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Indicate whether the statement is true or false.

1. The objective function coefficients represent per unit objective function contributions from one unit of the associated decision variables.
   a. True
   b. False

2. The decisions in an optimization problem are often represented in a mathematical model by the symbols X1, X2, …, Xn.
   a. True
   b. False

3. An extreme point of the feasible region can include negative values of coordinates.
   a. True
   b. False

4. In mathematical programming formulations the objective function may contain cubic terms.
   a. True
   b. False

5. The best way of solving LP problems is to apply managerial intuition regarding the levels of decision variables.
   a. True
   b. False

6. The first step in formulating an LP model is determining the decision variables.
   a. True
   b. False

7. How much money should an individual withdraw each year from various retirement accounts is an example of a constraint.
   a. True
   b. False

8. Mathematical programming is an approach that involves determining how to allocate the resources in such a way as to maximize profits or minimize costs.
   a. True
   b. False

Indicate the answer choice that best completes the statement or answers the question.

9. Linear programming problems have
   a. linear objective functions, non-linear constraints.
   b. non-linear objective functions, non-linear constraints.
   c. non-linear objective functions, linear constraints.
   d. linear objective functions, linear constraints.

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10. A diet is being developed which must contain at least 100 mg of vitamin C. Two fruits are used in this diet. Bananas contain 30 mg of vitamin C and Apples contain 20 mg of vitamin C. The diet must contain at least 100 mg of vitamin C. Which of the following constraints reflects the relationship between Bananas, Apples and vitamin C?

a. 20 A + 30 B ≥ 100
b. 20 A + 30 B ≤ 100
c. 20 A + 30 B = 100
d. 20 A = 100

11. The second step in formulating a linear programming problem is

a. Identify any upper or lower bounds on the decision variables.
b. State the constraints as linear combinations of the decision variables.
c. Understand the problem.
d. Identify the decision variables.
e. State the objective function as a linear combination of the decision variables.

12. Limited resources are modeled in optimization problems as

a. an objective function.
b. constraints.
c. decision variables.
d. alternatives.

13. The desire to maximize profits is an example of a(n)

a. decision.
b. constraint.
c. objective.
d. parameter.

14. A facility produces two products. The labor constraint (in hours) is formulated as: $350x_1+300x_2 \leq 10{,}000$. The number 10,000 represents

a. a profit contribution of one unit of product 1.
b. one unit of product 1 uses 10,000 hours of labor.
c. there are 10,000 hours of labor available for use.
d. the problem has no objective function.

15. Which of the following is the general format of an objective function?

a. $f(X_1, X_2, ..., X_n) \leq b$
b. $f(X_1, X_2, ..., X_n) \geq b$
c. $f(X_1, X_2, ..., X_n) = b$
d. $f(X_1, X_2, ..., X_n)$

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16. A set of values for the decision variables that satisfy all the constraints and yields the best objective function value is
   a. a feasible solution.
   b. an optimal solution.
   c. a corner point solution.
   d. both (a) and (c).

17. A redundant constraint is one which
   a. plays no role in determining the feasible region of the problem.
   b. is parallel to the level curve.
   c. is added after the problem is already formulated.
   d. can only increase the objective function value.

18. When do alternate optimal solutions occur in LP models?
   a. When a binding constraint is parallel to a level curve.
   b. When a non-binding constraint is perpendicular to a level curve.
   c. When a constraint is parallel to another constraint.
   d. Alternate optimal solutions indicate an infeasible condition.

19. The following linear programming problem has been written to plan the production of two products. The company wants to maximize its profits.

X_1 = number of product 1 produced in each batch
X_2 = number of product 2 produced in each batch

MAX: $150 X_1 + 250 X_2$
Subject to: $2 X_1 + 5 X_2 \leq 200$
$3 X_1 + 7 X_2 \leq 175$
$X_1, X_2 \geq 0$

How much profit is earned per each unit of product 2 produced?
   a. 150
   b. 175
   c. 200
   d. 250

20. The constraint for resource 1 is $5 X_1 + 4 X_2 \leq 200$. If $X_1 = 20$, what it the maximum value for X_2?
   a. 20
   b. 25
   c. 40
   d. 50

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21. The constraint for resource 1 is 5 X_1 + 4 $X_2 \geq$ 200. If X_1 = 40 and X_2 = 20, how many additional units, if any, of resource 1 are employed above the minimum of 200?

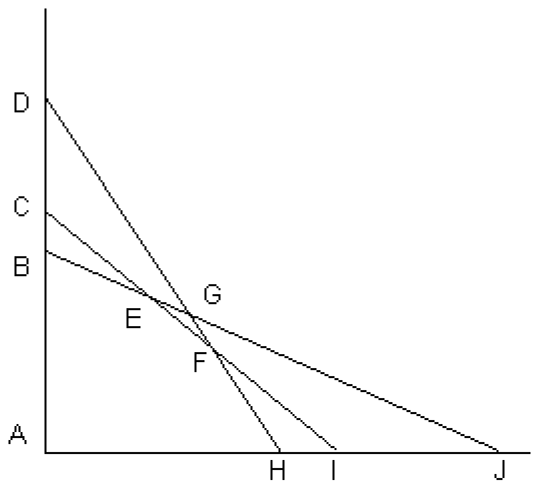
a. 0

b. 20

c. 40

d. 80

22. The following diagram shows the constraints for a LP model. Assume the point (0,0) satisfies constraint (B,J) but does not satisfy constraints (D,H) or (C,I). Which set of points on this diagram defines the feasible solution space?



a. A, B, E, F, H

b. A, D, G, J

c. F, G, H, J

d. I, F, G, J

23. The third step in formulating a linear programming problem is

a. Identify any upper or lower bounds on the decision variables.

b. State the constraints as linear combinations of the decision variables.

c. Understand the problem.

d. Identify the decision variables.

e. State the objective function as a linear combination of the decision variables.

24. The symbols X_1, Z_1, Dog are all examples of

a. decision variables.

b. constraints.

c. objectives.

d. parameters.

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25. The number of units to ship from Chicago to Memphis is an example of a(n)
    a. decision.
    b. constraint.
    c. objective.
    d. parameter.

26. The following linear programming problem has been written to plan the production of two products. The company wants to maximize its profits.

X_1 = number of product 1 produced in each batch
X_2 = number of product 2 produced in each batch

MAX: $150 X_1 + 250 X_2$
Subject to: $2 X_1 + 5 X_2 \leq 200$
$3 X_1 + 7 X_2 \leq 175$
$X_1, X_2 \geq 0$

How much profit is earned if the company produces 10 units of product 1 and 5 units of product 2?
    a. 750
    b. 2500
    c. 2750
    d. 3250

27. A manager has only 200 tons of plastic for his company. This is an example of a(n)
    a. decision.
    b. constraint.
    c. objective.
    d. parameter.

28. A facility produces two products and wants to maximize profit. The objective function to maximize is $z=350x_1+300x_2$. The number 350 means that:
    a. one unit of product 1 contributes $350 to the objective function
    b. one unit of product 1 contributes $300 to the objective function
    c. the problem is unbounded
    d. the problem has no constraints

29. Which of the following actions would expand the feasible region of an LP model?
    a. Loosening the constraints.
    b. Tightening the constraints.
    c. Multiplying each constraint by 2.
    d. Adding an additional constraint.

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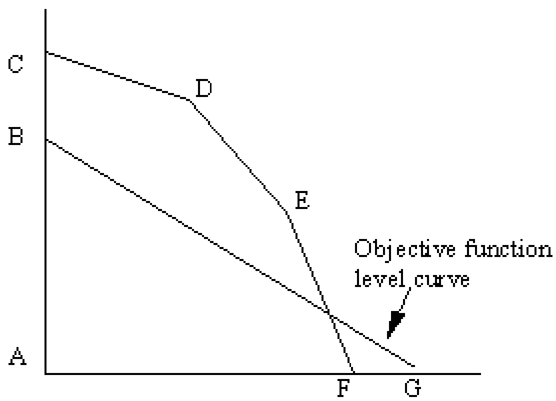
30. Most individuals manage their individual retirement accounts (IRAs) so they
    a. maximize the amount of money they withdraw.
    b. minimize the amount of taxes they must pay.
    c. retire with a minimum amount of money.
    d. leave all their money to the government.

31. For an infeasible problem, the feasible region:
    a. is an empty set
    b. has infinite number of feasible solutions
    c. has only one optimal solution
    d. is unbounded

32. This graph shows the feasible region (defined by points ACDEF) and objective function level curve (BG) for a maximization problem. Which point corresponds to the optimal solution to the problem?



    a. A
    b. B
    c. C
    d. D
    e. E

33. If constraints are added to an LP model the feasible solution space will generally
    a. decrease.
    b. increase.
    c. remain the same.
    d. become more feasible.

34. Mathematical programming is referred to as
    a. optimization.
    b. satisficing.
    c. approximation.
    d. simulation.

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35. What is the goal in optimization?
    a. Find the decision variable values that result in the best objective function and satisfy all constraints.
    b. Find the values of the decision variables that use all available resources.
    c. Find the values of the decision variables that satisfy all constraints.
    d. None of these.

36. The first step in formulating a linear programming problem is
    a. Identify any upper or lower bounds on the decision variables.
    b. State the constraints as linear combinations of the decision variables.
    c. Understand the problem.
    d. Identify the decision variables.
    e. State the objective function as a linear combination of the decision variables.

37. A facility produces two products. The labor constraint (in hours) is formulated as: $350x_1+300x_2 \leq 10{,}000$. The number 350 means that
    a. one unit of product 1 contributes $350 to the objective function.
    b. one unit of product 1 uses 350 hours of labor.
    c. the problem is unbounded.
    d. the problem has no objective function.

38. What are the three common elements of an optimization problem?
    a. objectives, resources, goals.
    b. decisions, constraints, an objective.
    c. decision variables, profit levels, costs.
    d. decisions, resource requirements, a profit function.

39. If there is no way to simultaneously satisfy all the constraints in an LP model the problem is said to be
    a. infeasible.
    b. open ended.
    c. multi-optimal.
    d. unbounded.

40. Suppose that the left side of the constraint cannot take a specific value, b. This can be expressed mathematically as
    a. $f(X_1, X_2, ..., X_n) \leq b$.
    b. $f(X_1, X_2, ..., X_n) \geq b$.
    c. $f(X_1, X_2, ..., X_n) = b$.
    d. $f(X_1, X_2, ..., X_n) \neq b$.

41. A linear formulation means that:
    a. the objective function and all constraints must be linear
    b. only the objective function must be linear
    c. at least one constraint must be linear
    d. no more than 50% of the constraints must be linear

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42. A company uses 4 pounds of resource 1 to make each unit of X_1 and 3 pounds of resource 1 to make each unit of X_2. There are only 150 pounds of resource 1 available. Which of the following constraints reflects the relationship between X_1, X_2 and resource 1?

a. $4 X_1 + 3 X_2 \geq 150$

b. $4 X_1 + 3 X_2 \leq 150$

c. $4 X_1 + 3 X_2 = 150$

d. $4 X_1 \leq 150$

43. A greater than or equal to constraint can be expressed mathematically as

a. $f(X_1, X_2, ..., X_n) \leq b$.

b. $f(X_1, X_2, ..., X_n) \geq b$.

c. $f(X_1, X_2, ..., X_n) = b$.

d. $f(X_1, X_2, ..., X_n) \neq b$.

44. Why do we study the graphical method of solving LP problems?

a. Lines are easy to draw on paper.

b. To develop an understanding of the linear programming strategy.

c. It is faster than computerized methods.

d. It provides better solutions than computerized methods.

45. A common objective when manufacturing printed circuit boards is

a. maximizing the number of holes drilled.

b. maximizing the number of drill bit changes.

c. minimizing the number of holes drilled.

d. minimizing the total distance the drill bit must be moved.

46. The constraint for resource 1 is $5 X_1 + 4 X_2 \geq 200$. If $X_2 = 20$, what it the minimum value for X_1?

a. 20

b. 24

c. 40

d. 50

47. Which of the following special conditions in an LP model represent potential errors in the mathematical formulation?

a. Alternate optimum solutions and infeasibility

b. Redundant constraints and unbounded solutions

c. Infeasibility and unbounded solutions

d. Alternate optimum solutions and redundant constraints

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48. The following linear programming problem has been written to plan the production of two products. The company wants to maximize its profits.

X_1 = number of product 1 produced in each batch
X_2 = number of product 2 produced in each batch

MAX: $150 X_1 + 250 X_2$
Subject to: $2 X_1 + 5 X_2 \leq 200$
$3 X_1 + 7 X_2 \leq 175$
$X_1, X_2 \geq 0$

How many units of resource one (the first constraint) are used if the company produces 10 units of product 1 and 5 units of product 2?

a. 45
b. 15
c. 55
d. 50

49. A common objective in the product mix problem is

a. maximizing cost.
b. maximizing profit.
c. minimizing production time.
d. maximizing production volume.

50. A company makes two products, X_1 and X_2. They require at least 20 of each be produced. Which set of lower bound constraints reflect this requirement?

a. $X_1 \geq 20, X_2 \geq 20$
b. $X_1 + X_2 \geq 20$
c. $X_1 + X_2 \geq 40$
d. $X_1 \geq 20, X_2 \geq 20, X_1 + X_2 \leq 40$

51. A production optimization problem has 4 decision variables and resource 1 limits how many of the 4 products can be produced. Which of the following constraints reflects this fact?

a. $f(X_1, X_2, X_3, X_4) \leq b_1$
b. $f(X_1, X_2, X_3, X_4) \geq b_1$
c. $f(X_1, X_2, X_3, X_4) = b_1$
d. $f(X_1, X_2, X_3, X_4) \neq b_1$

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52. The objective function for a LP model is 3 X_1 + 2 X_2. If X_1 = 20 and X_2 = 30, what is the value of the objective function?
   a. 0
   b. 50
   c. 60
   d. 120

53. Level curves are used when solving LP models using the graphical method. To what part of the model do level curves relate?
   a. constraints
   b. boundaries
   c. right hand sides
   d. objective function

54. Suppose that a constraint $2x_1+3x_2 \geq 900$ is binding. Then, a constraint $4x_1+6x_2 \geq 600$ is
   a. redundant.
   b. binding.
   c. limiting.
   d. infeasible.

55. When the objective function can increase without ever contacting a constraint the LP model is said to be
   a. infeasible.
   b. open ended.
   c. multi-optimal.
   d. unbounded.

56. If a problem has infinite number solutions, the objective function
   a. is parallel to one of the binding constraints.
   b. goes through exactly one corner point of the feasible region.
   c. cannot identify a feasible region.
   d. is infeasible.

57. What most motivates a business to be concerned with efficient use of their resources?
   a. Resources are limited and valuable.
   b. Efficient resource use increases business costs.
   c. Efficient resources use means more free time.
   d. Inefficient resource use means hiring more workers.

58. In a mathematical formulation of an optimization problem, the objective function is written as $z=2x_1+3x_2$. Then:
   a. x_1 is a decision variable
   b. x_2 is a parameter
   c. z needs to be maximized
   d. 2 is a first decision variable level

chapter 2

59. A mathematical programming application employed by a shipping company is most likely
   a. a product mix problem.
   b. a manufacturing problem.
   c. a routing and logistics problem.
   d. a financial planning problem.

60. The following linear programming problem has been written to plan the production of two products. The company wants to maximize its profits.

X_1 = number of product 1 produced in each batch
X_2 = number of product 2 produced in each batch

MAX: $150\ X_1 + 250\ X_2$
Subject to: $2\ X_1 + 5\ X_2 \leq 200$ − resource 1
$3\ X_1 + 7\ X_2 \leq 175$ − resource 2
$X_1, X_2 \geq 0$

How many units of resource 1 are consumed by each unit of product 1 produced?
   a. 1
   b. 2
   c. 3
   d. 5

61. A production optimization problem has 4 decision variables and a requirement that at least b_1 units of material 1 are consumed. Which of the following constraints reflects this fact?
   a. $f(X_1, X_2, X_3, X_4) \leq b_1$
   b. $f(X_1, X_2, X_3, X_4) \geq b_1$
   c. $f(X_1, X_2, X_3, X_4) = b_1$
   d. $f(X_1, X_2, X_3, X_4) \neq b_1$

62. The constraints of an LP model define the
   a. feasible region
   b. practical region
   c. maximal region
   d. opportunity region

63. The constraint for resource 1 is $5\ X_1 + 4\ X_2 \leq 200$. If $X_1 = 20$ and $X_2 = 5$, how much of resource 1 is unused?
   a. 0
   b. 80
   c. 100
   d. 200

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64. Some resources (i.e. meat and dairy products, pharmaceuticals, a can of paint) are perishable. This means that once a package (e.g. a can or a bag) is open the content should be used in its entirety. Which of the following constraints reflects this fact?

a. $f(X_1, X_2, X_3, X_4) \leq b_1$

b. $f(X_1, X_2, X_3, X_4) \geq b_1$

c. $f(X_1, X_2, X_3, X_4) = b_1$

d. $f(X_1, X_2, X_3, X_4) \neq b_1$

65. The following linear programming problem has been written to plan the production of two products. The company wants to maximize its profits.

X_1 = number of product 1 produced in each batch
X_2 = number of product 2 produced in each batch

MAX: $150 X_1 + 250 X_2$
Subject to: $2 X_1 + 5 X_2 \leq 200$
$3 X_1 + 7 X_2 \leq 175$
$X_1, X_2 \geq 0$

How many units of resource two (the second constraint) are unutilized if the company produces 10 units of product 1 and 5 units of product 2?

a. 110
b. 150
c. 155
d. 100

66. Which of the following fields of business analytics finds the optimal method of using resources to achieve the objectives of a business?

a. Simulation
b. Regression
c. Mathematical programming
d. Discriminant analysis

67. Retail companies try to find

a. the least costly method of transferring goods from warehouses to stores.
b. the most costly method of transferring goods from warehouses to stores.
c. the largest number of goods to transfer from warehouses to stores.
d. the least profitable method of transferring goods from warehouses to stores.

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68. Solve the following LP problem graphically by enumerating the corner points.

MIN: $8 X_1 + 5 X_2$

Subject to:
$6 X_1 + 7 X_2 \geq 84$
$X_1 \geq 4$
$X_2 \geq 6$
$X_1, X_2 \geq 0$

69. Jim's winery blends fine wines for local restaurants. One of his customers has requested a special blend of two burgundy wines, call them A and B. The customer wants 500 gallons of wine and it must contain at least 100 gallons of A and be at least 45% B. The customer also specified that the wine have an alcohol content of at least 12%. Wine A contains 14% alcohol while wine B contains 10%. The blend is sold for $10 per gallon. Wine A costs $4 per gallon and B costs $3 per gallon. The company wants to determine the blend that will meet the customer's requirements and maximize profit.

a. Formulate the LP model for this problem.

b. Solve the problem using the graphical method.

c. How much profit will Jim make on the order?

70. Solve the following LP problem graphically using level curves.

MAX: $5 X_1 + 6 X_2$

Subject to:
$3 X_1 + 8 X_2 \leq 48$
$12 X_1 + 11 X_2 \leq 132$
$2 X_1 + 3 X_2 \leq 24$
$X_1, X_2 \geq 0$

71. Solve the following LP problem graphically using level curves.

MAX: $5 X_1 + 3 X_2$

Subject to:
$2 X_1 - 1 X_2 \leq 2$
$6 X_1 + 6 X_2 \geq 12$
$1 X_1 + 3 X_2 \leq 5$
$X_1, X_2 \geq 0$

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72. The Happy Pet pet food company produces dog and cat food. Each food is comprised of meat, soybeans and fillers. The company earns a profit on each product but there is a limited demand for them. The pounds of ingredients required and available, profits and demand are summarized in the following table. The company wants to plan their product mix, in terms of the number of bags produced, in order to maximize profit.

Product	Profit per Bag ($)	Demand for product	Pounds of Meat per bag	Pounds of Soybeans per bag	Pounds of Filler per bag
Dog food	4	40	4	6	4
Cat food	5	30	5	3	10
	Material available (pounds)		100	120	160

a. Formulate the LP model for this problem.

b. Solve the problem using the graphical method.

73. Bob and Dora Sweet wish to start investing $1,000 each month. The Sweets are looking at five investment plans and wish to maximize their expected return each month. Assume interest rates remain fixed and once their investment plan is selected they do not change their mind. The investment plans offered are:

Fidelity	9.1% return per year
Optima	16.1% return per year
CaseWay	7.3% return per year
Safeway	5.6% return per year
National	12.3% return per year

Since Optima and National are riskier, the Sweets want a limit of 30% per month of their total investments placed in these two investments. Since Safeway and Fidelity are low risk, they want at least 40% of their investment total placed in these investments.

Formulate the LP model for this problem.

74. Solve the following LP problem graphically using level curves.

MAX: $7X_1 + 4X_2$

Subject to:

$2X_1 + X_2 \le 16$

$X_1 + X_2 \le 10$

$2X_1 + 5X_2 \le 40$

$X_1, X_2 \ge 0$

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75. The Byte computer company produces two models of computers, Plain and Fancy. It wants to plan how many computers to produce next month to maximize profits. Producing these computers requires wiring, assembly and inspection time. Each computer produces a certain level of profits but faces a limited demand. There are a limited number of wiring, assembly and inspection hours available next month. The data for this problem is summarized in the following table.

Computer Model	Profit per Model ($)	Maximum demand for product	Wiring Hours Required	Assembly Hours Required	Inspection Hours Required
Plain	30	80	0.4	0.5	0.2
Fancy	40	90	0.5	0.4	0.3
		Hours Available	50	50	22

a. Formulate the LP model for this problem.

b. Solve the problem using the graphical method.

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chapter 2

76. **Project 2.1**

Joey Koons runs a small custom computer parts company. As a sideline he offers customized and pre-built computer system packages. In preparation for the upcoming school year, he has decided to offer two custom computer packages tailored for what he believes are current student needs. System A provides a strong computing capability at a reasonable cost while System B provides a much more powerful computing capability, but at a higher cost. Joey has a fairly robust parts inventory but is concerned about his stock of those components that are common to each proposed system. A portion of his inventory, the item cost, and inventory level is provided in the table below.

Part	Type / Cost	On Hand	Type / Cost	On Hand	Type / Cost	On Hand	Type / Cost	On Hand
Processor	366 MHZ $175	40	500 MHZ $239	40	650 MHZ $500	40	700 MHZ $742	40
Memory	64 MB $95	40	96 MB $189	40	128 MB $250	15	256 MB $496	15
Hard Drive	4 GB $89	10	6 GB $133	25	13 GB $196	35	20 GB $350	50
Monitor	14 " $95	3	15 " $160	65	17 " $280	25	19 " $480	10
Graphics Card	Stock $100	100	3-D $250	15				
CD-ROM	24X $30	5	40X $58	25	72X $125	50	DVD $178	45
Sound Card	Stock $99	100	Sound II $150	50	Plat II $195	25		
Speakers	Stock $29	75	60 W $69	75	120 W $119	25		
Modem	Stock $99	125						
Mouse	Stock $39	125	Ergo $69	35				
Keyboard	Stock $59	100	Ergo $129	35				
Game Devices	Stock $165	25						

The requirements for each system are provided in the following table:

	System A	System B
Processor	366 MHZ	700 MHZ
Memory	64 MB	96 MB
Hard Drive	6 GB	20 GB
Monitor	15 "	15 "
Graphics Card	Stock	Stock
CD-ROM	40X	72X
Sound Card	Stock	Stock
Speakers	Stock	60W
Modem	Stock	Stock
Mouse	Stock	Stock
Keyboard	Stock	Stock

Each system requires assembly, testing and packaging. The requirements per system built and resources available are summarized in the table below.

	System A	System B	Total Hours Available
Assembly (hours)	2.25	2.50	200

77. Solve the following LP problem graphically using level curves.

MIN: $8\ X_1 + 12\ X_2$

Subject to:
$2\ X_1 + 1\ X_2 \geq 16$
$2\ X_1 + 3\ X_2 \geq 36$
$7\ X_1 + 8\ X_2 \geq 112$
$X_1, X_2 \geq 0$

78. Jones Furniture Company produces beds and desks for college students. The production process requires carpentry and varnishing. Each bed requires 6 hours of carpentry and 4 hour of varnishing. Each desk requires 4 hours of carpentry and 8 hours of varnishing. There are 36 hours of carpentry time and 40 hours of varnishing time available. Beds generate $30 of profit and desks generate $40 of profit. Demand for desks is limited so at most 8 will be produced.

a. Formulate the LP model for this problem.

b. Solve the problem using the graphical method.

79. Solve the following LP problem graphically by enumerating the corner points.

MAX: $4\ X_1 + 3\ X_2$

Subject to:
$6\ X_1 + 7\ X_2 \leq 84$
$X_1 \leq 10$
$X_2 \leq 8$
$X_1, X_2 \geq 0$

80. Solve the following LP problem graphically using level curves.

MIN: $5\ X_1 + 7\ X_2$

Subject to:
$4\ X_1 + 1\ X_2 \geq 16$
$6\ X_1 + 5\ X_2 \geq 60$
$5\ X_1 + 8\ X_2 \geq 80$
$X_1, X_2 \geq 0$

81. Solve the following LP problem graphically by enumerating the corner points.

MIN: $8\ X_1 + 3\ X_2$

Subject to:
$X_2 \geq 8$
$8\ X_1 + 5\ X_2 \geq 80$
$3\ X_1 + 5\ X_2 \geq 60$
$X_1, X_2 \geq 0$

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82. The Big Bang explosives company produces customized blasting compounds for use in the mining industry. The two ingredients for these explosives are agent A and agent B. Big Bang just received an order for 1400 pounds of explosive. Agent A costs $5 per pound and agent B costs $6 per pound. The customer's mixture must contain at least 20% agent A and at least 50% agent B. The company wants to provide the least expensive mixture which will satisfy the customers requirements.

a. Formulate the LP model for this problem.

b. Solve the problem using the graphical method.

83. Solve the following LP problem graphically by enumerating the corner points.

MAX:	$2X_1 + 7X_2$
Subject to:	$5X_1 + 9X_2 \leq 90$
	$9X_1 + 8X_2 \leq 144$
	$X_2 \leq 8$
	$X_1, X_2 \geq 0$

chapter 2

Answer Key

1. True

2. True

3. False

4. False

5. False

6. False

7. False

8. True

9. d

10. a

11. d

12. b

13. c

14. c

15. d

16. b

17. a

18. a

19. d

20. b

21. d

22. d

23. e

24. a

25. a

chapter 2

26. c

27. b

28. a

29. a

30. b

31. a

32. d

33. a

34. a

35. a

36. c

37. b

38. b

39. a

40. d

41. a

42. b

43. b

44. b

45. d

46. b

47. c

48. a

49. b

50. a

51. a

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52. d

53. d

54. a

55. d

56. a

57. a

58. a

59. c

60. b

61. b

62. a

63. b

64. c

65. a

66. c

67. a

68. Obj = 74.86
$X_1 = 4.00$
$X_2 = 8.57$

chapter 2

69.

a. Let X_1 = Gallons of wine A in mix
X_2 = Gallons of wine B in mix

MIN: $4 X_1 + 3 X_2$
Subject to: $X_1 + X_2 \geq 500$ (Total gallons of mix)
$X_1 \geq 100$ (X_1 minimum)
$X_2 \geq 225$ (X_2 minimum)
$.14 X_1 + .10 X_2 \geq 60$ (12% alcohol minimum)
$X_1, X_2 \geq 0$

b. Obj = 1750.00
$X_1 = 250.00$
$X_2 = 250.00$

c. $3250.00 total profit.

70. Obj = 57.43
$X_1 = 9.43$
$X_2 = 1.71$

71. Obj = 11.29
$X_1 = 1.57$
$X_2 = 1.14$

72.

a. Let X_1 = bags of Dog food to produce
X_2 = bags of Cat food to produce

MAX: $4 X_1 + 5 X_2$
Subject to: $4 X_1 + 5 X_2 \leq 100$ (meat)
$6 X_1 + 3 X_2 \leq 120$ (soybeans)
$4 X_1 + 10 X_2 \leq 160$ (filler)
$X_1 \leq 40$ (Dog food demand)
$X_2 \leq 30$ (Cat food demand)

b. Obj = 100.00
$X_1 = 10.00$
$X_2 = 12.00$

chapter 2

73.

MAX: $0.091X_1 + 0.161X_2 + 0.073X_3 + 0.056X_4 + 0.123X_5$

Subject to: $X_1 + X_2 + X_3 + X_4 + X_5 = 1000$

$X_2 + X_5 \leq 300$

$X_1 + X_4 \geq 400$

$X_1, X_2, X_3, X_4, X_5 \geq 0$

74. Obj = 58.00

$X_1 = 6.00$

$X_2 = 4.00$

75.

a. Let X_1 = Number of Plain computers produce

X_2 = Number of Fancy computers to produce

MAX: $30\ X_1 + 40\ X_2$

Subject to: $.4\ X_1 + .5\ X_2 \leq 50$ (wiring hours)

$.5\ X_1 + .4\ X_2 \leq 50$ (assembly hours)

$.2\ X_1 + .2\ X_2 \leq 22$ (inspection hours)

$X_1 \leq 80$ (Plain computers demand)

$X_2 \leq 90$ (Fancy computers demand)

$X_1, X_2 \geq 0$

b. Obj = 3975.00

$X_1 = 12.50$

$X_2 = 90.00$

76. The cost to make System A is $1007.00 while the cost to make System B is $1992.00. The inventory levels for hard drives limit System A production to 25 while the 700 MHZ processor inventory limits System B production to 40. The common monitor is the 15 " unit and its inventory limits total production to 60. Coupled with the assembly, testing, and packaging constraints, the LP formulation is:

Maximize	$\$243\ X_1 + \$333\ X_2$	
	$2.25\ X_1 + 2.50\ X_2 \leq 200$	{assembly hours}
	$1.25\ X_1 + 2.00\ X_2 \leq 150$	{testing hours}
	$0.50\ X_1 + 0.50\ X_2 \leq 75$	{packaging hours}
	$X_1 \leq 25$	{hard drive limits}
	$X_2 \leq 40$	{processor limits}
	$X_1 + X_2 \leq 60$	{monitor limits}
	$X_1, X_2 \geq 0$	

Build 20 System A and 40 System B, Total profit $18,180.

chapter 2

77. Alternate optima solutions exist between the corner points. The value of the objective function for both corner points is 144.00.

$X_1 = 9.6$	$X_1 = 18$
$X_2 = 5.6$	$X_2 = 0$

78.

a. Let X_1 = Number of Beds to produce
X_2 = Number of Desks to produce

MAX: $30\ X_1 + 40\ X_2$

Subject to:
$6\ X_1 + 4\ X_2 \leq 36$ (carpentry)
$4\ X_1 + 8\ X_2 \leq 40$ (varnishing)
$X_2 \leq 8$ (demand for X_2)
$X_1, X_2 \geq 0$

b. Obj = 240.00
$X_1 = 4.00$
$X_2 = 3.00$

79. Obj = 50.29
$X_1 = 10.00$
$X_2 = 3.43$

80. Obj = 72.17
$X_1 = 3.48$
$X_2 = 7.83$

81. Obj = 48.00
$X_1 = 0.00$
$X_2 = 16.00$

chapter 2

82.

a. Let X_1 = Pounds of agent A used
X_2 = Pounds of agent B used

MIN: $5 X_1 + 6 X_2$

Subject to: $X_1 \geq 280$ (Agent A requirement)
$X_2 \geq 700$ (Agent B requirement)
$X_1 + X_2 = 1400$ (Total pounds)
$X_1, X_2 \geq 0$

b. Obj = 7700.00
X_1 = 700.00
X_2 = 700.00

83. Obj = 63.20
X_1 = 3.6
X_2 = 8