB: Analytic skills

44) _____ is the difference between the left- and right-hand sides of a greater than or equal to constraint.
Answer: Surplus
Diff: 1 Page Ref: 52
Section Heading: A Minimization Model Example
Keywords: surplus
AACSB: Analytic skills

45) If the objective function is parallel to a constraint, the linear program could have _____.
Answer: multiple optimal solutions
Diff: 2 Page Ref: 44
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphical solutions, multiple optimal solutions
AACSB: Analytic skills

46) Corner points on the boundary of the feasible solution area are called _____ points.
Answer: extreme
Diff: 1 Page Ref: 41
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: feasibility, constraints
AACSB: Analytic skills

47) _____ are at the endpoints of the constraint line segment that the objective function parallels.
Answer: Alternate optimal solutions
Diff: 3 Page Ref: 54
Section Heading: Irregular Types of Linear Programming Problems
Keywords: alternative optimal solutions, multiple optimal solutions
AACSB: Analytic skills

48) The _____ step in formulating a linear programming model is to define the decision variables.
Answer: first
Diff: 1 Page Ref: 33
Section Heading: A Maximization Model Example
Keywords: linear programming, formulation
AACSB: Analytic skills

49) The management scientist constructed a linear program to help the alchemist maximize his gold production process. The computer model chugged away for a few minutes and returned an answer of infinite profit., which is what might be expected from a(n) _____ problem.
Answer: unbounded
Diff: 1 Page Ref: 55
Section Heading: Irregular Types of Linear Programming Problems
Keywords: unbounded
AACSB: Analytic skills

50) The _____ property of linear programming models indicates that the values of all the model parameters are known and are assumed to be constant.
Answer: certainty
Diff: 2 Page Ref: 56
Section Heading: Characteristics of Linear Programming Problems
Keywords: properties of linear programming models, certainty
AACSB: Analytic skills

51) The _____ property of linear programming models indicates that the rate of change, or slope, of the objective function or a constraint is constant.
Answer: proportionality or linearity
Diff: 2 Page Ref: 56
Section Heading: Characteristics of Linear Programming Problems
Keywords: properties of linear programming models, certainty
AACSB: Analytic skills

52) The _____ property of linear programming models indicates that the decision variables cannot be restricted to integer values and can take on any fractional value.
Answer: divisibility
Diff: 2 Page Ref: 56
Section Heading: Characteristics of Linear Programming Problems
Keywords: properties of linear programming models, divisibility
AACSB: Analytic skills

53) The constraint 2X +XY violates the _____ property of linear programming.
Answer: proportionality or linear
Diff: 1 Page Ref: 56
Section Heading: Characteristics of Linear Programming Problems
Keywords: properties of linear programming models
AACSB: Analytic skills

54) Consider the following minimization problem:

$$\begin{aligned} \text{Min } z = \quad & x_1 + 2x_2 \\ \text{s.t.} \quad & x_1 + x_2 \geq 300 \\ & 2x_1 + x_2 \geq 400 \\ & 2x_1 + 5x_2 \leq 750 \\ & x_1, x_2 \geq 0 \end{aligned}$$

What is the optimal solution?
Answer: $x_1 = 250$, $x_2 = 50$, $z = 350$
Diff: 3 Page Ref: 47-53
Section Heading: A Minimization Model Example
Keywords: Graphical solution, simultaneous solution
AACSB: Analytic skills

55) Consider the following minimization problem:

$$\begin{aligned} \text{Min } z = \quad & x_1 + 2x_2 \\ \text{s.t.} \quad & x_1 + x_2 \geq 300 \\ & 2x_1 + x_2 \geq 400 \\ & 2x_1 + 5x_2 \leq 750 \\ & x_1, x_2 \geq 0 \end{aligned}$$

Which constraints are binding at the optimal solution? ($x_1 = 250$, $x_2 = 50$)
Answer: constraints 1 and 3
Diff: 1 Page Ref: 47-53
Section Heading: A Minimization Model Example
Keywords: Graphical solution, simultaneous solution
AACSB: Analytic skills

56) Solve the following graphically:

Max $z = 3x_1 + 4x_2$

s.t. $x_1 + 2x_2 \leq 16$

$2x_1 + 3x_2 \leq 18$

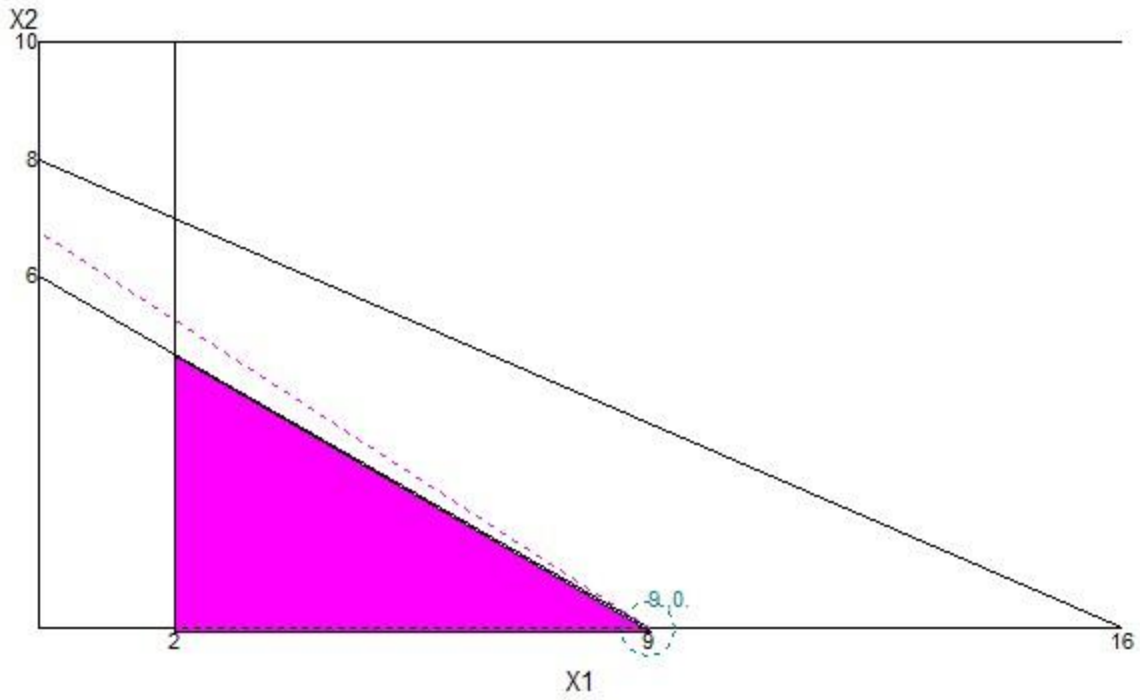
$x_1 \geq 2$

$x_2 \leq 10$

$x_1, x_2 \geq 0$

What are the optimal values of x_1, x_2, and z?

Answer: $x_1 = 9$, $x_2 = 0$, $z = 27$



Diff: 3 Page Ref: 35-46

Section Heading: Graphical Solutions of Linear Programming Models

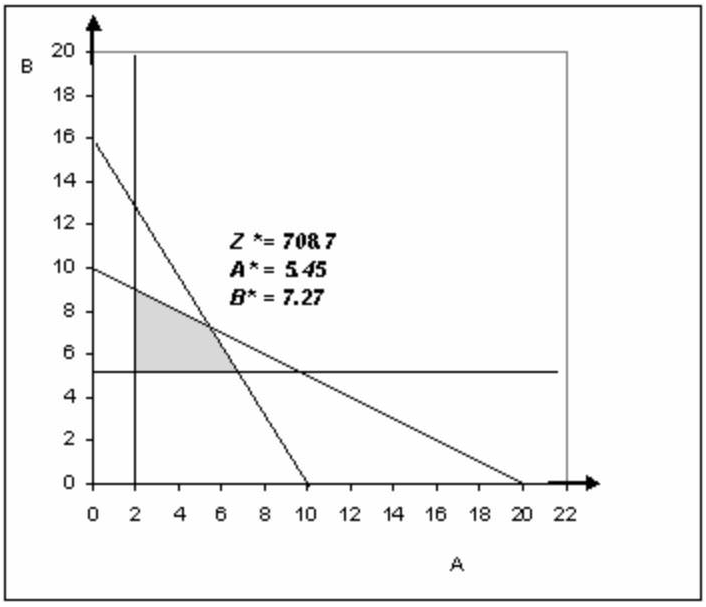
Keywords: graphical solution, simultaneous solution

AACSB: Analytic skills

57) Consider the following linear program:

MAX $Z = 60A + 50B$
s.t. $10A + 20B \leq 200$
$8A + 5B \leq 80$
$A \geq 2$
$B \geq 5$

Solve this linear program graphically and determine the optimal quantities of A, B, and the value of Z.
Answer: Solution shown below.

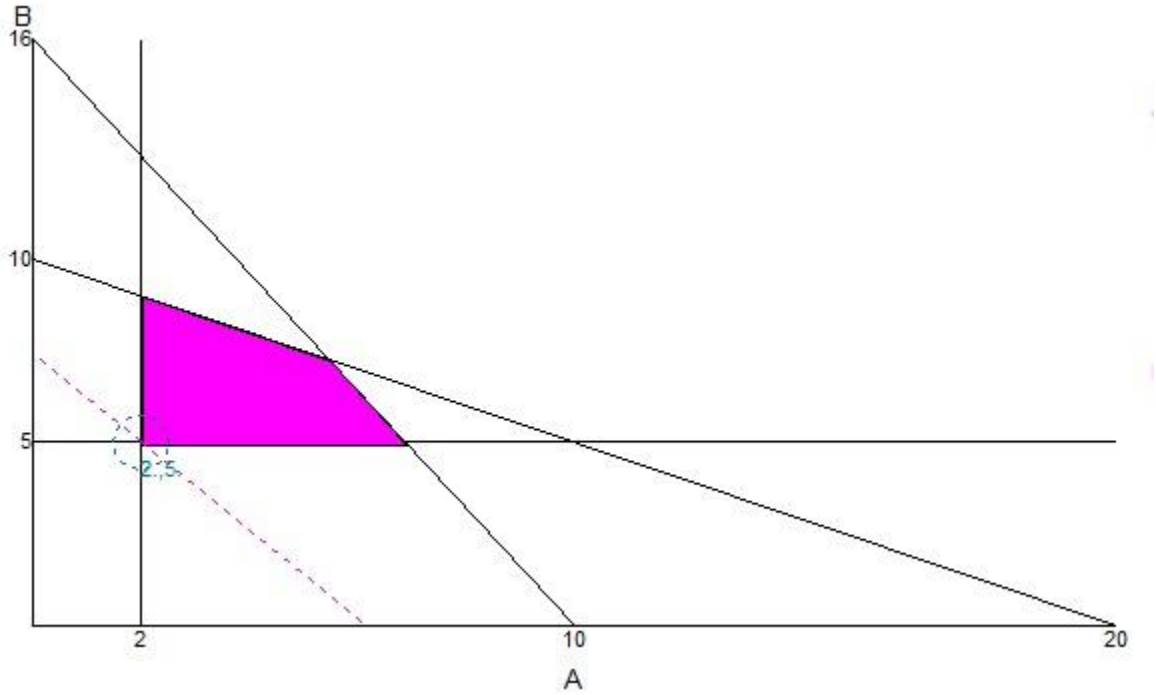


Diff: 2 Page Ref: 35-46
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphical linear programming
AACSB: Analytic skills

58) Consider the following linear program:

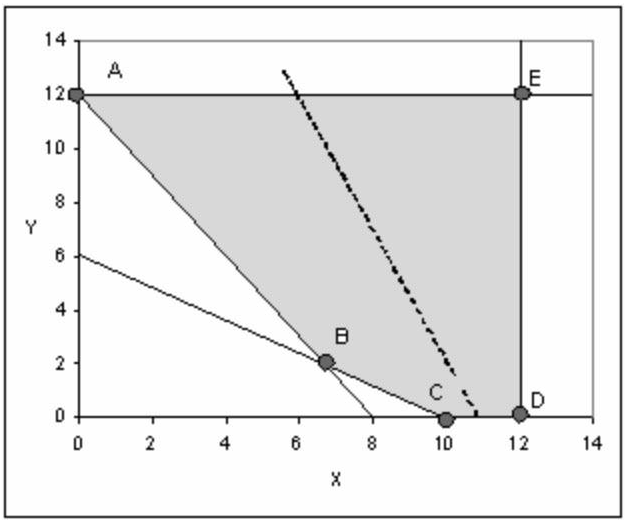
MIN $Z = 60A + 50B$
s.t. $10A + 20B \leq 200$
$8A + 5B \leq 80$
$A \geq 2$
$B \geq 5$

Solve this linear program graphically and determine the optimal quantities of A, B, and the value of Z.
Answer: A = 2, B = 5, Z = 370



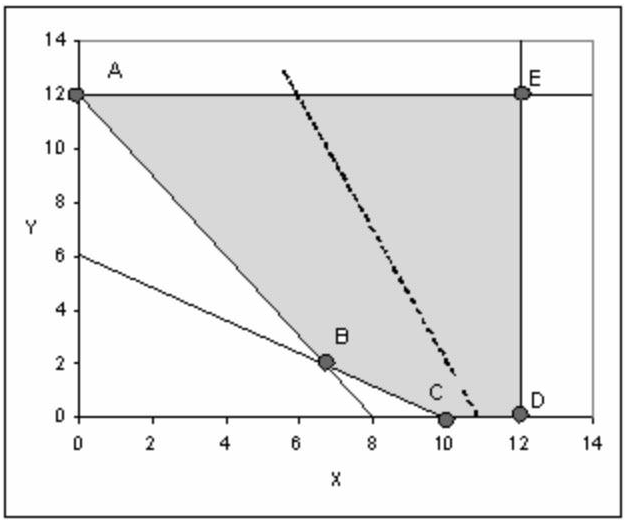
Diff: 2 Page Ref: 35-46
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphical linear programming
AACSB: Analytic skills

59) A graphical representation of a linear program is shown below. The shaded area represents the feasible region, and the dashed line in the middle is the slope of the objective function.



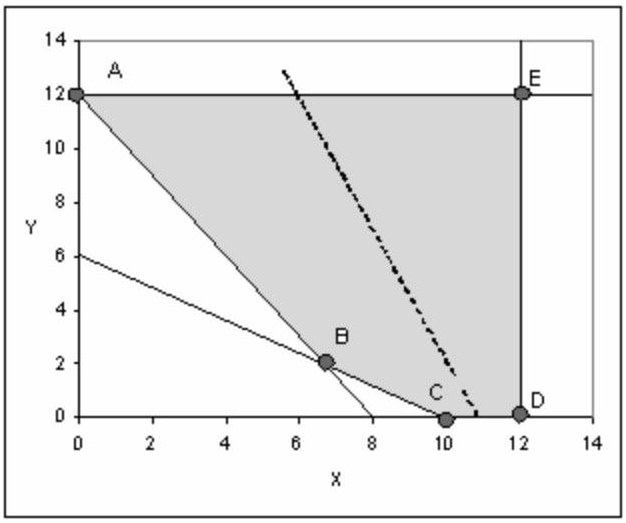
If this is a maximization, which extreme point is the optimal solution?
Answer: E
Diff: 1 Page Ref: 41
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphical solution, extreme points, feasible region
AACSB: Analytic skills

60) A graphical representation of a linear program is shown below. The shaded area represents the feasible region, and the dashed line in the middle is the slope of the objective function.



If this is a minimization, which extreme point is the optimal solution?
Answer: A
Diff: 2 Page Ref: 41
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphical solution, extreme points, feasible region
AACSB: Analytic skills

61) A graphical representation of a linear program is shown below. The shaded area represents the feasible region, and the dashed line in the middle is the slope of the objective function.



What would the be the new slope of the objective function if multiple optimal solutions occurred along line segment AB?
Answer: -3/2
Diff: 2 Page Ref: 44
Section Heading: Irregular Types of Linear Programming Problems
Keywords: graphical solution, multiple optimal solutions
AACSB: Analytic skills

62) Consider the following linear programming problem:
Max Z = $\$15x + \$20y$
Subject to: $8x + 5y \leq 40$
$0.4x + y \geq 4$
$x, y \geq 0$
Determine the values for x and y that will maximize revenue. Given this optimal revenue, what is the amount of slack associated with the first constraint?
Answer: $x = 0$, $y = 8$, revenue = \$160, $s_1 = 0$
Diff: 2 Page Ref: 44
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphical solution, slack variables
AACSB: Analytic skills

63) Consider the following linear programming problem:
Max Z = 3x$ + 9y$
Subject to: 20x$ + 32y$ ≤ 1600
4x$ + 2y$ ≤ 240
y ≤ 40
x, y ≥ 0
Solve for the quantities of x and y which will maximize Z. What is the value of the slack variable associated with constraint 2?
Answer: x = 16, y = 40, z = $408 and slack ($s_2$) = 96
Diff: 2 Page Ref: 44
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphical solution, slack variables
AACSB: Analytic skills

64) Consider the following linear programming problem:
Max Z = $5x_1$ + $3x_2$
Subject to: $6x_1$ + $2x_2$ ≤ 18
$15x_1$ + $20x_2$ ≤ 60
x_1 , x_2 ≥ 0
Find the optimal profit and the values of x_1 and x_2 at the optimal solution.
Answer: Z = 16.333, x_1 = 2.6667, x_2 = 1.0
Diff: 2 Page Ref: 42
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphical solution
AACSB: Analytic skills

65) The poultry farmer decided to make his own chicken scratch by combining alfalfa and corn in rail car quantities. A rail car of corn costs $400 and a rail car of alfalfa costs $200. The farmer's chickens have a minimum daily requirement of vitamin K (500 milligrams) and iron (400 milligrams), but it doesn't matter whether those elements come from corn, alfalfa, or some other grain. A unit of corn contains 150 milligrams of vitamin K and 75 milligrams of iron. A unit of alfalfa contains 250 milligrams of vitamin K and 50 milligrams of iron. Formulate the linear programming model for this situation.
Answer: Min Z = $4005C + $200A
Subject to: 150C + 250A ≥ 500
75C + 50A ≥ 400
C, A ≥ 0
Diff: 3 Page Ref: 34
Section Heading: A Maximization Model Example
Keywords: constraint, model formulation
AACSB: Analytic skills

66) Consider the following linear programming problem:
Max Z = $3x_1 + 3x_2$
Subject to: $10x_1 + 4x_2 \leq 60$
$25x_1 + 50x_2 \leq 200$
$x_1, x_2 \geq 0$
Find the optimal profit and the values of x_1 and x_2 at the optimal solution.
Answer: Z = 20.25, x_1 = 5.5, x_2 = 1.25
Diff: 2 Page Ref: 34-42
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphical solution
AACSB: Analytic skills

67) Consider the following linear programming problem:
MIN Z = $10x_1 + 20x_2$
Subject to: $x_1 + x_2 \geq 12$
$2x_1 + 5x_2 \geq 40$
$x_2 \leq 13$
$x_1, x_2 \geq 0$
What is minimum cost and the value of x_1 and x_2 at the optimal solution?
Answer: Z = 173.333, x_1 = 6.667, x_2 = 5.333
Diff: 2 Page Ref: 47-53
Section Heading: A Minimization Model Example
Keywords: graphical solution
AACSB: Analytic skills

68) Consider the following linear programming problem:
MIN Z = $3x_1 + 2x_2$
Subject to: $2x_1 + 3x_2 \geq 12$
$5x_1 + 8x_2 \geq 37$
$x_1, x_2 \geq 0$
What is minimum cost and the value of x_1 and x_2 at the optimal solution?
Answer: 9.25 at x_1 = 0 and x_2 = 4.625
Diff: 3 Page Ref: 42
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: minimization problem
AACSB: Analytic skills

69) Consider the following linear programming problem:

MIN Z = $3x_1 + 2x_2$

Subject to: $2x_1 + 3x_2 \geq 12$

$5x_1 + 8x_2 \geq 37$

$x_1, x_2 \geq 0$

At the optimal solution point, the objective function value is 18. If the constraints are changed from greater than to less than constraints and the objective function is changed from minimize to maximize, what happens to the optimal solution? Demonstrate whether it falls at the same optimal point.

Answer: No, reversing the signs for the constraints and the objective function does not typically retain the same optimal solution. In this case, at $x_2 = 4.625$ the new objective function value is 9.25. In the original formulation the optimal value was at $x_1 = 6$.

Diff: 3 Page Ref: 42

Section Heading: A Minimization Model Example

Keywords: optimal solutions

AACSB: Analytic skills

70) Consider the following linear programming problem:

MIN Z = $10x_1 + 20x_2$

Subject to: $x_1 + x_2 \geq 12$

$2x_1 + 5x_2 \geq 40$

$x_2 \leq 13$

$x_1, x_2 \geq 0$

At the optimal solution, what is the value of surplus associated with constraint 1 and constraint 3, respectively?

Answer: constraint 1: (0 surplus), constraint 2: (7.667 surplus)

Diff: 2 Page Ref: 47-53

Section Heading: A Minimization Model Example

Keywords: graphical solution

AACSB: Analytic skills

71) Given this set of constraints, for what objective function is the point x=5, y=3 in the feasible region?

s.t $3x + 6y \leq 30$

$10x + 10y \leq 60$

$10x + 15y \leq 90$

Answer: No objective function can move that point into the feasible region.

Diff: 2 Page Ref: 40

Section Heading: Graphical Solutions of Linear Programming Models

Keywords: feasibility, constraints

AACSB: Analytic skills

72) Consider the following linear programming problem:
MIN Z = $2x_1 + 3x_2$
Subject to: $x_1 + 2x_2 \leq 20$
$5x_1 + x_2 \leq 40$
$4x_1 + 6x_2 \leq 60$
$x_1 , x_2 \geq 0$
What is the optimal solution?
Answer: Multiple optimal solutions exist between the extreme point (0,10) and (6.92,5.38) along the line with a slope of -2/3.
Diff: 2 Page Ref: 47-53
Section Heading: A Minimization Model Example
Keywords: graphical solution, multiple optimal solutions
AACSB: Analytic skills

73) A company producing a standard line and a deluxe line of dishwashers has the following time requirements (in minutes) in departments where either model can be processed.

	Standard	**Deluxe**
Stamping	3	6
Motor installation	10	10
Wiring	10	15

The standard models contribute $20 each and the deluxe $30 each to profits. Because the company produces other items that share resources used to make the dishwashers, the stamping machine is available only 30 minutes per hour, on average. The motor installation production line has 60 minutes available each hour. There are two lines for wiring, so the time availability is 90 minutes per hour.

Let x = number of standard dishwashers produced per hour
y = number of deluxe dishwashers produced per hour

Write the formulation for this linear program.
Answer: Max $20x + 30y$
s.t $3x + 6y \leq 30$
$10x + 10y \leq 60$
$10x + 15y \leq 90$
Diff: 2 Page Ref: 33
Section Heading: A Maximization Model Example
Keywords: formulation, objective function, constraints
AACSB: Analytic skills

74) In a linear programming problem, the binding constraints for the optimal solution are:

$5x_1 + 3x_2 \leq 30$

$2x_1 + 5x_2 \leq 20$

As long as the slope of the objective function stays between _____ and _____, the current optimal solution point will remain optimal.
Answer: -5/3, -2/5
Diff: 3 Page Ref: 44
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: optimal solution, solution interpretation, slope
AACSB: Analytic skills

75) In a linear programming problem, the binding constraints for the optimal solution are:

$5x_1 + 3x_2 \leq 30$

$2x_1 + 5x_2 \leq 20$

Which of these objective functions will lead to the same optimal solution?
A) $2x_1 + 1x_2$
B) $7x_1 + 8x_2$
C) $80x_1 + 60x_2$
D) $25x_1 + 15x_2$
Answer: D
Diff: 3 Page Ref: 39
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: optimal solution, solution interpretation, slope
AACSB: Analytic skills

76) Decision variables
A) measure the objective function.
B) measure how much or how many items to produce, purchase, hire, etc.
C) always exist for each constraint.
D) measure the values of each constraint.
Answer: B
Diff: 2 Page Ref: 31
Section Heading: Model Formulation
Keywords: decision variables
AACSB: Analytic skills

77) In a linear programming problem, a valid objective function can be represented as:
A) Max Z = 5xy
B) Max Z $5x^2 + 2y^2$
C) Max $3x + 3y + 1/3\ z$
D) Min $(x_1 + x_2) / x_3$
Answer: C
Diff: 3 Page Ref: 56
Section Heading: Characteristics of Linear Programming Problems
Keywords: objective function
AACSB: Analytic skills

78) Which of the following could not be a linear programming problem constraint?
A) $1A + 2B \neq 3$
B) $1A + 2B = 3$
C) $1A + 2B \leq 3$
D) $1A + 2B \geq 3$
Answer: A
Diff: 2 Page Ref: 33
Section Heading: A Maximization Model Example
Keywords: formulation, constraints
AACSB: Analytic skills

79) A linear programming model consists of
A) decision variables.
B) an objective function.
C) constraints.
D) all of the above
Answer: D
Diff: 1 Page Ref: 31
Section Heading: Model Formulation
Keywords: components of linear programming
AACSB: Analytic skills

80) The minimization of cost or maximization of profit is the
A) constraint of operations management.
B) goal of management science.
C) objective of linear programming.
D) assumption of financiality.
Answer: C
Diff: 1 Page Ref: 31
Section Heading: Model Formulation
Keywords: objective, cost minimization, profit maximization
AACSB: Analytic skills

81) Which of the following could be a linear programming objective function?
A) $Z = 1A + 2BC + 3D$
B) $Z = 1A + 2B + 3C + 4D$
C) $Z = 1A + 2B / C + 3D$
D) $Z = 1A + 2B^2 + 3D$
Answer: B
Diff: 2 Page Ref: 56
Section Heading: Characteristics of Linear Programming Problems
Keywords: objective function
AACSB: Analytic skills

82) The production manager for the Coory soft drink company is considering the production of two kinds of soft drinks: regular (R) and diet (D). Two of her limited resources are production time (8 hours = 480 minutes per day) and syrup (1 of the ingredients), limited to 675 gallons per day. To produce a regular case requires 2 minutes and 5 gallons of syrup, while a diet case needs 4 minutes and 3 gallons of syrup. Profits for regular soft drink are $3.00 per case and profits for diet soft drink are $2.00 per case. What is the objective function?
A) MAX $2R + $4D
B) MAX $3R + $2D
C) MAX $3D + $2R
D) MAX $4D + $2R
Answer: B
Diff: 2 Page Ref: 32
Section Heading: A Maximization Model Example
Keywords: formulation, objective function
AACSB: Analytic skills

83) The production manager for the Coory soft drink company is considering the production of two kinds of soft drinks: regular (R) and diet(D). Two of the limited resources are production time (8 hours = 480 minutes per day) and syrup (1 of the ingredients), limited to 675 gallons per day. To produce a regular case requires 2 minutes and 5 gallons of syrup, while a diet case needs 4 minutes and 3 gallons of syrup. Profits for regular soft drink are $3.00 per case and profits for diet soft drink are $2.00 per case. What is the time constraint?
A) $2D + 4R \leq 480$
B) $2R + 3D \leq 480$
C) $3R + 2D \leq 480$
D) $2R + 4D \leq 480$
Answer: D
Diff: 2 Page Ref: 32
Section Heading: A Maximization Model Example
Keywords: formulation, constraints
AACSB: Analytic skills

84) Non-negativity constraints
A) require the use of greater-than-or-equal-to constraints.
B) restrict the decision variables to positive values.
C) restrict the decision variables to negative values.
D) do not restrict the sign of the decision variable.
Answer: B
Diff: 2 Page Ref: 34
Section Heading: A Maximization Model Example
Keywords: constraints
AACSB: Analytic skills

85) Cully Furniture buys two products for resale: big shelves (B) and medium shelves (M). Each big shelf costs $500 and requires 100 cubic feet of storage space, and each medium shelf costs $300 and requires 90 cubic feet of storage space. The company has $75,000 to invest in shelves this week, and the warehouse has 18,000 cubic feet available for storage. Profit for each big shelf is $300 and for each medium shelf is $150. What is the objective function?
A) MAX Z = $300 B + $100 M
B) MAX Z = $300 M + $150 B
C) MAX Z = $300 B + $150 M
D) MAX Z = $300 B + $500 M
Answer: C
Diff: 2 Page Ref: 33
Section Heading: A Maximization Model Example
Keywords: formulation, objective function
AACSB: Analytic skills

86) Cully Turniture buys two products for resale: big shelves (B) and medium shelves (M). Each big shelf costs $500 and requires 100 cubic feet of storage space, and each medium shelf costs $300 and requires 90 cubic feet of storage space. The company has $75,000 to invest in shelves this week, and the warehouse has 18,000 cubic feet available for storage. Profit for each big shelf is $300 and for each medium shelf is $150. What is the storage space constraint?
A) 90 B + 100 M ≥ 18000
B) 90 B + 100 M ≤ 18000
C) 100 B + 90 M ≤ 18000
D) 500 B + 300 M ≤ 18000
Answer: C
Diff: 2 Page Ref: 34
Section Heading: A Maximization Model Example
Keywords: formulation, constraints
AACSB: Analytic skills

87) The _____ property of linear programming models indicates that the decision variables cannot be restricted to integer values and can take on any fractional value.
A) linearity
B) additive
C) divisibility
D) proportionality
Answer: C
Diff: 2 Page Ref: 56
Section Heading: Characteristics of Linear Programming Problems
Keywords: properties of linear programming models
AACSB: Analytic skills

88) The _____ property of linear programming models indicates that the rate of change or slope of the objective function or a constraint is constant.
A) additive
B) divisibility
C) certainty
D) proportionality
Answer: D
Diff: 2 Page Ref: 56
Section Heading: Characteristics of Linear Programming Problems
Keywords: properties of linear programming models
AACSB: Analytic skills

89) The _____ property of linear programming models indicates that the values of all the model parameters are known and are assumed to be constant.
A) additive
B) divisibility
C) certainty
D) proportionality
Answer: C
Diff: 2 Page Ref: 56
Section Heading: Characteristics of Linear Programming Problems
Keywords: properties of linear programming models
AACSB: Analytic skills

90) The region that satisfies all of the constraints in a graphical linear programming problem is called the
A) region of optimality.
B) feasible solution space.
C) region of non-negativity.
D) optimal solution space.
Answer: B
Diff: 1 Page Ref: 38
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphical solution, feasibility
AACSB: Analytic skills

91) In the formulation of a $\geq$ constraint,
A) a surplus variable is subtracted.
B) a surplus variable is added.
C) a slack variable is subtracted.
D) a slack variable is added.
Answer: A
Diff: 1 Page Ref: 52
Section Heading: A Minimization Model Example
Keywords: surplus
AACSB: Analytic skills

92) Which of the following statements is ***not*** true?
A) An infeasible solution violates all constraints.
B) A feasible solution point does not have to lie on the boundary of the feasible solution.
C) A feasible solution satisfies all constraints.
D) An optimal solution satisfies all constraints.
Answer: A
Diff: 2 Page Ref: 38
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphical solution, feasibility
AACSB: Analytic skills

93) A hot dog manufacturer wishes to minimize the cost in dollars of producing a low-cost niched product while meeting the dietary guidelines for protein and sodium. Once the model has been run, the surplus variable in the sodium constraint has a value of 1300 milligrams. The best interpretation of this outcome is:
A) The value of the sodium in a hot dog is 1300.
B) The amount of sodium in a single hot dog should be 1300 milligrams.
C) The minimum cost hot dog has 1300 milligrams more sodium than required.
D) A hot dog should have at least 1300 milligrams of sodium.
Answer: C
Diff: 2 Page Ref: 52
Section Heading: A Minimization Model Example
Keywords: surplus
AACSB: Analytic skills

94) Which of these statements is best?
A) An unbounded problem is also infeasible.
B) An infeasible problem is also unbounded.
C) An unbounded problem has feasible solutions.
D) An infeasible problem has unbounded solutions.
Answer: C
Diff: 2 Page Ref: 55
Section Heading: Irregular Types of Linear Programming Problems
Keywords: infeasible problem, infeasible solution
AACSB: Analytic skills

95) The optimal solution to a linear programming model that has been solved using the graphical approach
A) is typically located at the origin.
B) must be below and on the left side of all constraint lines.
C) must be above and the the right of all constraint lines.
D) is typically at some corner of the feasible region.
Answer: A
Diff: 1 Page Ref: 39
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: solution
AACSB: Analytic skills

96) Without satisfying the non-negativity constraint, a solution that satisfies all the other constraints of a linear programming problem is called
A) feasible.
B) infeasible.
C) semi-feasible.
D) optimal.
Answer: B
Diff: 3 Page Ref: 38
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphical solution, feasibility
AACSB: Analytic skills

97) An intern sets up a linear program to optimize the use of paper products in the men's washroom. The system of equations he develops is:
Max $2T + 3S + 4ST$
s.t $3T + 6S \leq 40$
$10T + 10S \leq 66$
$10T + 15S \leq 99$
His mentor studies the model, frowns, and admonishes the intern for violating which of the following properties of linear programming models?
A) Divisibility
B) Proportionality
C) Certainty
D) Additivity
Answer: D
Diff: 1 Page Ref: 56
Section Heading: Characteristics of Linear Programming Problems
Keywords: additivity
AACSB: Analytic skills

98) Which of the following is ***not*** a typical characteristic of a linear programming problem?
A) Restrictions exist.
B) A choice among alternatives is required.
C) The problem can be solved graphically.
D) The problem has an objective.
Answer: C
Diff: 1 Page Ref: 56
Section Heading: Characteristics of Linear Programming Problems
Keywords: graphical solution
AACSB: Analytic skills

99) The production manager for the Coory soft drink company is considering the production of two kinds of soft drinks: regular and diet. Two of her limited resources are production time (8 hours = 480 minutes per day) and syrup (1 of the ingredients), limited to 675 gallons per day. To produce a regular case requires 2 minutes and 5 gallons of syrup, while a diet case needs 4 minutes and 3 gallons of syrup. Profits for regular soft drink are $3.00 per case and profits for diet soft drink are $2.00 per case. Which of the following is not a feasible production combination?
A) 90R and 75D
B) 135R and 0D
C) 75R and 90D
D) 40R and 100D
Answer: C
Diff: 3 Page Ref: 36
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphical solution, feasibility
AACSB: Analytic skills

100) The production manager for the Coory soft drink company is considering the production of two kinds of soft drinks: regular and diet. Two of her limited resources are production time (8 hours = 480 minutes per day) and syrup (1 of the ingredients), limited to 675 gallons per day. To produce a regular case requires 2 minutes and 5 gallons of syrup, while a diet case needs 4 minutes and 3 gallons of syrup. Profits for regular soft drink are $3.00 per case and profits for diet soft drink are $2.00 per case. What are the optimal daily production quantities of each product and the optimal daily profit?
A) R = 75, D = 90, Z = $405
B) R = 135, D = 0, Z = $405
C) R = 90, D = 75, Z = $420
D) R = 40, D= 100, Z = $320
Answer: C
Diff: 3 Page Ref: 41
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphical solution
AACSB: Analytic skills

101) _____ is used to analyze changes in model parameters.
A) Optimal solution
B) Feasible solution
C) Sensitivity analysis
D) A slack variable
Answer: C
Diff: 2 Page Ref: 44
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: sensitivity analysis
AACSB: Analytic skills

102) Cully Furniture buys two products for resale: big shelves (B)and medium shelves (M). Each big shelf costs $500 and requires 100 cubic feet of storage space, and each medium shelf costs $300 and requires 90 cubic feet of storage space. The company has $75,000 to invest in shelves this week, and the warehouse has 18,000 cubic feet available for storage. Profit for each big shelf is $300 and for each medium shelf is $150. Which of the following is not a feasible purchase combination?
A) 100 big shelves and 82 medium shelves
B) 150 big shelves and 0 medium shelves
C) 100 big shelves and 100 medium shelves
D) 100 big shelves and 0 medium shelves
Answer: C
Diff: 3 Page Ref: 39
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: formulation, feasibility
AACSB: Analytic skills

103) Cully Furniture buys two products for resale: big shelves (B) and medium shelves (M). Each big shelf costs $500 and requires 100 cubic feet of storage space, and each medium shelf costs $300 and requires 90 cubic feet of storage space. The company has $75,000 to invest in shelves this week, and the warehouse has 18,000 cubic feet available for storage. Profit for each big shelf is $300 and for each medium shelf is $150. What is the maximum profit?
A) $35,000
B) $45,000
C) $55,000
D) $65,000
Answer: B
Diff: 3 Page Ref: 39
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphical solution
AACSB: Analytic skills

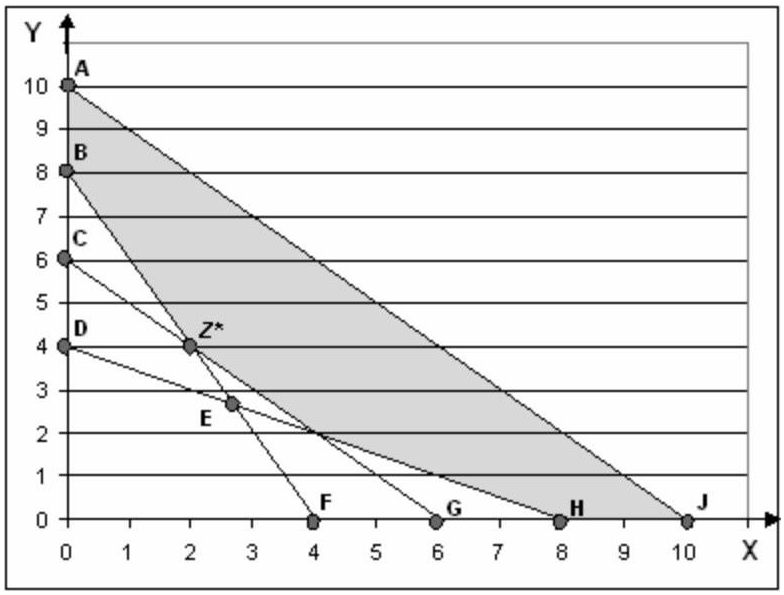
104) Cully Furniture buys two products for resale: big shelves (B) and medium shelves (M). Each big shelf costs $500 and requires 100 cubic feet of storage space, and each medium shelf costs $300 and requires 90 cubic feet of storage space. The company has $75,000 to invest in shelves this week, and the warehouse has 18,000 cubic feet available for storage. Profit for each big shelf is $300 and for each medium shelf is $150. In order to maximize profit, how many big shelves (B) and how many medium shelves (M) should be purchased?
A) B = 90, M = 75
B) B = 150, M = 0
C) B = 0, M = 200
D) B = 100, M = 100
Answer: B
Diff: 3 Page Ref: 34
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphical solution
AACSB: Analytic skills

105) The theoretical limit on the number of constraints that can be handled by a linear programming problem is:
A) 2
B) 3
C) 4
D) unlimited
Answer: D
Diff: 1 Page Ref: 31
Section Heading: Model Formulation
Keywords: constraints
AACSB: Analytic skills

106) Consider the following maximization problem.
MAX z = $x + 2y$
s.t.
$2x + 3y \leq 6$
$5x + 6y \leq 30$
$y \geq 1$

The optimal solution
A) occurs where $x = 4.67$ and $y = 1.11$.
B) occurs where $x = 0$ and $y = 2$.
C) occurs where $x = 6$ and $y = 0$.
D) results in an objective function value of 12.
Answer: B
Diff: 1 Page Ref: 42
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphical solution, extreme points, feasible region
AACSB: Analytic skills

The following is a graph of a linear programming problem. The feasible solution space is shaded, and the optimal solution is at the point labeled *Z**.



107) This linear programming problem is a(n)
A) maximization problem.
B) minimization problem.
C) irregular problem.
D) cannot tell from the information given
Answer: B
Diff: 1 Page Ref: 50
Section Heading: A Minimization Model Example
Keywords: graphical solution
AACSB: Analytic skills

108) The equation for constraint DH is:
A) $4X + 8Y \geq 32$
B) $8X + 4Y \geq 32$
C) $X + 2Y \geq 8$
D) $2X + Y \geq 8$
Answer: C
Diff: 3 Page Ref: 49
Section Heading: A Minimization Model Example
Keywords: graphical solution, constraints
AACSB: Analytic skills

109) Which of the following points is ***not*** feasible?
A) A
B) B
C) H
D) G
Answer: D
Diff: 1 Page Ref: 38
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphical solution, feasible point
AACSB: Analytic skills

110) Which line is represented by the equation $2X + Y \geq 8$?
A) BF
B) CG
C) DH
D) AJ
Answer: A
Diff: 2 Page Ref: 36
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphical solution, constraints
AACSB: Analytic skills

111) Which of the following constraints has a surplus greater than 0?
A) BF
B) CG
C) DH
D) AJ
Answer: C
Diff: 2 Page Ref: 36
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphical solution, constraints
AACSB: Analytic skills

112) The constraint AJ
A) is a binding constraint.
B) has no surplus.
C) does not contain feasible points.
D) contains the optimal solution.
Answer: B
Diff: 3 Page Ref: 36
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphical solution, constraints
AACSB: Analytic skills

113) Multiple optimal solutions can occur when the objective function is _____ a constraint line.
A) unequal to
B) equal to
C) perpendicular to
D) parallel to
Answer: D
Diff: 2 Page Ref: 54
Section Heading: Irregular Types of Linear Programming Problems
Keywords: irregular types of linear programming problems
AACSB: Analytic skills

114) A slack variable
A) is the amount by which the left side of a $\geq$ constraint is larger than the right side.
B) is the amount by which the left side of a $\leq$ constraint is smaller than the right side.
C) is the difference between the left and right side of a constraint.
D) exists for each variable in a linear programming problem.
Answer: B
Diff: 2 Page Ref: 44
Section Heading: Slack Variables
Keywords: slack variables
AACSB: Analytic skills

115) The production manager for the Coory soft drink company is considering the production of two kinds of soft drinks: regular and diet. Two of her limited resources are production time (8 hours = 480 minutes per day) and syrup (1 of the ingredients), limited to 675 gallons per day. To produce a regular case requires 2 minutes and 5 gallons of syrup, while a diet case needs 4 minutes and 3 gallons of syrup. Profits for regular soft drink are $3.00 per case and profits for diet soft drink are $2.00 per case. For the production combination of 135 cases of regular and 0 cases of diet soft drink, which resources will not be completely used?
A) only time
B) only syrup
C) time and syrup
D) neither time nor syrup
Answer: A
Diff: 2 Page Ref: 36
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: slack variables
AACSB: Analytic skills

116) Cully Furniture buys two products for resale: big shelves (B) and medium shelves (M). Each big shelf costs $500 and requires 100 cubic feet of storage space, and each medium shelf costs $300 and requires 90 cubic feet of storage space. The company has $75,000 to invest in shelves this week, and the warehouse has 18,000 cubic feet available for storage. Profit for each big shelf is $300 and for each medium shelf is $150. If the furniture company purchases no big shelves and 200 medium shelves, which of the two resources will be completely used (at capacity)?
A) investment money only
B) storage space only
C) investment money and storage space
D) neither investment money nor storage space
Answer: B
Diff: 2 Page Ref: 39
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: slack variables
AACSB: Analytic skills

117) Consider the following linear program:
MAX z = $5x + 3y$
s.t. $x - y \leq 6$
$x \leq 1$

The optimal solution
A) is infeasible.
B) occurs where $x = 1$ and $y = 0$.
C) occurs where $x = 0$ and $y = 1$.
D) results in an objective function value of 5.
Answer: D
Diff: 2 Page Ref: 39
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: slack variables
AACSB: Analytic skills

118) The first step in solving a graphical linear programming model is to
A) plot the model constraints as equations on the graph and indicate the feasible solution area.
B) plot the objective function and move this line out from the origin to locate the optimal solution point.
C) solve simultaneous equations at each corner point to find the solution values at each point.
D) determine which constraints are binding.
Answer: A
Diff: 1 Page Ref: 36
Section Heading: Graphical Solutions of Linear Programming Models
Keywords: graphic solution, steps for solving a graphical linear prog model
AACSB: Analytic skills

119) The optimal solution of a minimization problem is at the extreme point _____ the origin.
A) farthest from
B) closest to
C) exactly at
D) parallel to
Answer: B
Diff: 2 Page Ref: 50
Section Heading: A Minimization Model Example
Keywords: minimization problem
AACSB: Analytic skills

120) Multiple optimal solutions provide _____ flexibility to the decision maker.
A) greater
B) less
C) greater or equal
D) less or equal
Answer: A
Diff: 2 Page Ref: 54
Section Heading: Irregular Types of Linear Programming Problems
Keywords: irregular types of linear programming problems
AACSB: Analytic skills

121) Which of the following special cases ***does not*** require reformulation of the problem in order to obtain a solution?
A) unboundedness
B) infeasibility
C) alternate optimality
D) Each one of these cases requires reformulation.
Answer: C
Diff: 3 Page Ref: 54
Section Heading: Irregular Types of Linear Programming Problems
Keywords: irregular types of linear programming problems
AACSB: Analytic skills

122) If the feasible region for a linear programming problem is unbounded, then the solution to the corresponding linear programming problem is _____ unbounded.
A) always
B) sometimes
C) never
D) There is not enough information to complete this statement.
Answer: B
Diff: 3 Page Ref: 55
Section Heading: Irregular Types of Linear Programming Problems
Keywords: irregular types of linear programming problems, unboundedness
AACSB: Analytic skills