***Business Analytics, 2e, GE* (Evans)**

**Chapter 13 Linear Optimization**

1) Which of the following best defines decision variables in an optimization model?

A) They are limitations, requirements, or other restrictions that are imposed on any solution.

B) They are the quantities that the model seeks to maximize or minimize.

C) They are quantities for which no feasible solutions exist.

**D) They are unknown values that the model seeks to determine.**

Answer: D

Diff: 1

Blooms: Remember

Topic: Building Linear Optimization Models

LO1: Apply the four-step process to show a mathematical model for an optimization problem.

LO2: Identify different business uses for statistics and the major statistical tools businesses use

2) Which of the following best defines objective functions?

A) They are limitations, requirements, or other restrictions that are imposed on any solution in an optimization model.

B) **They are quantities that an optimization model seeks to maximize or minimize.**

C) They are quantities for which no feasible solutions exist in an optimization model.

D) They are unknown values that an optimization model seeks to determine.

Answer: B

Diff: 1

Blooms: Remember

Topic: Building Linear Optimization Models

LO1: Apply the four-step process to show a mathematical model for an optimization problem.

3) Which of the following best defines constraints in an optimization problem?

**A) They are limitations, requirements, or other restrictions that are imposed on any solution.**

B) They are quantities that an optimization model seeks to maximize or minimize.

C) They are quantities for which no feasible solutions exist.

D) They are unknown values that the model seeks to determine.

Answer: A

Diff: 1

Blooms: Remember

Topic: Building Linear Optimization Models

LO1: Apply the four-step process to show a mathematical model for an optimization problem.

Use the following information to answer the following question(s), using the SUMPRODUCT function.

Stone Age Surfboards is a small manufacturer of two types of popular high-tide surfboards, the Rockwell and the Limestone models. The manufacturing process consists of two departments: fabrication and finishing. The fabrication department has 15 skilled workers, each of whom works 5 hours per day. The finishing department has 5 workers, who also work a 5-hour shift. Each pair of Rockwell surfboards requires 3 labor hours in the fabrication department and 1.5 labor hours in finishing. The Limestone model requires 4.5 labor-hours in fabrication and 2 labor-hours in finishing. The company operates 6 days a week. It makes a per-unit profit of $60 on the Rockwell model and $75 on the Limestone model. Approximately 4.1 Rockwell models and 8.4 Limestone models are produced per day.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | A | B | C | D |
| 1 | **Stone Age Surfboards** |  |  |  |
| 2 |  |  |  |  |
| 3 | **Data** |  |  |  |
| 4 |  | **Product** | |  |
| 5 | **Department** | Rockwell | Limestone | Limitation (hours) |
| 6 | Fabrication | 3 | 4.5 | 75 |
| 7 | Finishing | 1.5 | 2 | 25 |
| 8 |  |  |  |  |
| 9 | Profit/Unit | $60.00 | $75.00 |  |
| 10 |  |  |  |  |
| 11 |  |  |  |  |
| 12 | **Model** |  |  |  |
| 13 |  | Rockwell | Limestone |  |
| 14 | Quantity Produced | 4.1 | 8.4 | Hours Used |
| 15 | Fabrication |  |  |  |
| 16 | Finishing |  |  |  |
| 17 |  |  |  |  |
| 18 |  |  |  | Excess Limestone |
| 19 | Market Mixture |  |  |  |
| 20 |  |  |  |  |
| 21 |  |  |  | Total Profit |
| 22 | Profit Contribution |  |  |  |

4) What is the total number of hours used for fabrication?

A) 42.58

B) 50.10

C) 35.64

D) 22.95

Answer: B

Diff: 2

Blooms: Apply

AACSB: Analytic Skills

Topic: Implementing Linear Optimization Models on Spreadsheets

LO1: Implement linear optimization models on spreadsheets.

LO2: Identify different business uses for statistics and the major statistical tools businesses use

5) What is the total number of hours used for the finishing operation?

A) 42.58

B) 50.10

C) 35.64

D) 22.95

Answer: D

Diff: 2

Blooms: Apply

AACSB: Analytic Skills

Topic: Implementing Linear Optimization Models on Spreadsheets

LO1: Implement linear optimization models on spreadsheets.

LO2: Identify different business uses for statistics and the major statistical tools businesses use

6) What is the total profit generated?

A) $ 876.00

B) $ 675.50

C) $ 480.50

D) $ 965.00

Answer: A

Diff: 2

Blooms: Apply

AACSB: Analytic Skills

Topic: Implementing Linear Optimization Models on Spreadsheets

LO1: Implement linear optimization models on spreadsheets.

LO2: Identify different business uses for statistics and the major statistical tools businesses use

Consider the spreadsheet for Stone Age Surfboards provided below. Use this data to answer the following question(s), using the Standard Solver.

Stone Age Surfboards is a small manufacturer of two types of popular low-tide surfboards, the Graystone and the Lava models. The manufacturing process consists of two departments: fabrication and finishing. The fabrication department has 8 skilled workers, each of whom works 9.25 hours per day. The finishing department has 5 workers, each of whom works a 6-hour shift per day. Each pair of Graystone surfboards requires 2.5 labor hours in the fabrication department and 2 labor hours in finishing. The Lava model requires 4.2 labor-hours in fabrication and 3.6 labor-hours in finishing. The company operates 6 days a week. It makes a per unit profit of $40 on the Graystone model and $60 on the Lava model. The company anticipates selling at least twice as many Lava models as Graystone models.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | A | B | C | D |
| 1 | **Stone Age Surfboards** |  |  |  |
| 2 |  |  |  |  |
| 3 | **Data** |  |  |  |
| 4 |  | **Product** | |  |
| 5 | **Department** | Graystone | Lava | Limitation (hours) |
| 6 | Fabrication | 2.5 | 4.2 | 74 |
| 7 | Finishing | 2 | 3.6 | 30 |
| 8 |  |  |  |  |
| 9 | Profit/Unit | $40.00 | $60.00 |  |
| 10 |  |  |  |  |
| 11 |  |  |  |  |
| 12 | **Model** |  |  |  |
| 13 |  | Graystone | Lava |  |
| 14 | Quantity Produced |  |  | Hours Used |
| 15 | Fabrication |  |  |  |
| 16 | Finishing |  |  |  |
| 17 |  |  |  |  |
| 18 |  |  |  | Excess Lava |
| 19 | Market Mixture |  |  |  |
| 20 |  |  |  |  |
| 21 |  |  |  | Total Profit |
| 22 | Profit Contribution |  |  |  |

7) What is the total number of hours used for fabrication?

A) 54.5

B) 30.0

C) 35.5

D) 43.8

Answer: C

Diff: 2

Blooms: Apply

AACSB: Analytic Skills

Topic: Solving Linear Optimization Models

LO1: Use the standard and premium Solver add-ins to solve linear optimization models in Excel.

LO2: Identify different business uses for statistics and the major statistical tools businesses use

8) What is the total number of hours used for the finishing operation?

A) 18.7

B) 30.0

C) 35.5

D) 24.2

Answer: B

Diff: 2

Blooms: Apply

AACSB: Analytic Skills

Topic: Solving Linear Optimization Models

LO1: Use the standard and premium Solver add-ins to solve linear optimization models in Excel.

9) What is the total profit generated?

A) $ 675.68

B) $ 920.57

C) $ 521.74

D) $ 788.32

Answer: C

Diff: 2

Blooms: Apply

AACSB: Analytic Skills

Topic: Solving Linear Optimization Models

LO1: Use the standard and premium Solver add-ins to solve linear optimization models in Excel.

10) What is the value of slack obtained from the answer report?

A) 46.78

B) 38.46

C) 59.24

D) 23.85

Answer: B

Diff: 2

Blooms: Apply

AACSB: Analytic Skills

Topic: Solving Linear Optimization Models

LO1: Use the standard and premium Solver add-ins to solve linear optimization models in Excel.

11) What is the Allowable Increase for Lava surfboards produced?

A) 30

B) 24

C) 12

D) 18

Answer: C

Diff: 2

Blooms: Apply

AACSB: Analytic Skills

Topic: Solving Linear Optimization Models

LO1: Use the standard and premium Solver add-ins to solve linear optimization models in Excel.

12) What is the Allowable Decrease for Graystone surfboards produced?

A) 30.74

B) 80.00

C) 12.33

D) 6.67

Answer: D

Diff: 2

Blooms: Apply

AACSB: Analytic Skills

Topic: Solving Linear Optimization Models

LO1: Use the standard and premium Solver add-ins to solve linear optimization models in Excel.

13) What is the shadow price for the finishing hours used?

A) 32.46

B) 17.39

C) 8.33

D) 6.67

Answer: B

Diff: 2

Blooms: Apply

AACSB: Analytic Skills

Topic: Solving Linear Optimization Models

LO1: Use the standard and premium Solver add-ins to solve linear optimization models in Excel.

14) What is the Allowable Increase in the finishing hours used?

A) 32.46

B) 8.33

C) 26.84

D) 16.67

Answer: A

Diff: 2

Blooms: Apply

AACSB: Analytic Skills

Topic: Solving Linear Optimization Models

LO1: Use the standard and premium Solver add-ins to solve linear optimization models in Excel.

15) What is the Allowable Decrease in the fabrication hours used?

A) 26.84

B) 16.67

C) 8.33

D) 38.46

Answer: D

Diff: 2

Blooms: Apply

AACSB: Analytic Skills

Topic: Solving Linear Optimization Models

LO1: Use the standard and premium Solver add-ins to solve linear optimization models in Excel.

16) What will be the total profit contribution from Lava surfboards?

A) $ 391.30

B) $ 521.74

C) $ 130.43

D) $ 276.65

Answer: A

Diff: 2

Blooms: Apply

AACSB: Analytic Skills

Topic: Solver Outcomes and Solution Messages

LO1: List the four possible outcomes when solving a linear optimization model and recognize them from Solver messages.

17) What will be the total profit contribution from Graystone surfboards?

A) $ 391.30

B) $ 521.74

C) $ 130.43

D) $ 276.65

Answer: C

Diff: 2

Blooms: Apply

AACSB: Analytic Skills

Topic: Solver Outcomes and Solution Messages

LO1: List the four possible outcomes when solving a linear optimization model and recognize them from Solver messages.

18) If the unit profit on Graystone surfboards is increased by $10, what is the total profit generated?

A) $ 489.13

B) $ 521.74

C) $ 423.91

D) $ 554.35

Answer: D

Diff: 2

Blooms: Apply

AACSB: Analytic Skills

Topic: Using Optimization Models for Prediction and Insight

LO1: Use Solver for conducting what-if analysis of optimization models.

19) If the unit profit on Graystone surfboards is increased by $10, what is the Allowable Increase for Lava surfboards?

A) 30.00

B) 85.00

C) 16.67

D) 58.75

Answer: A

Diff: 2

Blooms: Apply

AACSB: Analytic Skills

Topic: Using Optimization Models for Prediction and Insight

LO1: Use Solver for conducting what-if analysis of optimization models.

20) If the unit profit on Graystone surfboards is increased by $10, what is the Allowable Decrease for Lava surfboards?

A) 30.00

B) 85.00

C) 16.67

D) 58.75

Answer: B

Diff: 2

Blooms: Apply

AACSB: Analytic Skills

Topic: Using Optimization Models for Prediction and Insight

LO1: Use Solver for conducting what-if analysis of optimization models.

21) If the unit profit on Graystone surfboards is increased by $10, what is the shadow price for the finishing hours used?

A) $ 18.48

B) $ 17.39

C) $ 15.42

D) $ 14.15

Answer: A

Diff: 2

Blooms: Apply

AACSB: Analytic Skills

Topic: Using Optimization Models for Prediction and Insight

LO1: Use Solver for conducting what-if analysis of optimization models.

22) If the unit profit on both Graystone and Lava surfboards is increased by $10, what is the total profit generated?

A) $ 521.74

B) $ 505.43

C) $ 423.91

D) $ 619.57

Answer: D

Diff: 2

Blooms: Apply

AACSB: Analytic Skills

Topic: Using Optimization Models for Prediction and Insight

LO1: Use Solver for conducting what-if analysis of optimization models.

23) If the unit profit on both Graystone and Lava surfboards is increased by $10, what is the Allowable Decrease for Lava surfboards?

A) 95.00

B) 38.46

C) 20.00

D) 11.11

Answer: A

Diff: 2

Blooms: Apply

AACSB: Analytic Skills

Topic: Using Optimization Models for Prediction and Insight

LO1: Use Solver for conducting what-if analysis of optimization models.

24) If the unit profit on both Graystone and Lava surfboards is increased by $10, what is the shadow price for the finishing hours used?

A) -4.35

B) 8.33

C) 20.65

D) 32.46

Answer: C

Diff: 2

Blooms: Apply

AACSB: Analytic Skills

Topic: Using Optimization Models for Prediction and Insight

LO1: Use Solver for conducting what-if analysis of optimization models.

25) Due to decreasing profits, if the production of Graystone surfboards is stopped, compute the total profit the firm can earn.

A) $ 521.74

B) $ 489.13

C) $ 423.91

D) $ 500.00

Answer: D

Diff: 2

Blooms: Apply

AACSB: Analytic Skills

Topic: Using Optimization Models for Prediction and Insight

LO1: Use Solver for conducting what-if analysis of optimization models.

26) Which of the following solving methods is selected in the Solver dialog for linear and linear integer optimization problems?

A) GRG Nonlinear

**B) Simplex LP**

C) SOCP Barrier Engine

D) Evolutionary

Answer: B

Diff: 1

Blooms: Remember

Topic: Solving Linear Optimization Models

LO1: Use the standard and premium Solver add-ins to solve linear optimization models in Excel.

Use the following information to answer the question(s) below.

Cerebro Manufacturing produces four types of structural support fittings-plugs, rails, rivets, and clips-which are machined on two CNC machining centers. The machining centers have a capacity of 250,000 minutes per year. The gross margin per unit and machining requirements are shown in the spreadsheet below.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | A | B | C | D | E | F |
| 1 | **Cerebro Manufacturing Model** |  |  |  |  |  |
| 2 |  |  |  |  |  |  |
| 3 | **Product** | **Plugs** | **Rails** | **Rivets** | **Clips** | **Machine Capacity**  **(mins./year)** |
| 4 | **Gross margin/unit** | $ 0.40 | $ 1.20 | $ 0.80 | $ 1.10 |  |
| 5 | **Minutes/unit** | 1 | 2 | 3 | 1.5 | 250,000 |
| 6 | **Gross margin/minute** |  |  |  |  |  |
| 7 | **Maximum production** |  |  |  |  |  |
| 8 | **Profit** |  |  |  |  |  |

27) What is the gross margin per minute of plugs manufactured?

A) $ 0.60

B) $ 0.73

C) $ 0.40

D) $ 0.27

Answer: C

Diff: 1

Blooms: Apply

AACSB: Analytic Skills

Topic: How Solver Works

LO1: Explain how Solver works.

28) What is the gross margin per minute of rivets manufactured?

A) $ 0.60

B) $ 0.73

C) $ 0.40

D) $ 0.27

Answer: D

Diff: 1

Blooms: Apply

AACSB: Analytic Skills

Topic: How Solver Works

LO1: Explain how Solver works.

29) What is the maximum possible production of rails based on the machine capacity?

A) 250,000.00

B) 83,333.33

C) 166,666.67

D) 125,000.00

Answer: D

Diff: 1

Blooms: Apply

AACSB: Analytic Skills

Topic: How Solver Works

LO1: Explain how Solver works.

30) What is the maximum production of clips based on the machine capacity?

A) 250,000.00

B) 83,333.33

C) 166,666.67

D) 125,000.00

Answer: C

Diff: 1

Blooms: Apply

AACSB: Analytic Skills

Topic: How Solver Works

LO1: Explain how Solver works.

31) What is the total profit generated from the manufacture of only plugs?

A) $ 66,666.67

B) $ 100,000.00

C) $ 183,333.33

D) $ 150,000.00

Answer: B

Diff: 1

Blooms: Apply

AACSB: Analytic Skills

Topic: How Solver Works

LO1: Explain how Solver works.

32) What is the total profit generated from the manufacture of rivets?

A) $ 66,666.67

B) $ 100,000.00

C) $ 183,333.33

D) $ 150,000.00

Answer: A

Diff: 1

Blooms: Apply

AACSB: Analytic Skills

Topic: How Solver Works

LO1: Explain how Solver works.

33) Which of the following options is used if *Solver* gives an error message that linearity is not satisfied?

A) Ignore Integer Constraints

B) Show Iteration Results

C) Use Automatic Scaling

D) Use Multistart

Answer: C

Diff: 1

Blooms: Remember

Topic: How Solver Works

LO1: Explain how Solver works.

34) When a model has a unique optimal solution, it means that \_\_\_\_\_\_\_\_.

A) the objective is maximized or minimized by more than one combination of decision variables

B) there is no solution that simultaneously satisfies all the constraints

C) the Allowable Increase or Allowable Decrease values for changing cells are zero

D) there is exactly one solution that will result in the maximum or minimum objective

Answer: D

Diff: 1

Blooms: Remember

Topic: Solver Outcomes and Solution Messages

LO1: List the four possible outcomes when solving a linear optimization model and recognize them from Solver messages.

35) If a model has alternative optimal solutions, \_\_\_\_\_\_\_\_.

**A) the objective is maximized or minimized by more than one combination of decision variables**

B) there is no solution that simultaneously satisfies all the constraints

C) the objective can be increased or decreased to infinity or negative infinity

D) there is exactly one solution that will result in the maximum or minimum objective

Answer: A

Diff: 1

Blooms: Remember

Topic: Solver Outcomes and Solution Messages

LO1: List the four possible outcomes when solving a linear optimization model and recognize them from Solver messages.

36) Alternate optimal solutions exist when the \_\_\_\_\_\_\_\_.

A) reduced cost is equal to the shadow price

B) ratio of the objective coefficient to the constraint coefficient is one

**C) Allowable Increase values for changing cells are zero**

D) final value of the changing cells is greater than that of the constraints

Answer: C

Diff: 1

Blooms: Remember

Topic: Solver Outcomes and Solution Messages

LO1: List the four possible outcomes when solving a linear optimization model and recognize them from Solver messages.

37) An unbounded problem is one for which \_\_\_\_\_\_\_\_.

A) the objective is maximized or minimized by more than one combination of decision variables

B) there is no solution that simultaneously satisfies all the constraints

**C) the objective can be increased or decreased to infinity or negative infinity while the solution remains feasible**

D) there is exactly one solution that will result in the maximum or minimum objective

Answer: C

Diff: 2

Blooms: Remember

Topic: Solver Outcomes and Solution Messages

LO1: List the four possible outcomes when solving a linear optimization model and recognize them from Solver messages.

38) An infeasible problem is one for which \_\_\_\_\_\_\_\_.

A) the objective is maximized or minimized by more than one combination of decision variables

**B) there is no solution that simultaneously satisfies all the constraints**

C) the objective can be increased or decreased to infinity or negative infinity

D) there is exactly one solution that will result in the maximum or minimum objective

Answer: B

Diff: 1

Blooms: Remember

AACSB: Analytic Skills

Topic: Solver Outcomes and Solution Messages

LO1: List the four possible outcomes when solving a linear optimization model and recognize them from Solver messages.

39) The \_\_\_\_\_\_\_\_ indicates how much the value of the objective function will change as the right-hand side of a constraint is increased by 1.

A) objective coefficient

**B) shadow price**

C) binding constraint

D) reduced cost

Answer: B

Diff: 1

Blooms: Remember

Topic: Using Optimization Models for Prediction and Insight

LO1: Interpret the Solver sensitivity report.

40) Which of the following approaches provided by the *AnalyticSolver Platform* can automatically run multiple optimizations while varying model parameters within a predefined range?

A) sensitivity analysis

B) breakdown analysis

**C) parameter analysis**

D) uncertainty analysis

Answer: C

Diff: 1

Blooms: Remember

Topic: Using Optimization Models for Prediction and Insight

LO1: Use the Sensitivity Report to evaluate scenarios.

**41) A constraint function is a function of the decision variables in the problem.**

**Answer: TRUE**

Diff: 1

Blooms: Remember

Topic: Building Linear Optimization Models

LO1: Apply the four-step process to show a mathematical model for an optimization problem.

**42) Any solution that satisfies all constraints of a problem is called a feasible solution.**

**Answer: TRUE**

Diff: 1

Blooms: Remember

Topic: Solving Linear Optimization Models

LO1: Implement linear optimization models on spreadsheets.

**43) A binding constraint is one for which the Cell Value is greater than the right-hand side of the value of the constraint.**

**Answer: FALSE**

Diff: 1

Blooms: Remember

Topic: Solving Linear Optimization Models

LO1: Use the standard and premium Solver add-ins to solve linear optimization models in Excel.

44) Infeasible problems can occur when the demand requirement is higher than the available capacity.

Answer: TRUE

Diff: 1

Blooms: Remember

Topic: Solver Outcomes and Solution Messages

LO1: List the four possible outcomes when solving a linear optimization model and recognize them from Solver messages.

**45) Whenever a constraint has positive slack, the shadow price is equal to one.**

**Answer: FALSE**

Diff: 1

Blooms: Remember

Topic: Using Optimization Models for Prediction and Insight

LO1: Interpret the Solver sensitivity report.

46) What are the two basic properties of a linear optimization model?

Answer: A linear optimization model has two basic properties: (1) The objective function and all constraints are linear functions of the decision variables. This means that each function is simply a sum of terms, each of which is some constant multiplied by a decision variable. (2) All variables are continuous, meaning that they may assume any real value. This assumption may not be realistic for a practical business problem, but it simplifies the solution method.

Diff: 1

Blooms: Remember

Topic: Building Linear Optimization Models

LO1: State the properties that characterize linear optimization models.

47) What are the Excel functions to avoid in linear optimization?

Answer: Several common functions in Excel can cause difficulties when attempting to solve linear programs using Solver because they are discontinuous and no longer satisfy the conditions of a linear model. Common Excel functions to avoid are ABS, MIN, MAX, INT, ROUND, IF, and COUNT.

Diff: 1

Blooms: Remember

Topic: Implementing Linear Optimization Models on Spreadsheets

LO1: Implement linear optimization models on spreadsheets.

48) Explain the simplex method used by Solver.

Answer: *Solver* uses a mathematical algorithm called the simplex method. It characterizes feasible solutions algebraically by solving systems of linear equations. It moves systematically from one corner point to another to improve the objective function until an optimal solution is found. Because of the linearity of the constraints and objective function, the simplex method is guaranteed to find an optimal solution if one exists and usually does so quickly and efficiently.

Diff: 1

Blooms: Remember

Topic: How Solver Works

LO1: Explain how Solver works.

49) What are the four possible outcomes that can be obtained by solving a linear optimization model?

Answer:

• When a model has a **unique optimal solution**, it means that there is exactly one solution that will result in the maximum (or minimum) objective.

• If a model has **alternative optimal solutions**, the objective is maximized (or minimized) by more than one combination of decision variables.

• An **unbounded problem** is one for which the objective can be increased or decreased without bound.

• An **infeasible problem** is one for which no feasible solution exists.

Diff: 1

Blooms: Remember

Topic: Solver Outcomes and Solution Messages

LO1: List the four possible outcomes when solving a linear optimization model and recognize them from Solver messages.

50) What is the importance of Shadow Price in the Sensitivity Report?

Answer: The Constraintssection of the Sensitivity Report lists the final value of the constraint function (the left-hand side), a number called the shadow price, the original right-hand side value of the constraint, and an Allowable Increase and Allowable Decrease. The Shadow Pricetells how much the value of the objective function will change as the right-hand side of a constraint is increased by 1.Whenever a constraint has positive slack, the shadow price is zero. When a constraint involves a limited resource, the shadow price represents the economic value of having an additional unit of that resource.

Diff: 1

Blooms: Remember

Topic: Using Optimization Models for Prediction and Insight

LO1: Interpret the Solver sensitivity report.