exposure value of at least 90,000.

	Medium Cost/Ad	Exposure Value/Ad	Min Units	Max Units
Radio	$500	2,000	0	15
TV	$2,000	4,000	10	
Magazine	$200	2,700		12

How many of each type of ad should be placed in order to minimize the cost of achieving the minimum required total exposure? Use the auxiliary variable approach to model this problem, and write a short memo to the marketing manager explaining the solution and sensitivity information.

6. Klein Industries manufactures three types of air compressors: small, medium, and large, which have unit profits of $20.46, $34.28, and $16.22, respectively. The projected monthly sales are:

	Small	Medium	Large
Minimum	14,000	6,200	2,600
Maximum	21,000	12,500	4,200

The production process consists of three primary activities: bending and forming, welding, and painting. The amount of time in minutes needed to process each product in each department is shown below:

	Small	Medium	Large	Available Time
Bending/forming	0.4	0.7	0.8	23,400
Welding	0.6	1.0	1.2	[illegible]
Painting	1.4	2.6	[illegible]	46,800

How many of each type of air compressor should the company produce to maximize profit?

a. Formulate and solve a linear optimization model using the auxiliary variable cell method and write a short memo to the production manager explaining the sensitivity information.

b. Solve the model without the auxiliary variables and explain the relationship between the reduced costs and the shadow prices found in part a.

7. The International Chef, Inc. markets three blends of oriental tea: premium, Duke Grey, and breakfast. The firm uses tea leaves from India, China, and new domestic California sources.

	Tea Leaves (percent)		
Quality	Indian	Chinese	California
Premium	40	20	20
Duke Grey	20	30	40
Breakfast	40	40	40

Net profit per pound for each blend is $0.50 for premium, $0.30 for Duke Grey, and $0.20 for breakfast. The firm's regular weekly supplies are 20,000 pounds of

Indian tea leaves, 22,000 pounds of Chinese tea leaves, and 16,000 pounds of California tea leaves. Develop and solve a linear optimization model to determine the optimal mix to maximize profit, and write a short memo to the president, Kathy Chung, explaining the sensitivity information in language that she can understand.

8. Young Energy operates a power plant that includes a coal-fired boiler to produce steam to drive a generator. The company can purchase different types of coals and blend them to meet the requirements for burning in the boiler. The table below shows the characteristics of the different types of coals:

Type	BTU/lb.	% Ash	% Moisture	Cost ($/lb)
A	11,500	13%	10%	$2.49
B	11,800	10%	8%	$3.04
C	12,200	12%	8%	$2.99
D	12,100	12%	8%	$2.61

The required BTU/lb must be at least 11,900. In addition, the ash content can be at most 12.2% and the moisture content at most 9.4%. Develop and solve a linear optimization model to find the best coal blend for Young Energy. Explain how the company might reduce its costs by changing the blending restrictions.

9. The Hansel Corporation, located in Bangalore, India, makes plastics materials that are mixed with various additives and reinforcing materials before being melted, extruded, and cut into small pellets for sale to other manufacturers. Four grades of plastic are made, each of which might include up to four different additives. The table below shows the number of pounds of additive per pound of each grade of final product, the weekly availability of the additives, and cost and profitability information.

	Grade 1	Grade 2	Grade 3	Grade 4	Availability
Additive A	0.40	0.37	0.34	0.90	100,000
Additive B	0.30	0.33	0.33		90,000
Additive C	0.20	0.25	0.33		40,000
Additive D	0.10	0.05		0.10	10,000
Profit/lb	$2.00	$1.70	$1.50	$2.80	

Because of marketing considerations, the total amount of grades 1 and 2 should not exceed 60% of the total of all grades produced, and at least 30% of the total product mix should be grade 4.

a. How much of each grade should be produced to maximize profit? Develop and solve a linear optimization model.
b. A labor strike in India leads to a shortage of 20,000 units of additive C. What should the production manager do?
c. Management is considering raising the price on grade 2 to $2.00 per pound. How will the solution be changed?

10. Janette Douglas is coordinating a bake sale for a nonprofit organization. The organization has acquired $2,000 in donations to hold the sale [illegible] table