(NewAge Pharmaceutical) NewAge Pharmaceuticals produces the drug NasaMist from four chemicals. Today, the company must produce 5000 pounds of the drug. The three active ingredients in NasaMist are A, B, and C. By weight, at least 7% of NasaMist must consist of A, at least 5% must consist of B, and at least 3% must consist of C. The cost per pound of each chemical and the amount of each active ingredient in one pound of each chemical are given in the file **P04_48.xlsx**. At least 600 pounds of chemical 3 must be used. Determine the cheapest way of producing today's batch of NasaMist.

WinstonAlbright_6e_ P04_48.xlsx

NewAge data				
Cost/lb of chemicals				
Chemical 1	$8			
Chemical 2	$10			
Chemical 3	$11			
Chemical 4	$14			
Ingredient/lb of chemical				
	A	B	C	
Chemical 1	0.06	0.04	0.01	
Chemical 2	0.10	0.03	0.04	
Chemical 3	0.12	0.09	0.04	
Chemical 4	0.03	0.02	0.01	

Discussion: -

In these types of problems, we must blend various inputs together to produce desired outputs. NewAge company is using 4 types of chemicals to produce drug NasaMist. There are three ingredients in this drug. Each chemical will have certain percentage of ingredients. NasaMist drug is the output prepared by mixing these 4 chemicals, which means this drug contain the three ingredients as well. Our problem says that NasaMist drug should have at least certain percentage of these ingredients. From the problem we can understand that we can use these 4 chemicals to prepare a drug, but the output of the drug should have certain percentage of ingredients. So, our decision will be the amount of each input bended into output.

Mathematical Model: -

Parameters (Inputs):

$i \in 1,2,3,4$ (i: $Index\ for\ chemical\ type$)
$j \in 1,2,3$ (j: $Index\ for\ ingredients$)
D : $Demand\ \ to\ produce\ drug\ NasaMist; D = 5000\ pounds$
R_i : $Cost\ per\ lb\ of\ chemical\ i$
P : $Must\ use\ pounds\ of\ chemical\ 3\ in\ production; P = 600\ pounds$
W_j : $Weight\ of\ ingredient\ j\ required\ to\ produce\ drug\ NasaMist$

A_{ij} : *Ingredient j level per 1 lb of chemical i*

	A	B	C
Chemical 1	0.06	0.04	0.01
Chemical 2	0.10	0.03	0.04
Chemical 3	0.12	0.09	0.04
Chemical 4	0.03	0.02	0.01

Decision Variables:

x_i : *Chemical i in lbs used for producing drug NasaMist*

Calculated Variables:

$N_j = \sum_{i=1}^{4} (x_i * A_{ij}) \quad for\ j\epsilon\{1,2,3\}$ *Level of ingredient j available in produced drug*

Objective:

$$Minimize\ Total\ cost = \sum_{i=1}^{4} x_i * R_i$$

Constraints:

$x_i \geq 0;$ (1) *Non Negative constraint*

$N_j \geq W_j * D;\ for\ j\epsilon\{1,2,3\}$ (2) *Ingredient constraint in output drug*

$x_3 \geq P;$ (3) *Must use pounds of chemical 3 in production*

$\sum_{i=1}^{4} x_i \geq D;$ (4) *Demand constraint*

Constraint 2 will make sure that final output(drug) has certain level of ingredients A, B, C. As the levels are given in percentage we need to multiply the value with the demand. As it is cost minimizing problem and cost is directly proportional on the weight of the chemical used, our optimal solution will make sure to use lower cost chemicals by keeping ingredient levels as constraint.

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Excel Implementation: Please find the attached spreadsheet for solution.

Blending [NewAge Pharmaceutical]: LP-CH4-Q48

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NewAge data					Inputs			
					Decision variables			
Cost/lb of chemicals					Calculated Variables			
Chemical 1	$8				Constraints			
Chemical 2	$10				Objective			
Chemical 3	$11							
Chemical 4	$14							
Ingredient/lb of chemical								
	A	B	C			Usage in lb		
Chemical 1	0.06	0.04	0.01		Chemical 1	1666.67		
Chemical 2	0.10	0.03	0.04		Chemical 2	1944.44		
Chemical 3	0.12	0.09	0.04		Chemical 3	1388.89	>=	600
Chemical 4	0.03	0.02	0.01		Chemical 4	0.00		
						5000.00		
	A	B	C			>=		
Chemical 1	100.00	66.67	16.67			5000.00		
Chemical 2	194.44	58.33	77.78					
Chemical 3	166.67	125.00	55.56		Total Cost	$48,055.56		
Chemical 4	0.00	0.00	0.00					
	461.11	**250.00**	**150.00**					
	>=	>=	>=					
	350	250	150					
% Active ingredient required	0.07	0.05	0.03					