1.) Back Savers - Product Mix
Management wants to know the number of each backpack model they should produce (in order to maximize profit).

Notes to self from assignment:

Backpack Models	Material Required (SqFt)	Labor Hours Required	Sales Fcst	Profit / Unit
Collegiate	3	0.75	1,000	$32.00
Mini	2	0.66	1,200	$24.00

a. Decision Variables:

X_1 = Number of Collegiates to produce
X_2 = Number of Minis to produce

b. Goal (Objective Function):

Maximize — $Z = 32x_1 + 24x_2$

c. Subject to the following Constraints:

Constraint Note	Constraint Formula
Materials Available	$3x_1 + 2x_2 <= 5{,}000$
Collegiate Sales Forecast	$x_1 <= 1{,}000$
Mini Sales Forecast	$x_2 <= 1{,}200$
Labor Hours Available	$0.75x_1 + 0.66x_2 <= 1{,}400$
Non-Negativity	$x_1 >= 0$, $x_2 >= 0$

d. Full Mathematical Formulation:

Maximize

$Z = 32x_1 + 24x_2$

Subject to

$3x_1 + 2x_2 <= 5{,}000,$
$x_1 <= 1{,}000,$
$x_2 <= 1{,}200,$
$0.75x_1 + 0.66x_2 <= 1{,}400,$

And

$x_1 >= 0$, $x_2 >= 0$

2.) Weigelt Corp - Product/Plant Mix

How many of each size should be produced by each plant in order to maximize profit?

Notes to self from assignment:

Size	Profit Per Unit	Size of Unit (SqFt)	Sales Fcst
L	$420.00	20	900
M	$360.00	15	1,200
S	$300.00	12	750

Plant	Excess Capacity (units)	Available Storage In Each Plant (SqFt)
1	750	13,000
2	900	12,000
3	450	5,000

**Management Requests that the plants use the same percentage of their remaining capacities to produce the new product*

a. Define the decision variables:

	Size L	Size M	Size S
Plant 1	x_1	x_4	x_7
Plant 2	x_2	x_5	x_8
Plant 3	x_3	x_6	x_9

x_1 = Number of L units to produce at Plant 1
x_2 = Number of L units to produce at Plant 2
x_3 = Number of L units to produce at Plant 3
x_4 = Number of M units to produce at Plant 1
x_5 = Number of M units to produce at Plant 2
x_6 = Number of M units to produce at Plant 3
x_7 = Number of S units to produce at Plant 1
x_8 = Number of S units to produce at Plant 2
x_9 = Number of S units to produce at Plant 3

Notes to self:
Z = Profit

Obj Function:
Maximize — $Z = 420(x_1 + x_2 + x_3) + 360(x_4 + x_5 + x_6) + 300(x_7 + x_8 + x_9)$

Constraints:

Constraint Notes	Constraint Formula
$x_1 + x_4 + x_7 <= 750$	Plant 1 production cap
$x_2 + x_5 + x_8 <= 900$	Plant 2 production cap
$x_3 + x_6 + x_9 <= 450$	Plant 3 production cap
$x_1 + x_2 + x_3 <= 900$	Large Sales fcst
$x_4 + x_5 + x_6 <= 1{,}200$	Medium sales fcst
$x_7 + x_8 + x_9 <= 750$	Small sales fcst
$20x_1 + 15x_4 + 12x_7 <= 13{,}000$	Plant 1 storage cap
$20x_2 + 15x_5 + 12x_8 <= 12{,}000$	Plant 2 storage cap
$20x_3 + 15x_6 + 12x_9 <= 5{,}000$	Plant 3 storage cap
$(x_1 + x_4 + x_7)/750 = (x_2 + x_5 + x_8)/900 = (x_3 + x_6 + x_9)/450$	Equal percentage excess capacity used
$x_1 >= 0$, $x_2 >= 0$, $x_3 >= 0$, $x_4 >= 0$, $x_5 >= 0$, $x_6 >= 0$, $x_7 >= 0$, $x_8 >= 0$, $x_9 >= 0$	Non-Negativity

**Note → This assumes that the products produced at a certain plant should only be stored at that plant, and cannot be stored at other plants. No information was given on how storage should be treated.*

b. Formulate a linear programming model for this problem

Maximize

$Z = 420(x_1 + x_2 + x_3) + 360(x_4 + x_5 + x_6) + 300(x_7 + x_8 + x_9)$

Subject to

$x_1 + x_4 + x_7 <= 750,$
$x_2 + x_5 + x_8 <= 900,$
$x_3 + x_6 + x_9 <= 450,$
$x_1 + x_2 + x_3 <= 900,$
$x_4 + x_5 + x_6 <= 1{,}200,$
$x_7 + x_8 + x_9 <= 750,$
$20x_1 + 15x_4 + 12x_7 <= 13{,}000,$
$20x_2 + 15x_5 + 12x_8 <= 12{,}000,$
$20x_3 + 15x_6 + 12x_9 <= 5{,}000,$
$(x_1 + x_4 + x_7)/750 = (x_2 + x_5 + x_8)/900 = (x_3 + x_6 + x_9)/450,$

And

$x_1 >= 0, x_2 >= 0, x_3 >= 0, x_4 >= 0, x_5 >= 0, x_6 >= 0, x_7 >= 0, x_8 >= 0, x_9 >= 0$