Managerial Decision Modeling w/ Spreadsheets, **3e (Balakrishnan/Render/Stair)**
Chapter 2 Linear Programming Models: Graphical and Computer Methods

2.1 Chapter Questions

1) Consider the following linear programming model:

Max $X_1^2 + X_2 + 3X_3$

Subject to:

$X_1 + X_2 \leq 3$

$X_1 + X_2 \leq 1$

$X_1, X_2 \geq 0$

This problem violates which of the following assumptions?

A) certainty
B) proportionality
C) divisibility
D) linearity
E) integrality

Answer: D
Page Ref: 22
Topic: Developing a Linear Programming Model
Difficulty: Easy

2) Consider the following linear programming model:

Min $2X_1 + 3X_2$

Subject to:

$X_1 + 2X_2 \leq 1$

$X_2 \leq 1$

$X_1 \geq 0, X_2 \leq 0$

This problem violates which of the following assumptions?

A) additivity
B) divisibility
C) non-negativity
D) proportionality
E) linearity

Answer: C
Page Ref: 21
Topic: Developing a Linear Programming Model
Difficulty: Easy

3) A redundant constraint is eliminated from a linear programming model. What effect will this have on the optimal solution?
A) feasible region will decrease in size
B) feasible region will increase in size
C) a decrease in objective function value
D) an increase in objective function value
E) no change
Answer: E
Page Ref: 36
Topic: Special Situations in Solving Linear Programming Problems
Difficulty: Moderate

4) Consider the following linear programming model:
Max $2X_1 + 3X_2$
Subject to:
$X_1 \leq 2$
$X_2 \leq 3$
$X_1 \leq 1$
$X_1, X_2 \geq 0$
This linear programming model has:
A) alternate optimal solutions
B) unbounded solution
C) redundant constraint
D) infeasible solution
E) non-negative solution
Answer: C
Page Ref: 36
Topic: Special Situations in Solving Linear Programming Problems
Difficulty: Moderate

5) A linear programming model generates an optimal solution with fractional values. This solution satisfies which basic linear programming assumption?
A) certainty
B) divisibility
C) proportionality
D) linearity
E) non-negativity
Answer: B
Page Ref: 22
Topic: Developing a Linear Programming Model
Difficulty: Moderate

6) Consider the following linear programming model:

Max $X_1 + X_2$

Subject to:

$X_1 + X_2 \leq 2$

$X_1 \geq 1$

$X_2 \geq 3$

$X_1, X_2 \geq 0$

This linear programming model has:

A) alternate optimal solution

B) unbounded solution

C) redundant constraint

D) infeasible solution

E) unique solution

Answer: D

Page Ref: 37

Topic: Special Situations in Solving Linear Programming Problems

Difficulty: Easy

7) Consider the following linear programming model

Max $2X_1 + 3X_2$

Subject to:

$X_1 + X_2 \geq 4$

$X_1 \geq 2$

$X_1, X_2 \geq 0$

This linear programming model has:

A) redundant constraints

B) infeasible solution

C) alternate optimal solution

D) unique solution

E) unbounded solution

Answer: E

Page Ref: 39

Topic: Special Situations in Solving Linear Programming Problems

Difficulty: Easy

8) Consider the following linear programming model

Min $\quad 2X_1 + 3X_2$

Subject to:

$X_1 + X_2 \geq 4$

$X_1 \geq 2$

$X_1, X_2 \geq 0$

This linear programming model has:

A) unique optimal solution

B) unbounded solution

C) infeasible solution

D) alternate optimal solution

E) redundant constraints

Answer: A

Page Ref: 38

Topic: Special Situations in Solving Linear Programming Problems

Difficulty: Easy

Figure 1:

	A	B	C	D	E
1					
2		X_1	X_2		
3	Number to Make:				OBJ. FN. VALUE:
4					
5	Unit profit:	$4	$3		
6					
7	Constraints:			Used	Available
8	1	3	5		40
9	2	12	10		120
10	3	1	0		15

Figure 1 demonstrates an Excel spreadsheet that is used to model the following linear programming problem:

Max: $4X_1 + 3X_2$

Subject to:

$3X_1 + 5X_2 \le 40$

$12X_1 + 10X_2 \le 120$

$X_1 \ge 15$

$X_1, X_2 \ge 0$

Note: Cells B3 and C3 are the designated cells for the optimal values of X_1 and X_2, respectively, while cell E4 is the designated cell for the objective function value. Cells D8:D10 designate the left-hand side of the constraints.

9) Refer to Figure 1. What formula should be entered in cell E4 to compute total profitability?
A) =SUMPRODUCT(B5:C5,B2:C2)
B) =SUM(B3:C3)
C) =B2*B5 + C2*C5
D) =SUMPRODUCT(B5:C5,E8:E10)
E) =B3*B5 + C3*C5
Answer: E
Page Ref: 42
Topic: Setting Up and Solving Linear Programming Problems Using Excel's Solver
Difficulty: Easy

10) Refer to Figure 1. What formula should be entered in cell D9 to compute the amount of resource 2 that is consumed?
A) =B9*D9 + C9*D9
B) =SUMPRODUCT(B2:C2,B9:C9)
C) =SUM(B9:C9)
D) =SUMPRODUCT(B3:C3,B9:C9)
E) =SUMPRODUCT(B9:C9,B5:C5)
Answer: D
Page Ref: 42
Topic: Setting Up and Solving Linear Programming Problems Using Excel's Solver
Difficulty: Easy

11) Refer to Figure 1. Which cell(s) are the *Changing Cells* as designated by "Solver"?
A) E4
B) B2:C2
C) B3:C3
D) D8:D10
E) B5:C5
Answer: C
Page Ref: 42
Topic: Setting Up and Solving Linear Programming Problems Using Excel's Solver
Difficulty: Easy

12) Refer to Figure 1. What cell reference designates the *Target Cell* in "Solver"?
A) E4
B) B3
C) C3
D) D8:D10
E) E8:E10
Answer: A
Page Ref: 42
Topic: Setting Up and Solving Linear Programming Problems Using Excel's Solver
Difficulty: Easy

13) The constraint for a given resource is given by the following equation:
$2X_1 + 3X_2 \leq 20$
If $X_1 = 5$ and $X_2 = 3$, how many units of this resource are unused?
A) 20
B) 19
C) 1
D) 0
E) 17
Answer: C
Page Ref: 49
Topic: Setting Up and Solving Linear Programming Problems Using Excel's Solver
Difficulty: Easy

14) The constraint for a given resource is given by the following equation:
$2X_1 + 3X_2 \geq 20$
If $X_1 = 5$ and $X_2 = 4$ how many units of this resource are unused?
A) 20
B) 2
C) 22
D) 0
E) 9
Answer: B
Page Ref: 49
Topic: Setting Up and Solving Linear Programming Problems Using Excel's Solver
Difficulty: Easy

15) "Solver" typically generates which of the following report(s)?
A) answer report
B) sensitivity analysis report
C) limits report
D) A and B only
E) A, B, and C
Answer: E
Page Ref: 48
Topic: Setting Up and Solving Linear Programming Problems Using Excel's Solver
Difficulty: Easy

16) ________ systematically examines corner points, using algebraic steps, until an optimal solution is found.
A) The graphical approach
B) The simplex method
C) Karmarkar's method
D) Trial-and-error
E) none of the above
Answer: B
Page Ref: 52
Topic: Algebraic Solution Procedures for Linear Programming Problems
Difficulty: Moderate

17) ________ follows a path of points inside the feasible region to find an optimal solution.
A) The graphical approach
B) The simplex method
C) Karmarkar's method
D) Trial-and-error
E) none of the above
Answer: C
Page Ref: 52
Topic: Algebraic Solution Procedures for Linear Programming Problems
Difficulty: Moderate

18) If a linear programming problem has alternate optimal solutions, then the objective function value will vary according to each alternate optimal point.
Answer: FALSE
Page Ref: 38
Topic: Special Situations in Solving Linear Programming Problems
Difficulty: Moderate

19) Unbounded linear programming problems typically arise as a result of misformulation.
Answer: TRUE
Page Ref: 39
Topic: Special Situations in Solving Linear Programming Problems
Difficulty: Moderate

20) If an isoprofit line can be moved outward such that the objective function value can be made to reach infinity, then this problem has an unbounded solution.
Answer: TRUE
Page Ref: 39
Topic: Special Situations in Solving Linear Programming Problems
Difficulty: Easy

21) If a redundant constraint is eliminated from a linear programming model, this will have an impact on the optimal solution.
Answer: FALSE
Page Ref: 36
Topic: Special Situations in Solving Linear Programming Problems
Difficulty: Moderate

22) A linear programming model has the following two constraints: $X_1 \geq 3$ and $X_1 \geq 4$. This model has a redundant constraint.
Answer: TRUE
Page Ref: 36
Topic: Special Situations in Solving Linear Programming Problems
Difficulty: Easy

23) A linear programming problem has the following two constraints: $X_1 \leq 20$ and $X_1 \geq 25$. This problem is infeasible.
Answer: TRUE
Page Ref: 37
Topic: Special Situations in Solving Linear Programming Problems
Difficulty: Easy

24) It is possible to solve graphically a linear programming model with 4 decision variables.
Answer: FALSE
Page Ref: 26
Topic: Graphical Solution to a Linear Programming Model
Difficulty: Moderate

25) An isoprofit line represents a line whereby all profits are the same along the line.
Answer: TRUE
Page Ref: 29
Topic: Graphical Solution to a Linear Programming Model
Difficulty: Easy

26) Linear programming models typically do not have coefficients (i.e., objective function or constraint coefficients) that assume random values.
Answer: TRUE
Page Ref: 22
Topic: Developing a Linear Programming Model
Difficulty: Moderate

27) It is possible for a linear programming model to yield an optimal solution that has fractional values.
Answer: TRUE
Page Ref: 22
Topic: Developing a Linear Programming Model
Difficulty: Easy

28) A linear programming model has the following objective function:
Max: $X_1^2 + 3X_2 + 4X_3$. This model violates a key linear programming model assumption.
Answer: TRUE
Page Ref: 22
Topic: Developing a Linear Programming Model
Difficulty: Easy

29) In a product mix problem, a decision maker has limited availability of weekly labor hours. Labor hours would most likely constitute a decision variable rather than a constraint.
Answer: FALSE
Page Ref: 24
Topic: Formulating a Linear Programming Model
Difficulty: Easy

30) When using Solver, the parameter *Changing Cells* is typically associated with the objective function.
Answer: FALSE
Page Ref: 45
Topic: Setting Up and Solving Linear Programming Problems Using Excel's Solver
Difficulty: Easy

31) The simplex method is an algebraic solution procedure for a linear programming problem.
Answer: TRUE
Page Ref: 52
Topic: Algebraic Solution Procedures for Linear Programming Problems
Difficulty: Easy

32) Karmarkar's method is synonymous with the corner point method.
Answer: FALSE
Page Ref: 52
Topic: Algebraic Solution Procedures for Linear Programming Problems
Difficulty: Moderate

2.2 Excel Problems

1) Consider the following linear programming problem.

Maximize $6X_1 + 4X_2$

Subject to:

$X_1 + 2X_2 \leq 16$

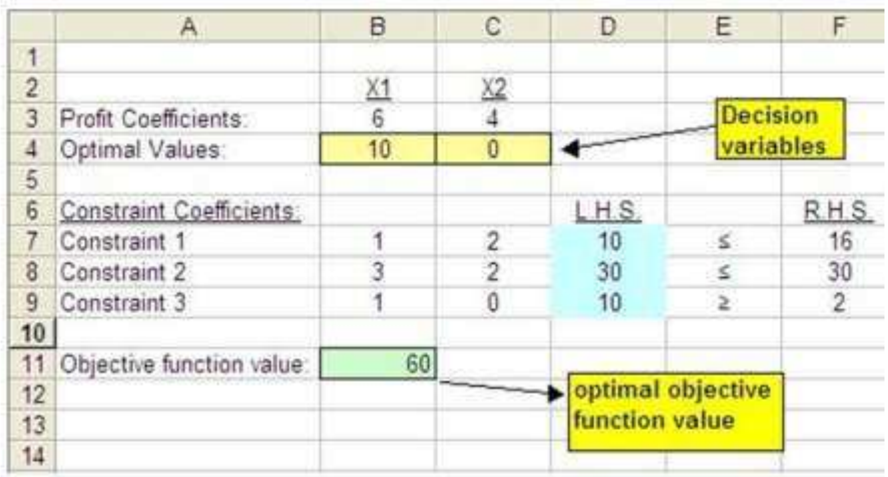
$3X_1 + 2X_2 \leq 24$

$X_1 \geq 2$

$X_1, X_2 \geq 0$

Use Solver to find the optimal values of X_1 and X_2.

Answer:



	A	B	C	D	E	F
1						
2		X1	X2			
3	Profit Coefficients:	6	4			
4	Optimal Values:	10	0			
5						
6	Constraint Coefficients:			L.H.S.		R.H.S.
7	Constraint 1	1	2	10	≤	16
8	Constraint 2	3	2	30	≤	30
9	Constraint 3	1	0	10	≥	2
10						
11	Objective function value:	60				
12						
13						
14						

2) Consider the following linear programming problem.

Maximize $5X_1 + 3X_2$

Subject to: $X_1 + X_2 \leq 20$

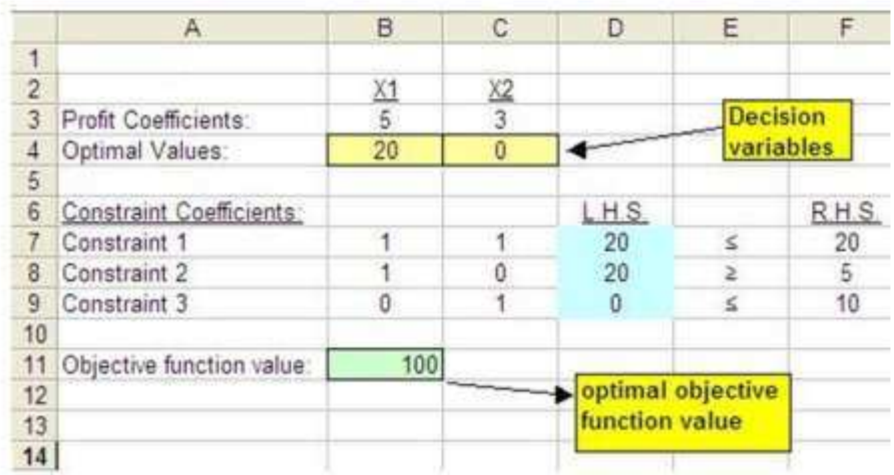
$X_1 \geq 5$

$X_2 \leq 10$

$X_1, X_2 \geq 0$

Use Solver to find the optimal values of X_1 and X_2.

Answer:



	A	B	C	D	E	F
1						
2		X1	X2			
3	Profit Coefficients:	5	3			
4	Optimal Values:	20	0			
5						
6	Constraint Coefficients:			L.H.S.		R.H.S.
7	Constraint 1	1	1	20	≤	20
8	Constraint 2	1	0	20	≥	5
9	Constraint 3	0	1	0	≤	10
10						
11	Objective function value:	100				
12						
13						
14						

3) Consider the following linear programming problem.

Minimize $3X_1 + 2X_2$

Subject to:

$X_1 + X_2 \geq 10$

$X_1 + X_2 \leq 20$

$X_2 \leq 10$

$X_1 \leq 18$

$X_1, X_2 \geq 0$

Use Solver to find the optimal values of X_1 and X_2.

Answer:

	A	B	C	D	E	F
1						
2		X1	X2			
3	Cost Coefficients:	3	2		Decision	
4	Optimal Values:	0	10		variables	
5						
6	Constraint Coefficients:			L.H.S.		R.H.S.
7	Constraint 1	1	1	10	≥	10
8	Constraint 2	1	1	10	≤	20
9	Constraint 3	0	1	10	≤	10
10	Constraint 4	1	0	0	≤	18
11						
12						
13	Objective function value	20				
14				optimal objective		
15				function value		
16						

4) Consider the following linear programming problem.

Minimize $\quad 6X_1 + 3X_2$

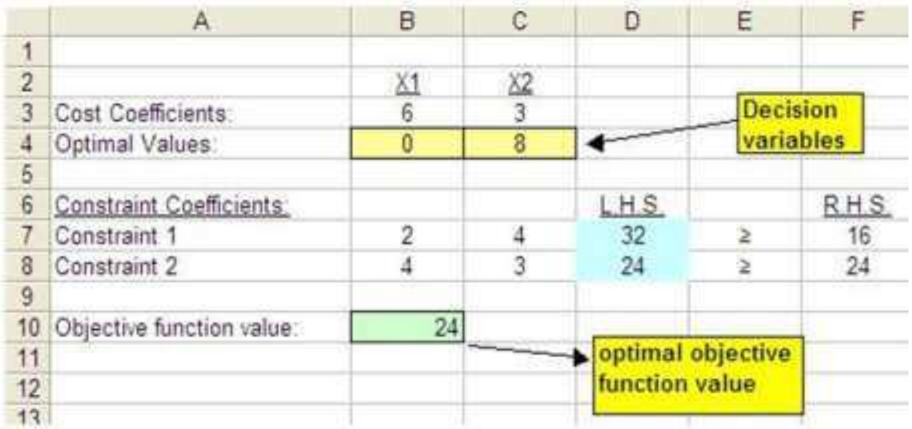
Subject to:

$2X_1 + 4X_2 \geq 16 \qquad 4X_1 + 3X_2 \geq 24$

$X_1, X_2 \geq 0$

Use Solver to find the optimal values of X_1 and X_2.

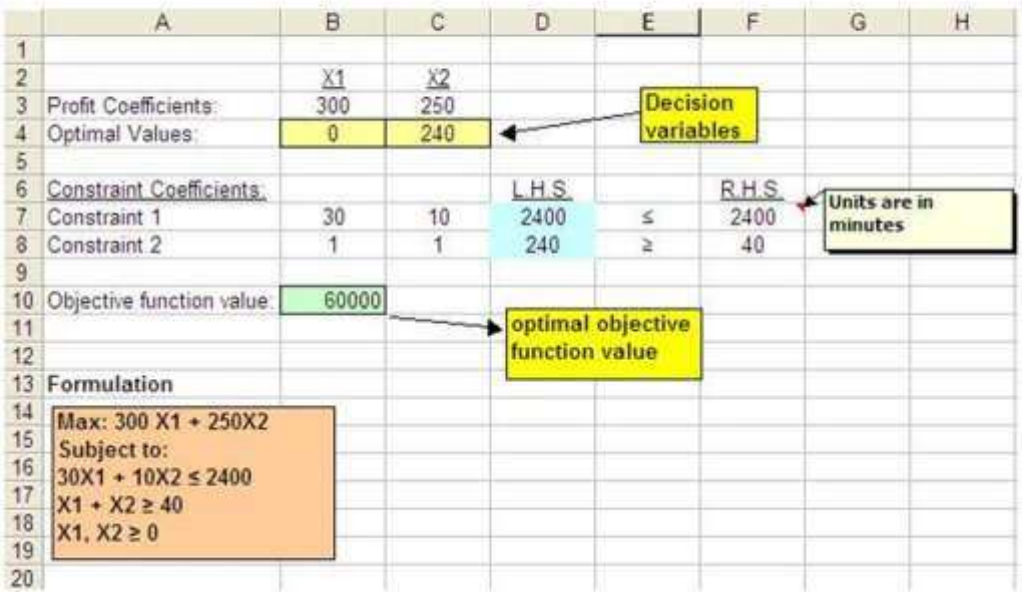
Answer:



	A	B	C	D	E	F
1						
2		X1	X2			
3	Cost Coefficients:	6	3		Decision variables	
4	Optimal Values:	0	8			
5						
6	Constraint Coefficients:			L.H.S.		R.H.S.
7	Constraint 1	2	4	32	≥	16
8	Constraint 2	4	3	24	≥	24
9						
10	Objective function value:	24				
11				optimal objective function value		
12						
13						

5) A computer retail store sells two types of flat screen monitors: 17 inches and 19 inches, with a profit contribution of $300 and $250, respectively. The monitors are ordered each week from an outside supplier. As an added feature, the retail store installs on each monitor a privacy filter that narrows the viewing angle so that only persons sitting directly in front of the monitor are able to see on-screen data. Each 19" monitor consumes about 30 minutes of installation time, while each 17" monitor requires about 10 minutes of installation time. The retail store has approximately 40 hours of labor time available each week. The total combined demand for both monitors is at least 40 monitors each week. How many units of each monitor should the retail store order each week to maximize its weekly profits and meet its weekly demand?

Answer:



	A	B	C	D	E	F	G	H
1								
2		X1	X2					
3	Profit Coefficients:	300	250		Decision			
4	Optimal Values:	0	240		variables			
5								
6	Constraint Coefficients:			L.H.S.		R.H.S.	Units are in	
7	Constraint 1	30	10	2400	≤	2400	minutes	
8	Constraint 2	1	1	240	≥	40		
9								
10	Objective function value:	60000						
11				optimal objective				
12				function value				
13	Formulation							

Max: 300 X1 + 250X2
Subject to:
30X1 + 10X2 ≤ 2400
X1 + X2 ≥ 40
X1, X2 ≥ 0

6) Creatine and protein are common supplements in most bodybuilding products. Bodyworks, a nutrition health store, makes a powder supplement that combines creatine and protein from two ingredients (X_1 and X_2). Ingredient X_1 provides 20 grams of protein and 5 grams of creatine per pound. Ingredient X_2 provides 15 grams of protein and 3 grams of creatine per pound. Ingredients X_1 and X_2 cost Bodyworks \$5 and \$7 per pound, respectively. Bodyworks wants its supplement to contain at least 30 grams of protein and 10 grams of creatine per pound and be produced at the least cost.

Determine what combination will maximize profits.

Answer:

	A	B	C	D	E	F
1						
2		X1	X2			
3	Cost Coefficients:	5	7		Decision variables	
4	Optimal Values:	2	0			
5						
6	Constraint Coefficients:			L.H.S.		R.H.S.
7	Constraint 1	20	15	40	≥	30
8	Constraint 2	5	3	10	≥	10
9						
10	Objective function value:	10				
11				optimal objective function value		
12						
13	**Formulation**					
14	**Min 5X1 + 7X2**					
15	**Subject to:**					
16	**20X1 + 15X2 ≥ 30**					
17	**5X1 + 3X2 ≥ 10**					
18	**X1, X2 ≥ 0**					
19						
20						

7) A furniture store produces beds and desks for college students. The production process requires assembly and painting. Each bed requires 6 hours of assembly and 4 hours of painting. Each desk requires 4 hours of assembly and 8 hours of painting. There are 40 hours of assembly time and 45 hours of painting time available each week. Each bed generates $35 of profit and each desk generates $45 of profit. As a result of a labor strike, the furniture store is limited to producing at most 8 beds each week. Determine how many beds and desks should be produced each week to maximize weekly profits.

Answer:

	A	B	C	D	E	F
1						
2		Beds	Desks			
3	Profit Coefficients:	$ 35.00	$ 45.00		Decision	
4	Optimal Values:	4.375	3.4375		variables	
5						
6	Constraint Coefficients:			L.H.S.		R.H.S.
7	Constraint 1	6	4	40	≤	40
8	Constraint 2	4	8	45	≤	45
9	Constraint 3	1	0	4.375	≤	8
10						
11						
12	Objective function value:	$ 307.81				
13				optimal objective		
14				function value		
15	**Formulation**					
16	**Min 35 Beds + 45 Chairs**					
17	**Subject to:**					
18	**6 Beds + 4 Chairs ≤ 40 (1)**					
19	**4 Beds + 8 Chairs ≤ 45 (2)**					
20	**Beds ≤ 8 (3)**					
21	**Beds, Chairs ≥ 0**					
22						

8) An ice cream shop sells single scoop ice cream cones that come in three flavors: chocolate only, vanilla only, and chocolate-vanilla twist. The cones are prepackaged and sold to a supermarket daily. The ingredients used along with the minimum demand of each flavor are shown as follows:

		Ice Cream Flavor	
	Chocolate	Vanilla	Chocolate-Vanilla
Ingredient:			
Chocolate	4 oz.	0 oz.	3 oz.
Vanilla	0 oz.	4 oz.	2 oz.
Min daily demand:	20 scoops	15 scoops	10 scoops

Each day, 40 pounds of chocolate and 38 pounds of vanilla are supplied to the ice cream shop from an outside vendor. The chocolate, vanilla, and chocolate-vanilla twist each yield a profit of $2.00, $2.50, and $3.00 per cone, respectively. How many chocolate, vanilla, and chocolate-vanilla twist cones must prepackage daily to maximize daily profits?

Answer:

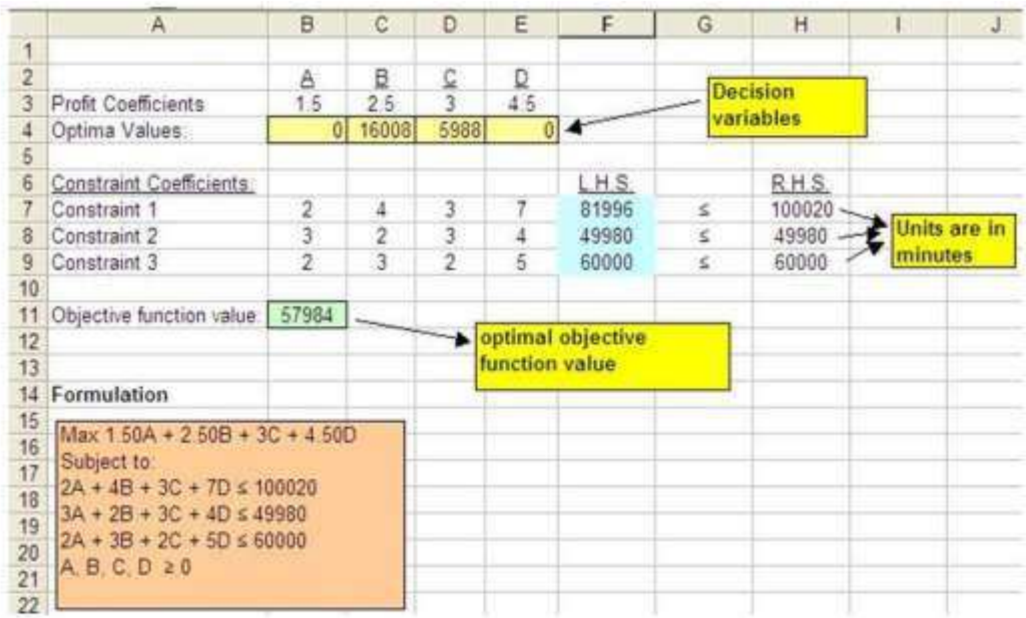
	A	B	C	D	E	F	G
1							
2		Chocolate	Vanilla	Chocolate_Vanilla			
3		X1	X2	X3			Decision
4	Profit Coefficients:	2	2.5	3			variables
5	Optimal Values:	20	58.66667	186.6666667			
6							
7	Constraint Coefficients:				L.H.S.		R.H.S.
8	Constraint 1	4	0	3	640	≤	640
9	Constraint 2	0	4	2	608	≤	608
10	Constraint 3	1	0	0	20	≥	20
11	Constraint 4	0	1	0	58.66667	≥	15
12	Constraint 5	0	0	1	186.6667	≥	10
13							
14	Objective function value:	746.6667					
15				optimal objective			
16				function value			
17	**Formulation**						
18	Max 2X1 + 2.50X2 + 3X3						
19	Subject to:						
20	4X1 + 3X3 ≤ 640						
21	4X2 + 2X3 ≤ 608						
22	X1 ≥ 20						
23	X2 ≥ 15						
24	X3 ≥ 10						
25	X1, X2, X3 ≥ 0						
26							

9) A company manufactures four products A, B, C, and D that must go through assembly, polishing, and packing before being shipped to a wholesaler. For each product, the time required for these operations is shown below (in minutes) as is the profit per unit sold.

Product	Assembly	Polish	Pack	Profit ($)
A	2	3	2	1.50
B	4	2	3	2.50
C	3	3	2	3.00
D	7	4	5	4.50

The company estimates that each year they have 1667 hours of assembly time, 833 hours of polishing time and 1000 hours of packing time available. How many of each product should the company make per year to maximize its yearly profit?

Answer:



	A	B	C	D	E	F	G	H	I	J
1										
2		A	B	C	D					
3	Profit Coefficients	1.5	2.5	3	4.5					
4	Optima Values	0	16008	5988	0					
5										
6	Constraint Coefficients					L.H.S.		R.H.S.		
7	Constraint 1	2	4	3	7	81996	≤	100020		
8	Constraint 2	3	2	3	4	49980	≤	49980		
9	Constraint 3	2	3	2	5	60000	≤	60000		
10										
11	Objective function value	57984								
12										
13										
14	Formulation									

10) Suppose that a farmer has 5 acres of land that can be planted with either wheat, corn, or a combination of the two. To ensure a healthy crop, a fertilizer and an insecticide must be applied at the beginning of the season before harvesting. The farmer currently has 100 pounds of the fertilizer and 150 pounds of the insecticide at the beginning of the season. Each acre of wheat planted requires 10 pounds of the fertilizer and 12 pounds of the insecticide. Each acre of corn planted requires 13 pounds of the fertilizer and 11 pounds of the insecticide. Each acre of wheat harvested yields a profit of $600, while each acre of corn harvested yields $750 in profit. What is the optimal allocation for the crops that maximizes the farmer's profit?

Answer:

	A	B	C	D	E	F
1						
2		Wheat (W)	Corn(C)			
3	Profit Coefficients:	600	750		Decision	
4	Optimal Values:	0	5		variables	
5						
6	Constraint Coefficients:			L.H.S.		R.H.S.
7	Constraint 1	1	1	5	≤	5
8	Constraint 2	10	13	65	≤	100
9	Constraint 3	12	11	55	≤	150
10						
11	Objective function value:	3750				
12				optimal objective		
13				function value		
14	**Formulation**					
15	Max 600W + 750C					
16	Subject to:					
17	W + C ≤ 5					
18	10W + 13C ≤ 100					
19	12W + 11C ≤ 150					
20	W, C ≥ 0					
21						

11) A carpenter makes tables and chairs. Each table can be sold for a profit of $50 and each chair for a profit of $30. The carpenter works a maximum of 40 hours per week and spends 5 hours to make a table and 2 hours to make a chair. Customer demand requires that he makes at least twice as many chairs as tables. The carpenter stores the finished products in his garage, and there is room for a maximum of 6 furniture pieces each week. Determine the carpenter's optimal production mix.

Answer:

	A	B	C	D	E	F
1						
2		Tables (T)	Chairs (C)			
3	Profit Coefficients:	$ 50.00	$ 30.00		Decision	
4	Optimal Values:	6	0		variables	
5						
6	Constraint Coefficients:			L.H.S.		R.H.S.
7	Constraint 1	5	2	30	≤	40
8	Constraint 2	2	-1	12	≥	0
9	Constraint 3	1	1	6	≤	6
10						
11	Objective function value:	$ 300.00				
12				optimal objective		
13				function value		
14	**Formulation**					

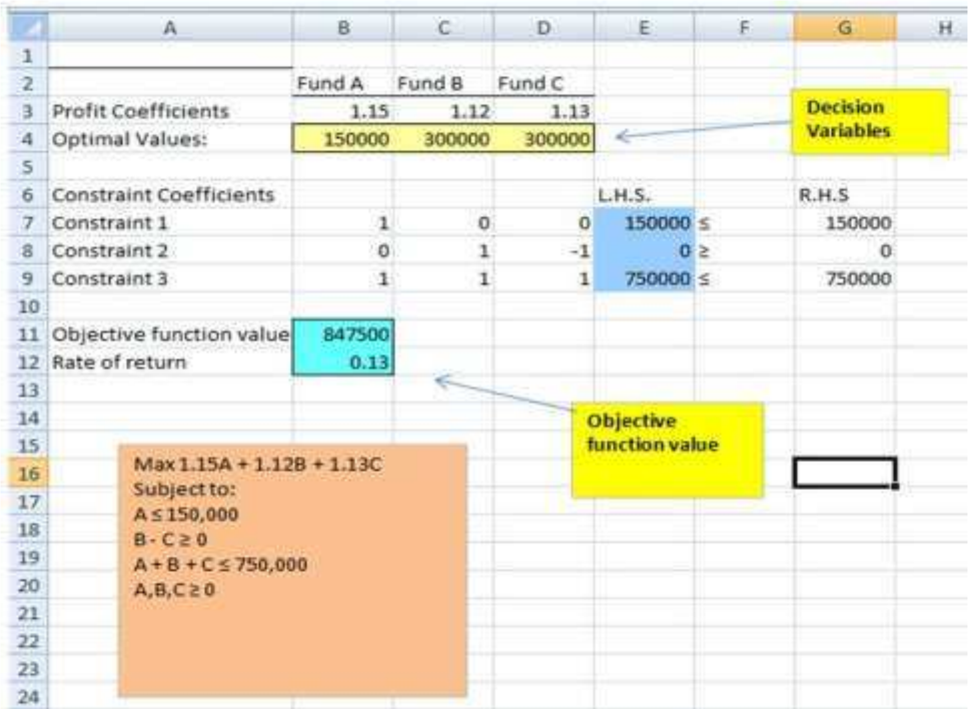
Max 50T + 30C
Subject to:
5T + 2C ≤ 40 (1)
2T - C ≥ 0 (2)
T + C ≤ 6 (3)
T, C ≥ 0

12) A bank is attempting to determine where its assets should be allocated in order to maximize its annual return. At present, $750,000 is available for investment in three types of mutual funds: A, B, and C. The annual rate of return on each type of fund is as follows: fund A, 15%; fund B, 12%; fund C; 13%. The bank's manager has placed the following restrictions on the bank's portfolio:

- No more than 20% of the total amount invested may be in fund A.
- The amount invested in fund B cannot exceed the amount invested in fund C.

Determine the optimal allocation that maximizes the bank's annual return.

Answer:



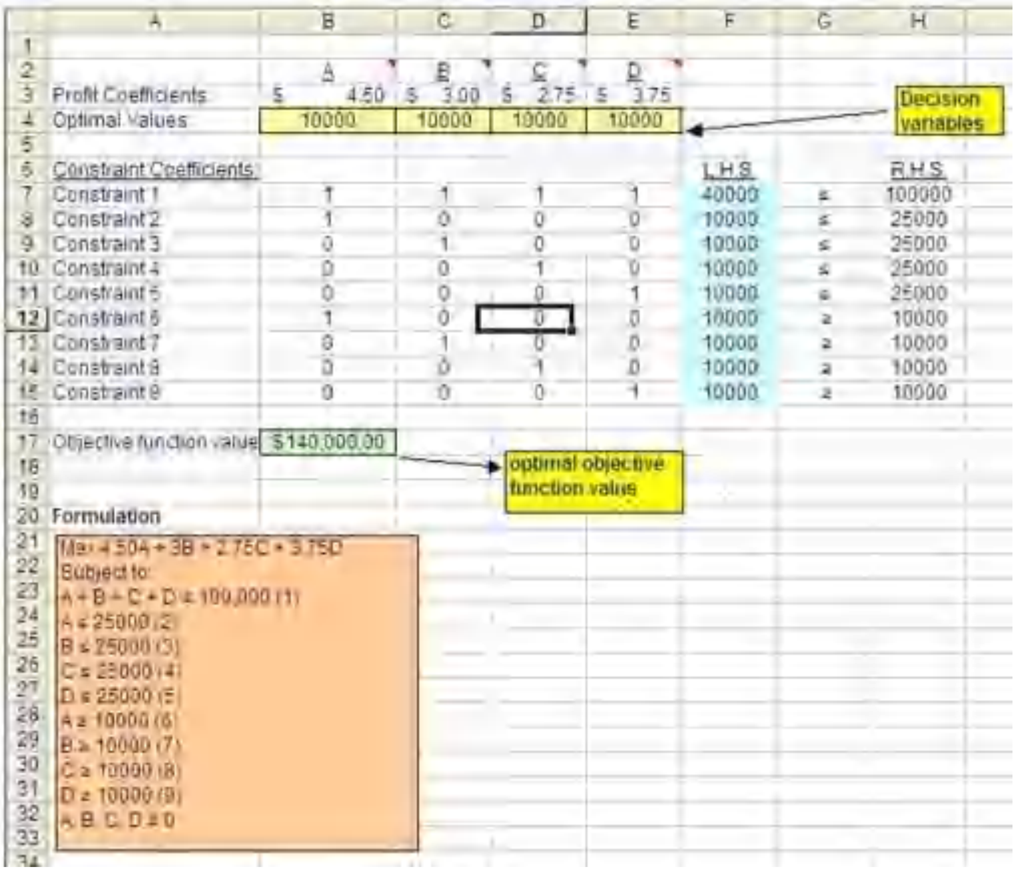
	A	B	C	D	E	F	G
1							
2		Fund A	Fund B	Fund C			
3	Profit Coefficients	1.15	1.12	1.13			
4	Optimal Values:	150000	300000	300000			
5							
6	Constraint Coefficients				L.H.S.		R.H.S
7	Constraint 1	1	0	0	150000	≤	150000
8	Constraint 2	0	1	-1	0	≥	0
9	Constraint 3	1	1	1	750000	≤	750000
10							
11	Objective function value	847500					
12	Rate of return	0.13					

13) A warehouse stocks five different products, A, B, C, and D. The warehouse has a total of 100,000 square feet of floor space available to accommodate all the products that it inventories. The monthly profit per square foot for each product is as follows:

Product	Profit per square foot
A	$4.50
B	$3.00
C	$2.75
D	$3.75

Each product must have at least 10,000 ft^2, and no single product can have more than 25% of the total warehouse space. The warehouse manager wants to know the floor space that should be allocated to each product to maximize profit.

Answer:



	A	B	C	D	E	F	G	H
1								
2		A	B	C	D			
3	Profit Coefficients	$ 4.50	$ 3.00	$ 2.75	$ 3.75			
4	Optimal Values	10000	10000	10000	10000			
5								
6	Constraint Coefficients:					L.H.S.		R.H.S.
7	Constraint 1	1	1	1	1	40000	≤	100000
8	Constraint 2	1	0	0	0	10000	≤	25000
9	Constraint 3	0	1	0	0	10000	≤	25000
10	Constraint 4	0	0	1	0	10000	≤	25000
11	Constraint 5	0	0	0	1	10000	≤	25000
12	Constraint 6	1	0	0	0	10000	≥	10000
13	Constraint 7	0	1	0	0	10000	≥	10000
14	Constraint 8	0	0	1	0	10000	≥	10000
15	Constraint 9	0	0	0	1	10000	≥	10000
16								
17	Objective function value	$140,000.00						

Decision variables

optimal objective function value

Formulation

Max 4.50A + 3B + 2.75C + 3.75D
Subject to:
A + B + C + D ≤ 100,000 (1)
A ≤ 25000 (2)
B ≤ 25000 (3)
C ≤ 25000 (4)
D ≤ 25000 (5)
A ≥ 10000 (6)
B ≥ 10000 (7)
C ≥ 10000 (8)
D ≥ 10000 (9)
A, B, C, D ≥ 0

14) A company that is introducing a new product would like to generate maximum market exposure. The marketing department currently has $100,000 of advertising budget for the year and is considering placing ads in three media: radio, television, and newspapers. The cost per ad and the exposure rating are as follows:

	Cost/ad	Exposure/ad
Radio	$10,000	30,000 individuals
Television	$25,000	50,000 individuals
Newspaper	$5000	20,000 individuals

The marketing department would like to place twice as many radio ads as television ads. They also would like to place at least 4 ads in each advertising media. What is the optimal allocation to each advertising medium to maximize audience exposure?

Answer:

	A	B	Formula Bar	D	E	F	G
1							
2							
3		Radio (R)	Television (T)	Newspaper (N)			Decision
4	Exposure/ad	30,000.00	50,000.00	20,000.00			variables
5	Optimal Values	4	2	2			
6							
7	Constraint Coefficients:				L.H.S.		R.H.S.
8	Constraint 1	10000	25000	5000	100000	≤	100,000
9	Constraint 2	1	0	0	4	≥	2
10	Constraint 3	0	1	0	2	≥	2
11	Constraint 4	0	0	1	2	≥	2
12	Constraint 5	1	-2	0	0	≥	0
13							
14	Objective function value	260000					
15				optimal objective			
16				function value			
17	**Formulation**						

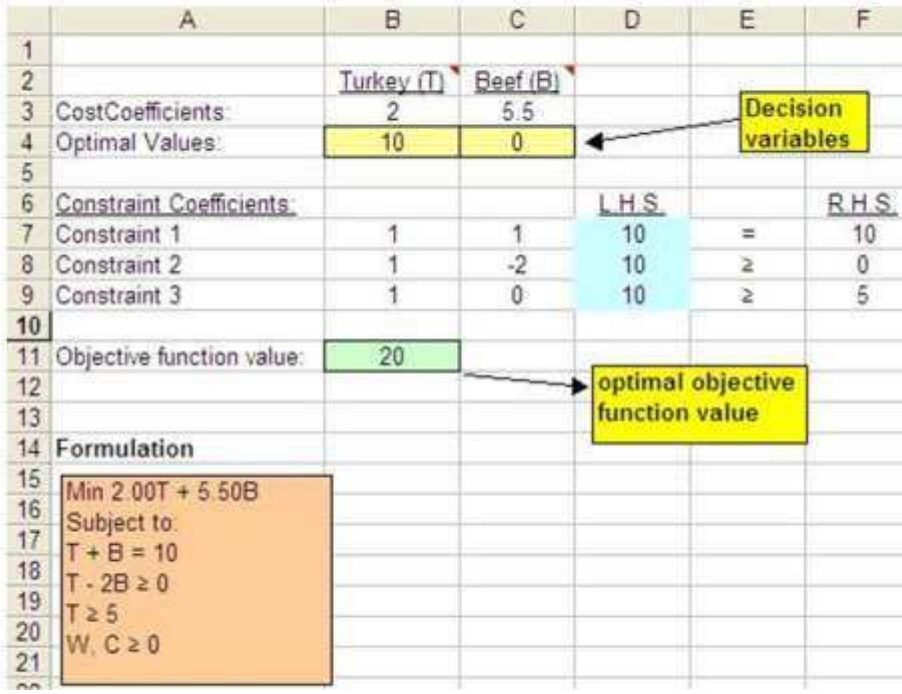
Max 30,000R + 50,000T + 20,000N
Subject to:
10,000R + 25,000T + 5000N ≤ 750,000
R ≥ 2
T ≥ 2
N ≥ 2
R - 2T ≥ 0
A, B, C ≥ 0

15) A meat packing store produces a dog food mixture that is sold to pet retail outlets in bags of 10 pounds each. The food mixture contains the ingredients turkey and beef. The cost per pound of each of these ingredients is as follows:

Ingredient	Cost/pound
Turkey	$2.00
Beef	$5.50

Each bag must contain at least 5 pounds of turkey. Moreover, the ratio of turkey to beef must be at least 2 to 1. What is the optimal mixture of the ingredients that will minimize total cost?

Answer:



	A	B	C	D	E	F
1						
2		Turkey (T)	Beef (B)			
3	CostCoefficients:	2	5.5			
4	Optimal Values:	10	0			
5						
6	Constraint Coefficients:			L.H.S.		R.H.S.
7	Constraint 1	1	1	10	=	10
8	Constraint 2	1	-2	10	≥	0
9	Constraint 3	1	0	10	≥	5
10						
11	Objective function value:	20				
14	Formulation					

16) A company can decide how many additional labor hours to acquire for a given week. Subcontractors will only work a maximum of 20 hours a week. The company must produce at least 200 units of product A, 300 units of product B, and 400 units of product C. In 1 hour of work, worker 1 can produce 15 units of product A, 10 units of product B, and 30 units of product C. Worker 2 can produce 5 units of product B, 20 units of product B, and 35 units of product C. Worker 3 can produce 20 units of product A, 15 units of product B, and 25 units of product C. Worker 1 demands a salary of $50/hr, worker 2 demands a salary of $40/hr, and worker 3 demands a salary of $45/hr. The company must choose how many hours they should hire from each worker to meet their production requirements and minimize labor cost.

Answer:

	Product A (A)	Product B (B)	Product C (C)			
Cost Coefficients	50	40	45			
Optimal Values	0	9.230769231	7.692307692			
Constraint Coefficients				L.H.S.		R.H.S.
Constraint 1	15	5	20	200	≥	200
Constraint 2	10	20	15	300	≥	300
Constraint 3	30	35	25	515.3846	≥	400
Constraint 4	1	0	0	0	≤	20
Constraint 5	0	1	0	9.230769	≤	20
Constraint 6	0	0	1	7.692308	≤	20
Objective function value	715.3846154					
Formulation						

Decision Variables

Optimal objective function value

Min 50A + 40B + 45C
Subject to:
15A + 5B + 20C ≥ 200
10A + 20B + 15C ≥ 300
30A + 35B + 25C ≥ 400
A,B,C ≤ 20
A,B,C ≥ 0