**Module A: Linear Programming**

**Practice Problems**

**MULTIPLE CHOICE**

Precision Pumps has a plant in Indiana that produces cases for industrial pumps. To manufacture the casings, three processes are required: Preparation, Assembly, and Inspection. Precision Pumps is considering a production run for two types of casings: the G-110 model and the G-220 model. The G-110 model requires 3 hours in Preparation, 5 hours in Assembly, and 1 hour for Inspection. The G-220 model requires 7 hours in Preparation, 10 hours in Assembly, and 1.5 hours for Inspection. The two models consume different quantities of a specialized stainless steel. A G-110 unit requires 15 pounds of this steel while a unit of G-220 needs 20 pounds. Precision Pumps will have access to 1,000 pounds of this steel each week. The company estimates that the profit generated by G-110 is $600/unit, and the profit produced by a G-220 unit is $1,000. In preparing next week’s schedule, Precision Pumps has allocated 480 hours for Preparation, 960 hours for Assembly, and 240 hours for Inspection. Let X stand for each unit of G-110 pump casings and Y stand for each unit of G-220 pump casings.

1. What would be the appropriate objective function for Precision Pumps?

|  |  |
| --- | --- |
| a. | Maximize $600 × X + $1,000 × Y |
| b. | Minimize 15 × X + 20 × Y |
| c. | Maximize X + Y |
| d. | Minimize 9 × X + 18.5 × Y |

ANS: A PTS: 1 DIF: Easy

2. What equation would represent the Preparation constraint?

|  |  |
| --- | --- |
| a. | 10 × X + 20 × Y <= 1,000 |
| b. | 3 × X + 7 × Y <= 480 |
| c. | 5 × X + 10 × Y <= 960 |
| d. | 1 × X + 1.5 × Y <= 240 |

ANS: B PTS: 1 DIF: Medium

3. What equation would represent the Assembly constraint?

|  |  |
| --- | --- |
| a. | 5 × X + 10 × Y <= 960 |
| b. | 1 × X + 1.5 × Y <= 240 |
| c. | 10 × X + 20 × Y <= 1,000 |
| d. | 3 × X + 7 × Y <= 480 |

ANS: A PTS: 1 DIF: Medium

4. What equation would represent the Inspection constraint?

|  |  |
| --- | --- |
| a. | 10 × X + 20 × Y <= 1,000 |
| b. | 3 × X + 7 × Y <= 480 |
| c. | 1 × X + 1.5 × Y <= 240 |
| d. | 5 × X + 10 × Y <= 960 |

ANS: C PTS: 1 DIF: Medium

5. What would be the optimal solution for next week’s production?

|  |  |
| --- | --- |
| a. | X = 160, Y = 66 |
| b. | X = 0, Y = 50 |
| c. | X = 30, Y = 0 |
| d. | X = 20, Y = 25 |

ANS: B PTS: 1 DIF: Hard

6. What would be the slack, if any, for the Preparation constraint?

|  |  |
| --- | --- |
| a. | 0 |
| b. | 50 |
| c. | 130 |
| d. | 200 |

ANS: C PTS: 1 DIF: Medium

7. What would be the slack, if any, for the Assembly constraint?

|  |  |
| --- | --- |
| a. | 0 |
| b. | 130 |
| c. | 350 |
| d. | 460 |

ANS: D PTS: 1 DIF: Medium

8. What would be the slack, if any, for the Inspection constraint?

|  |  |
| --- | --- |
| a. | 0 |
| b. | 50 |
| c. | 165 |
| d. | 190 |

ANS: C PTS: 1 DIF: Medium

9. Given the optimal solution, what would be the profit for Precision Pumps for the next week?

|  |  |
| --- | --- |
| a. | $23,000 |
| b. | $37,000 |
| c. | $42,000 |
| d. | $50,000 |

ANS: D PTS: 1 DIF: Medium

10. If Precision Pumps wishes to increase profits, what resource would have to be increased?

|  |  |
| --- | --- |
| a. | Preparation |
| b. | Assembly |
| c. | Inspection |
| d. | Specialty Steel |

ANS: D PTS: 1 DIF: Medium

Jules’s Gym serves food and shakes. They are planning on introducing a strawberry energy shake. The prime ingredients are raw strawberries and vitamin supplements. Each ounce of strawberries costs Jules’s Gym $0.12, and the cost of the vitamin supplement is 50% greater than the strawberries. Being a health drink, they want to guarantee that it has some minimum requirements. They want to assure the customers that each ounce of the drink has 240 milligrams of carbohydrates, 180 milligrams of protein, and 300 milligrams of fiber. Each ounce of a strawberry has 6 milligrams of carbohydrates, 2 milligrams of protein, and 25 milligrams of fiber. Each ounce of the vitamin supplement has 8 milligrams of carbohydrates, 1 milligram of protein, and 15 milligrams of fiber.

11. What would be the objective function for this problem? Let X stand for an ounce of strawberries and Y stand for an ounce of vitamin supplement.

|  |  |
| --- | --- |
| a. | 0.12 × X + 0.12 × Y |
| b. | 0.12 × X + 0.18 × Y |
| c. | 0.12 × X + 0.24 × Y |
| d. | 0.12 × X + 0.50 × Y |

ANS: B PTS: 1 DIF: Easy

12. What would be the optimal solution?

|  |  |
| --- | --- |
| a. | X = 90, Y = 0 |
| b. | X = 60, Y = 10 |
| c. | X = 40, Y = 40 |
| d. | X = 10, Y = 90 |

ANS: A PTS: 1 DIF: Hard

13. What would be the value of the optimal solution?

|  |  |
| --- | --- |
| a. | $0.90 |
| b. | $1.08 |
| c. | $1.20 |
| d. | $1.36 |

ANS: B PTS: 1 DIF: Medium

14. Dissatisfied with the above solution, Jules’s Gym decides to add another constraint. They wanted to be sure that the proportion of the vitamin supplement was greater than or equal to 25% of the amount of strawberries. Which of the following equations would represent that new constraint?

|  |  |
| --- | --- |
| a. | 0.25 × X + 1 × Y = 0 |
| b. | 1 × X - 0.25 × Y => 1 |
| c. | -0.25 × X + 1 × Y => 0 |
| d. | -0.25 × X + 1 × Y <= 1 |

ANS: C PTS: 1 DIF: Medium

15. Given this new constraint, what would be the optimal solution?

|  |  |
| --- | --- |
| a. | X = 90, Y = 0 |
| b. | X = 80, Y = 20 |
| c. | X = 60, Y = 25 |
| d. | X = 40, Y = 10 |

ANS: B PTS: 1 DIF: Hard

16. Given this new constraint, what would be the value of the optimal solution?

|  |  |
| --- | --- |
| a. | $0.90 |
| b. | $1.08 |
| c. | $1.20 |
| d. | $1.32 |

ANS: D PTS: 1 DIF: Medium

17. If Jules’s Gym wanted the amount of strawberries and vitamin supplement to be in equal amounts, which of the following equations would represent that constraint?

|  |  |
| --- | --- |
| a. | 1 × X - 1 × Y <= 1 |
| b. | 1 × X - 1 × Y = 1 |
| c. | 1 × X - 1 × Y <= 0 |
| d. | 1 × X - 1 × Y = 0 |

ANS: D PTS: 1 DIF: Medium

Edward Greenjeans has inherited a small farm (600 acres) from his aunt. He knows very little about farming, but he knows his aunt has grown corn and beets on her property. Ed estimates that he could make $1,000 for every acre of corn that he would grow and $750 for every acre of beets. The costs of planting, fertilizing, and harvesting each crop would be different. Mr. Greenjeans has been told that those costs for corn run $200 per acre while those costs for beets run $300 per acre. Since Ed doesn’t want to do any of the work by himself, he will use hired farm hands, and the time requirement for each acre of corn should be 100 hours while the time requirement for planting and harvesting beets would be 200 hours per acre. Mr. Greenjeans wants to plant at least 50 acres of beets and spend no more than $15,000 for planting, fertilizing, and harvesting. He also wants to limit the total amount of labor time to 9,000 hours.

18. What should be Mr. Greenjeans’s objective function? Let C represent the number of acres of corn planted and B represent the number of acres of beets planted.

|  |  |
| --- | --- |
| a. | Minimize $200 × C + $300 × B |
| b. | Minimize 100 × C + 200 × B |
| c. | Maximize $1,000 × C + $750 × B |
| d. | Minimize $1,000 × C + $750 × B |

ANS: C PTS: 1 DIF: Easy

19. What equation would represent the cost constraint?

|  |  |
| --- | --- |
| a. | $1,000 × C + $600 × B |
| b. | $200 × C + $300 × B <= $15,000 |
| c. | 100 × C + 200 × B <= 9,000 |
| d. | B >= 50 |

ANS: B PTS: 1 DIF: Medium

20. What equation would represent the Beet constraint?

|  |  |
| --- | --- |
| a. | $1,000 × C + $600 × B |
| b. | $200 × C + $300 × B <= $15,000 |
| c. | 100 × C + 200 × B <= 9,000 |
| d. | B >= 50 |

ANS: D PTS: 1 DIF: Easy

21. What would be the optimal solution?

|  |  |
| --- | --- |
| a. | no feasible solution |
| b. | multiple solutions |
| c. | C = 20 and B = 50 |
| d. | B = 50 |

ANS: A PTS: 1 DIF: Hard

22. Assume that Mr. Greenjeans was to increase the number of hours to 10,000 from 9,000. How would this change the optimal solution?

|  |  |
| --- | --- |
| a. | no feasible solution |
| b. | multiple solutions |
| c. | C = 20 and B = 50 |
| d. | C = 0 and B = 50 |

ANS: D PTS: 1 DIF: Hard

23. Given the change in labor hours (to 10,000), how would that change the economic value of the optimal solution?

|  |  |
| --- | --- |
| a. | no feasible solution |
| b. | multiple solutions |
| c. | $37,500 |
| d. | $50,000 |

ANS: C PTS: 1 DIF: Medium

24. Given the optimal solution in the prior problem, what would be his expenditures for planting, fertilizing, and harvesting?

|  |  |
| --- | --- |
| a. | $0 |
| b. | $10,000 |
| c. | $15,000 |
| d. | $37,500 |

ANS: C PTS: 1 DIF: Medium

25. What would be the limiting constraint(s)?

|  |  |
| --- | --- |
| a. | cost for planting, fertilizing, and harvesting |
| b. | labor time |
| c. | minimum requirements for beets |
| d. | both labor time and minimum requirements for beets |

ANS: D PTS: 1 DIF: Medium

26. Greenjeans has talked to his farm manager, who suggested that he shouldn’t necessarily set a requirement for the number of acres of beets to be planted. What would be the optimal solution if there were no constraints on planting beets?

|  |  |
| --- | --- |
| a. | no feasible solution |
| b. | multiple solutions |
| c. | C = 75, B = 0 |
| d. | C = 30, B = 30 |

ANS: C PTS: 1 DIF: Hard

27. Greenjeans has talked to his farm manager, who suggested that he shouldn’t necessarily set a requirement for the number of acres of beets to be planted. What would be the value of the optimal solution if there were no constraints on planting beets?

|  |  |
| --- | --- |
| a. | $33,000 |
| b. | $37,500 |
| c. | $75,000 |
| d. | $52,500 |

ANS: C PTS: 1 DIF: Hard

28. Greenjeans has talked to his farm manager, who suggested that he shouldn’t necessarily set a requirement for the number of acres of beets to be planted. Given the optimal solution, what would be the slack for the cost constraint?

|  |  |
| --- | --- |
| a. | $0 |
| b. | $3,000 |
| c. | $5,000 |
| d. | $6,000 |

ANS: A PTS: 1 DIF: Medium

29. Greenjeans has talked to his farm manager, who suggested that he shouldn’t necessarily set a requirement for the number of acres of beets to be planted. Given the optimal solution, what would be the slack for the labor constraint?

|  |  |
| --- | --- |
| a. | 0 |
| b. | 1,500 |
| c. | 4,000 |
| d. | 5,000 |

ANS: B PTS: 1 DIF: Medium

30. What equation would represent the labor constraint?

|  |  |
| --- | --- |
| a. | $1,000 × C + $600 × B |
| b. | $200 × C + $300 × B <= $15,000 |
| c. | 100 × C + 200 × B <= 9,000 |
| d. | B >= 50 |

ANS: C PTS: 1 DIF: Medium

LeBrue Furniture manufactures fine, handcrafted furniture. Their plant in Alabama has been retooled and will produce their Danish-styled desks and chairs. Each dining room table generates $900 per unit, and each chair generates $600 per unit. Production of both desks and chairs share four processes: Cutting, Sanding, Assembly, and Finishing. Desks require 4 hours in Cutting, 6 hours in Sanding, 9 hours in Assembly, and 3 hours in Finishing. Chairs require 2 hours in Cutting, 1 hour in Sanding, 3 hours in Assembly, and 2 hours in Finishing. The production manager has drawn up a schedule for next week. She has assigned 1,200 hours to be available in Cutting, 1,800 to be available in Sanding, 2,700 hours to be available in Assembly, and 900 hours to be available in Finishing. This week, LeBrue has to fulfill a contract for 50 desks.

31. What would be the objective function for this situation? Let D stand for the number of desks and C stand for the number of chairs.

|  |  |
| --- | --- |
| a. | Minimize 22 × D + 8 × C |
| b. | Minimize 900 × D + 600 × C |
| c. | Maximize 900 × D + 600 × C |
| d. | Maximize 600 × D + 900 × D |

ANS: C PTS: 1 DIF: Easy

32. How many constraints (exclusive of the objective function) does this situation have?

|  |  |
| --- | --- |
| a. | 1 |
| b. | 3 |
| c. | 5 |
| d. | 6 |

ANS: C PTS: 1 DIF: Medium

33. What equation would represent the Cutting constraint?

|  |  |
| --- | --- |
| a. | 4 × D + 2 × C <= 1,200 |
| b. | 6 × D + 1 × C <= 1,800 |
| c. | 9 × D + 3 × C <= 2,700 |
| d. | 3 × D + 2 × C <= 1,200 |

ANS: A PTS: 1 DIF: Medium

34. What equation would represent the Sanding constraint?

|  |  |
| --- | --- |
| a. | 4 × D + 2 × C <= 1,200 |
| b. | 6 × D + 1 × C <= 1,800 |
| c. | 9 × D + 3 × C <= 2,700 |
| d. | 3 × D + 2 × C <= 1,200 |

ANS: B PTS: 1 DIF: Medium

35. What equation would represent the Assembly constraint?

|  |  |
| --- | --- |
| a. | 4 × D + 2 × C <= 1,200 |
| b. | 6 × D + 1 × C <= 1,800 |
| c. | 9 × D + 3 × C <= 2,700 |
| d. | 3 × D + 2 × C <= 1,200 |

ANS: C PTS: 1 DIF: Medium

36. What equation would represent the Finishing constraint?

|  |  |
| --- | --- |
| a. | 4 × D + 2 × C <= 1,200 |
| b. | 6 × D + 1 × C <= 1,800 |
| c. | 9 × D + 3 × C <= 2,700 |
| d. | 3 × D + 2 × C <= 900 |

ANS: D PTS: 1 DIF: Medium

37. What would be the optimal solution to the production schedule?

|  |  |
| --- | --- |
| a. | no feasible solution |
| b. | multiple solutions |
| c. | D = 300, C = 0 |
| d. | D= 0, C = 600 |

ANS: B PTS: 1 DIF: Hard

38. What would be the value of the optimal solution to the production schedule?

|  |  |
| --- | --- |
| a. | no feasible solution |
| b. | multiple solutions |
| c. | $270,000 |
| d. | $360,000 |

ANS: C PTS: 1 DIF: Hard

39. What constraints limit the overall profit that LeBrue could make this week?

|  |  |
| --- | --- |
| a. | Cutting |
| b. | Cutting and Sanding |
| c. | Cutting, Sanding, and Assembly |
| d. | Cutting, Sanding, Assembly, and Finishing |

ANS: D PTS: 1 DIF: Medium

40. Assume that in addition to the requirement to produce at least 50 desks, LeBrue received a rush order to produce 40 chairs. What would be the optimal solution?

|  |  |
| --- | --- |
| a. | no feasible solution |
| b. | multiple solutions |
| c. | D = 272.33, C = 40 |
| d. | D = 250, C = 80 |

ANS: B PTS: 1 DIF: Hard

41. What would be the value of the new optimal solution?

|  |  |
| --- | --- |
| a. | no feasible solution |
| b. | multiple solutions |
| c. | $270,000 |
| d. | $360,000 |

ANS: C PTS: 1 DIF: Medium

Victor Armstrong just inherited $1,000,000 from his uncle. There was a stipulation in the will that Victor invests the million dollars for five years before Victor can have complete access to the capital, although he can spend any interest. Victor went to an investment counselor, who suggested that Victor invest with two types of mutual funds. The first mutual fund—the Alpha Fund—focuses on growth stocks and has an anticipated return of 10% a year. The second mutual fund—the Elite Fund—is composed mostly of Blue Chip stocks and has an estimated annual return of 6%. The Alpha Fund being a high-growth fund is riskier, with a risk coefficient of 1.5. The Elite Fund is actually less risky than the market at large and has a risk coefficient of 0.8. Victor took a test given by the investment counselor, and it was determined that the maximum risk coefficient for him would be 1.2. The cost of one unit of the Alpha Fund is $10,000 while a unit of the Elite Fund costs $5,000. Victor wants an interest income of $65,000 a year for the years that the money is invested.

42. What would be the objective function for Victor if he wished to maximize his interest income? Let A stand for the number of units of the Alpha Fund purchased and E stand for the number of units of the Elite Fund.

|  |  |
| --- | --- |
| a. | Maximize 0.001 × A + 0.006 × E |
| b. | Maximize 0.10 × A + 0.06 × E |
| c. | Maximize 1 × A + 0.6 × E |
| d. | Maximize 1,000 × A + 300 × E |

ANS: D PTS: 1 DIF: Medium

43. What equation would represent the total investment constraint?

|  |  |
| --- | --- |
| a. | A + E <= 1,000 |
| b. | 100A + 50 × E = 1,000 |
| c. | 10 × A + 5 × E = 1,000,000 |
| d. | $10,000 × A + $5,000 × E <= $1,000,000 |

ANS: D PTS: 1 DIF: Medium

44. What equation would represent the risk constraint?

|  |  |
| --- | --- |
| a. | 1.5 × A + 0.8 × E = 1.2 |
| b. | 1.5 × A + 0.8 × E <= 1.2 |
| c. | 0.3 × A - 0.4 × E <= 0 |
| d. | 0.8 × A + 0.6 × E = 0 |

ANS: C PTS: 1 DIF: Hard

45. What equation would represent the required interest return constraint?

|  |  |
| --- | --- |
| a. | 0.001 × A + 0.006 × E => $6,500 |
| b. | 0.10 × A + 0.06 × E => $65,000 |
| c. | 1 × A + 0.6 × E => $6,500 |
| d. | 1,000 × A + 300 × E => $65,000 |

ANS: D PTS: 1 DIF: Medium

46. What would be the optimal solution (rounded to integers)?

|  |  |
| --- | --- |
| a. | A = 50, E = 85 |
| b. | A = 60, E = 70 |
| c. | A = 73, E = 55 |
| d. | A = 92, E = 10 |

ANS: C PTS: 1 DIF: Hard

47. What would be the value for the optimal solution (rounded to integers)?

|  |  |
| --- | --- |
| a. | $65,000 |
| b. | $75,000 |
| c. | $89,500 |
| d. | $97,000 |

ANS: C PTS: 1 DIF: Medium

48. Victor questions the test that determined that his maximum risk coefficient would be 1.2. He feels that it should be 1.0, which is the same as the average market. Given that, what equation would represent the risk constraint?

|  |  |
| --- | --- |
| a. | 1.0 × A - 1.0 × E = 0 |
| b. | 1.0 × A - 1.0 × E <= 1 |
| c. | 1.0 × A + 1.0 × E <= 2 |
| d. | 0.5 × A - 0.2E <= 0 |

ANS: D PTS: 1 DIF: Hard

49. What would be the optimal solution (rounded to integers) with this new constraint?

|  |  |
| --- | --- |
| a. | A = 44, E = 111 |
| b. | A = 55, E = 90 |
| c. | A = 33, E = 75 |
| d. | A = 12, E = 10 |

ANS: A PTS: 1 DIF: Hard

50. What would be the value for the optimal solution (rounded to integers) with this new constraint?

|  |  |
| --- | --- |
| a. | $60,000 |
| b. | $77,300 |
| c. | $89,500 |
| d. | $95,300 |

ANS: B PTS: 1 DIF: Medium