**LP Additional Practice Problems**

1. *Refrigerators.* A plant produces two types of refrigerators, A and B. There are two production lines, one dedicated to producing refrigerators of Type A, the other to producing refrigerators of Type B. The capacity of the production line for A is 60 units per day, the capacity of the production line for B is 50 units per day. A requires 20 minutes of labor whereas B requires 40 minutes of labor. Presently, there is a maximum of 40 hours of labor per day which can be assigned to either production line. Profit contributions are $20 per refrigerator of type A produced and $30 per type B produced. What should the daily production be?
2. *Trail Mix.* Determine how to produce bags of trail mix at minimum cost. Ingredients: **F**lakes, **P**ecans, **R**aisins, **S**eeds, **W**alnuts. The weight of each bag needs to be at least 10 lbs. The costs per pound and the nutritional requirements are summarized in the following table:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Cost / lb. | F, $3 | P, $7 | R, $5 | S, $4 | W, $6 | Requirement per package |
| Vitamins(g/lb) | 10 | 30 | 20 | 10 | 20 | at least 100 g |
| Minerals(g/lb) | 4 | 9 | 7 | 5 | 2 | at least 50 g |
| Protein(g/lb) | 10 | 2 | 4 | 1 | 1 | at least 75 g |
| Calories/lb | 160 | 300 | 450 | 500 | 500 | £ 3000 cal. |

Each package must contain at least 1 lb. of W, at least 0.75 lbs. each of P, R and S. No min quantity for flakes.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Outlet** | **Boys** | **Women** | **Men** | **Cost** |
| TV | 5 | 1 | 3 | $600/ minute |
| Magazine | 2 | 6 | 3 | $500/ page |
| **Target** | **24** | **18** | **24** |  |

1. *Megamarketing.* MegaMarketing is planning a concentrated one-week advertising campaign for their new CutsEverything SuperKnife. The ads have been designed and produced and now they wish to determine how much money to spend in each advertising outlet. In reality, they have hundreds of possible outlets to choose from. We will illustrate their problem with two outlets: Prime-time TV, and newsmagazines.

The problem of optimally spending advertising dollars can be formulated in many ways. Our approach is to define targets for reaching each market segment and to minimize the money spent to reach those targets. For SuperKnife, the target segments are Teenage Boys, Affluent Women (ages 40-49), and Retired Men.

Each minute of primetime TV and page of newsmagazine advertisement reaches a certain number of people (in millions). The reach for each medium (in million people per ad minute or per ad page), the target sizes (in millions), and cost per outlet (per minute) are summarized in the table above.

How many minutes of Prime-time TV, and how many pages of news magazine should MegaMarketing purchase to meet the target segments?

1. *Cookie Baking:* Jimmy is baking chocolate chip and oatmeal raisin cookies for sale. He gets 25 cents for each chocolate chip cookie and 30 cents for each oatmeal raisin cookie. He cannot make more than 500 cookies of each kind, and he cannot make more than 800 cookies total. He must make at least one-third as many chocolate chip cookies as oatmeal raisin cookies. How many of each kind of cookies should he make to make the most money?
2. *Managing a Portfolio.* A local bank wants to build a bond portfolio from a set of five bonds with $1 million available for investment. The expected annual return, the worst-case annual return on each bond, and the “duration” of each bond are given in the following table. (The duration of a bond is a measure of the bond’s sensitivity to changes in interest rates.)

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Expected Return** | **Worst Case Return** | **Duration** |
| Bond 1 | 12.5% | 8.0% | 8 |
| Bond 2 | 11.5% | 7.5% | 7 |
| Bond 3 | 10.5% | 6.8% | 6 |
| Bond 4 | 9.5% | 7.0% | 5 |
| Bond 5 | 8.5% | 7.4% | 3 |

The bank wants to maximize the expected return from its bond investments, subject to three conditions:

* The average worst-case return for the portfolio must be at least 7.2 percent.
* The average duration of the portfolio must be at most 6.
* Because of diversification requirements, at most 40 percent of the total amount invested can be invested in a single bond.

1. What is the maximum return on the $1 million investment? How should the investment be distributed among the bonds to achieve this return? (Assume that bonds can be purchased in fractional amounts.)
2. What is the marginal rate of return on the investment amount? That is, what would be the percentage return on an additional dollar invested?
3. *Scheduling Consultants.* You are the Director of the Computer Center for Gaillard College and responsible for scheduling the staffing of the center, which is open from 8 a.m. until midnight. You have monitored the usage of the center at various times of the day and determined that the following number of computer consultants are required:

|  |  |
| --- | --- |
| **Time of Day** | **Minimum Number of Consultants** |
| 8 a.m. – noon | 4 |
| Noon – 4 p.m. | 8 |
| 4 p.m. – 8 p.m. | 10 |
| 8 p.m. - midnight | 6 |

Two types of computer consultants can be hired: full-time and part-time. The full-time consultants work for eight consecutive hours in any of the following shifts: morning (8 a.m – 4 p.m.), afternoon (noon – 8 p.m.), and evening (4 p.m. – midnight). Full-time consultants are paid $14 per hour.

Part-time consultants can be hired to work any of the four shifts listed in the table. Part-time consultants are paid $12 per hour. An additional requirement is that during every time period, there must be at least one full-time consultant on duty for every part-time consultant on duty.

Determine a minimum-cost staffing plan for the center. How many full-time consultants and part-time consultants will be needed? What is the minimum cost?

1. *Coffee Blending.* As a newly appointed Chief Product Officer of Huggamug Coffee you have been tasked to develop a new coffee blend. Given current demand projections, the required minimum amount of coffee to be blended each week is 2000 tons. Further, there are three certified coffee bean suppliers that you can source from: one from Brazil (BR), one from Colombia (CO) and one from Peru (PE). Your data on past supplier performance is that the aroma scores of the three suppliers are 75, 60 and 85, respectively. Further, the strength scores of the three suppliers are 15, 20 and 18, respectively. Lastly, each week the three suppliers can deliver 750, 600 and 1,000 tons, at the cost of 1000, 1200 and 1400 $/ton, respectively. Your blend must have an aroma score of at least 78 and a strength score of at least 16.75. What blend would achieve these performance criteria at a minimum cost?
2. *Transportation:* The following table shows the transportation costs (in $/item) from four factories to three stores, as well as the demand at each store, and the maximum supply of each factory. Determine the minimum cost shipping plan that satisfied the demand and supply requirements.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Per unit transportation costs** | | | | | |
|  |  | Stores | | | |  |
|  |  | Atl | Bos | Chi | Den | Supply |
| Factories | Minn | 0.60 | 0.56 | 0.22 | 0.40 | 9000 |
| Pitt | 0.36 | 0.30 | 0.28 | 0.58 | 12000 |
| Tucs | 0.65 | 0.68 | 0.55 | 0.42 | 13000 |
| Demand | | 7500 | 8500 | 9500 | 8000 |  |

1. *Burger Company:* The Green New Deal Burger Co is exploring new sources of meatless meat. To attract a new group of carb-conscious consumers, the company is using large amounts of soy protein in their burger patties with the key operational decision being where to source processed soybeans. Currently, the available soy suppliers are willing to supply soy in the following amounts and at the following price:

Friendly Farms (FF): at most 200 lbs at $4/lbs

Misty Meadows (MM): at most 310 lbs at $3/lbs

Treasure Tree (TT): at most 420 lbs at $2/lbs

Shipping costs in $ per lbs are:

To: Plant A Plant B

From: FF 3 3.5

MM 2 2.5

TT 6 4

Fridge capacity for soybean storage and labor costs at the production plants are as follows:

Plant A Plant B

Capacity 460 lbs 560 lbs

Labor cost $26/lb $21/lb

Each patty is sold at $5 and requires 0.15 lbs of processed soy. The company can sell at this price all they can produce.

1. What is the best mixture of the quantities supplied by the three suppliers to the two plants so that the company maximizes its profits? Is the company profitable?
2. The Keto/Paleo-community is demanding that the carb content in the patty be further reduced to less than 1%, which would require the amount of soy per patty to go up to 0.2 lbs. Assuming that prices are not allowed to increase, is the venture still profitable?
3. You were able to identify an additional soybean supplier, Pretty Pastures (PP), who is willing to supply *exactly* 200 lbs of soy for $1000 (PP will not supply any other quantity than 200lbs). If their offer is accepted, PP will ship directly to plant B at no additional cost. Do you accept their offer?
4. *Transshipment:* Your company ownsthree factories: F1, F2, F3. and five warehouses: W1, W2, W3, W4, W5. Goods are shipped from factories to two depots (D1, D2), repackaged and then shipped to the warehouses. Shipping costs, capacities and demands are shown below. Find the shipping plan with minimum cost.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| From factories | D1 | D2 | W6 | Capacity |
| F1 | 1.28 | 1.36 | 1.73 | 2500 |
| F2 | 1.33 | 1.38 | 1.91 | 3000 |
| F3 | 1.68 | 1.55 | 1.86 | 2300 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| From depots | W1 | W2 | W3 | W4 | W5 |
| D1 | 0.60 | 0.42 | 0.32 | 0.44 | 0.68 |
| D2 | 0.57 | 0.30 | 0.40 | 0.38 | 0.72 |
| Demand | 1200 | 1300 | 1400 | 1500 | 1600 |

Warehouse 6 (W6) demand = 800