Juan wants to determine the combination of items he should pack in his duffel bag to maximize his profit. This problem is an example of a type of integer programming problem known as a "knapsack" problem. Formulate and solve this problem.

19. The Avalon Floor Cleaner Company is trying to determine the number of salespeople it should allocate to its three regions—the East, the Midwest, and the West. The company has 100 salespeople that it wants to assign to the three regions. The annual average unit sales volume achieved by a salesperson in each region is as follows:

Region	Units per Salesperson
East	25,000
Midwest	18,000
West	31,000

Because travel distances, costs of living, and other factors vary among the three regions, the annual cost of having a salesperson is $5,000 in the East, $11,000 in the Midwest, and $7,000 in the West. The company has $700,000 budgeted for expenses. To ensure nationwide exposure for its product, the company has decided that each region must have at least 10 salespeople. The company wants to know how many salespeople to allocate to each region to maximize total average units sold. Formulate an integer programming model for this problem and solve it by using the computer.

20. During the war with Iraq in 1991, the Terraco Motor Company produced a lightweight, all-terrain vehicle code-named "J99 Terra" for the military. The company is now planning to sell the Terra to the public. It has five plants that manufacture the vehicle and four regional distribution centers. The company is unsure of public demand for the Terra, so it is considering reducing its fixed operating costs by closing one or more plants, even though it would incur an increase in transportation costs. The relevant costs for the problem are provided in the following table. The transportation costs are per thousand vehicles shipped; for example, the cost of shipping 1,000 vehicles from plant 1 to warehouse C is $32,000.

From Plant	Transportation Costs ($1,000s) to Warehouse A	B	C	D	Annual Production Capacity	Annual Fixed Operating Costs
1	$56	$21	$32	$65	12,000	$2,100,000
2	18	46	7	35	18,000	850,000
3	12	71	41	52	14,000	1,800,000
4	30	24	61	28	10,000	1,100,000
5	45	50	26	31	16,000	900,000
Annual Demand	6,000	14,000	8,000	10,000		

Formulate and solve an integer programming model for this problem to assist the company in determining which plants should remain open and which should be closed and the number of vehicles that should be shipped from each plant to each warehouse to minimize total cost.

21. The Otter Creek Winery produces three kinds of table wine—a blush, a white, and a red. The winery has 30,000 pounds of grapes available to produce wine this season. A cask of blush requires 360 pounds of grapes, a cask of white requires 375 pounds, and a cask of red requires 410 pounds. The