OPTIMIZATION ASSIGNMENT -2

AADILA JASMIN – 2019A7PS0801U

QUESTION: A wilderness hiker must pack three items: food, first-aid kits, and clothes. The back-pack has a capacity of 3 ft3. Each unit of food takes 1 ft3. A first-aid kit occupies 1/4 ft3, and each piece of cloth takes about 1/2 ft3. The hiker assigns the priority weights 3, 4, and 5 to food, first aid, and clothes, respectively, which means that clothes are the most valuable of the three items. From experience, the hiker must take at least one unit of each item and no more than two first-aid kits. How many of each item should the hiker take?

THEORY:

This question is a type of Knapsack Dynamic programming problem.

Knapsack Dynamic programming problem: Given weights (priority weights) and values of n items (3 in this case), put these items in a knapsack of capacity W (Space capacity of 3 in this question) to get the maximum total value in the knapsack (Objective to maximize). In other words, given two integer arrays values[0..n-1] and weight[0..n-1] which represent values and weights associated with n items respectively.

ABOUT THE SOFTWARE USED:

Solver is a Microsoft Excel add-in program that is used to determine maximum and minimum value of a cell (the objective function, which is Z in this problem) by modifying other cells. It uses techniques from the operations research field to find optimal solutions for all kinds of decision problems. Solver adjusts the values of the decision variables so that the needs of the constraints given in the problem are met. Various methods of solving such as Simplex LP, GRG non-linear, and Evolutionary are included. We need to provide the decision variables, constraints and the objective function along with other details such as “maximization” or “minimization” so that the optimal value can be calculated.

SOLUTION

The above problem is a **Dynamic Programming** - Knap Sack problem. The data given is as follows:

Item Number	Item	Volume (cubic feet) per piece	Priority Weight
x1	Food	1	3 (least valuable)
x2	First-aid Kits	1/4	4
x3	Clothes	1/2	5 (most valuable)

- ➔ **Let x1, x2, x3 be the units of food, first-aid kit, and clothes carried respectively.**

Backpack space limit: 3 cubic feet.

Constraints:

At least one unit of each, so, we have,

- ➔ **x_1>=1, x_2>=1, x_3 >= 1**

No more than 2 first aid kits so,

- ➔ **x_2 <= 2**

and since the space capacity of the bag is 3 cubic feet

- ➔ **$x_1(1) + x_2(1/4) + x_3(1/2) <= 3$**

Non negativity constraint

- ➔ **$x_1, x_2, x_3 >= 0$**

Objective function (based on the priority weights of each item)

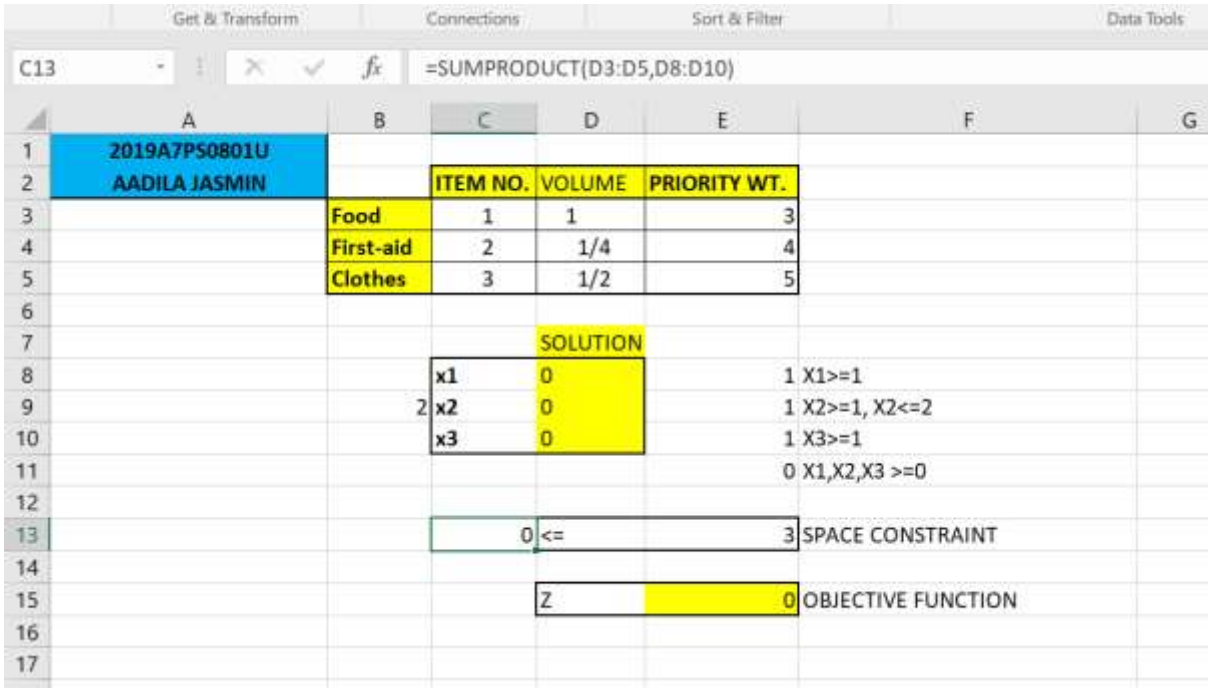
- ➔ **Maximize $Z = 3x_1 + 4x_2 + 5x_3$**
- ➔ **All the variable must be positive integers.**

STEPS TAKEN TOWARDS SOLUTION:

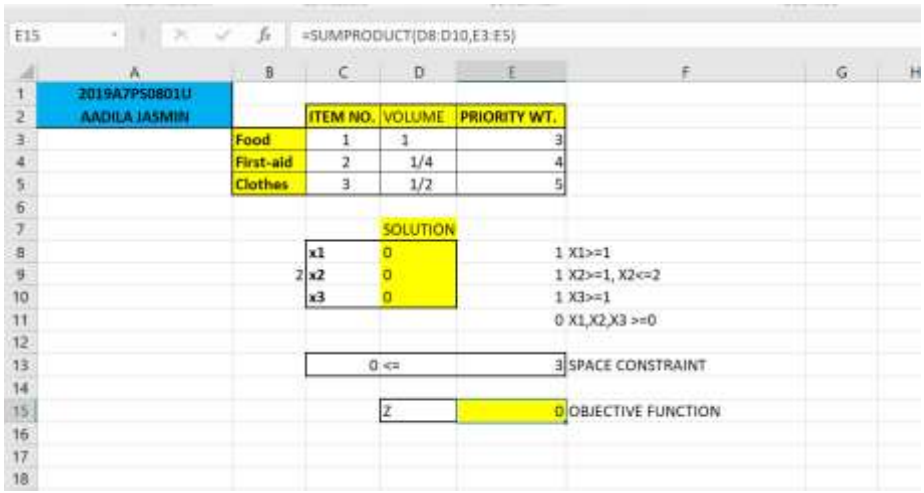
Step1: Install Excel Solver extension and add it to Microsoft Excel.

Step2: Add all the data to the excel sheet. Initialize the decision variables to 0. I have taken the cells D8, D9, D10 as the target cells to be changed corresponding to x1, x2, x3 which are units of food,

first aid, clothes, respectively.

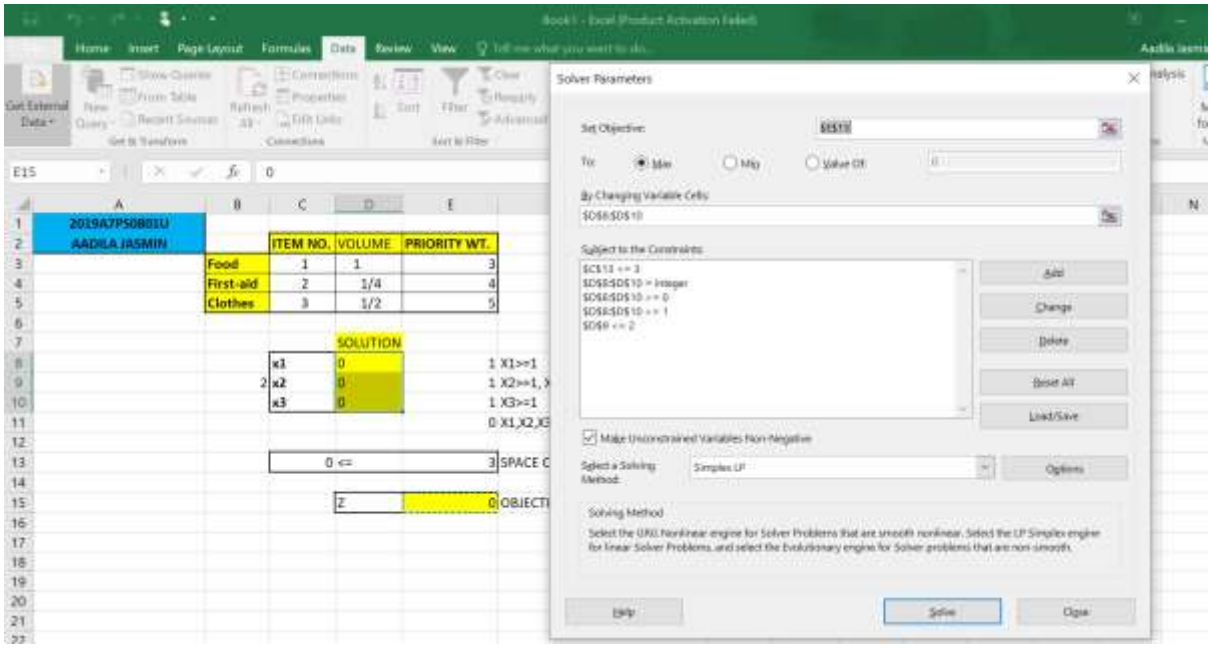


Step3: Form the equations for the constraints. For example, setting the space constraint as sum product of volume with x1, x2, x3 and setting the objective function which is the product of x1,x2,x3 and its respective priority weights. (I have used the "SUMPRODUCT" formula.)

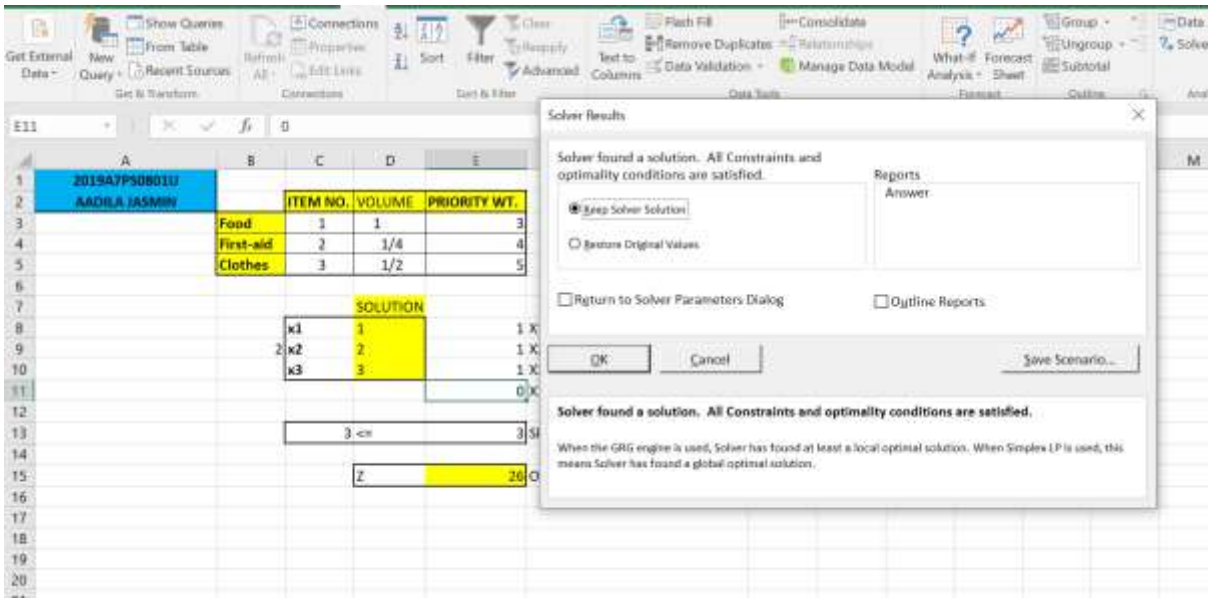


Step4: Open the solver extension on excel under the Data Menu and add all the details. This includes setting the Objective function, "Maximization" option, and setting all the constraints using the "add" option. We also have to set all the constraints as "integers" in order to avoid getting fractional results.

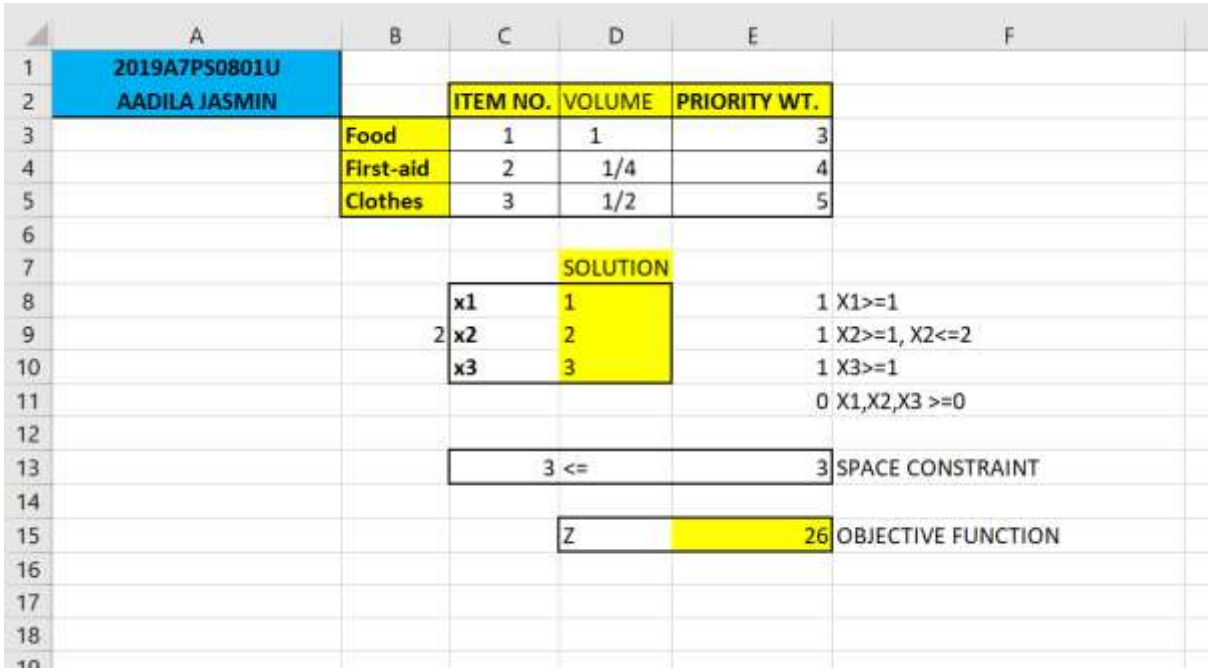
We have all the constraints added including space constraint, non-negativity constraint, the limitations as described earlier and the integer constraint.



Step5: Click on Solve and select “keep solver solution” in order to obtain the final results.



THE FINAL RESULTS:



	A	B	C	D	E	F
1	2019A7PS0801U					
2	AADILA JASMIN		ITEM NO.	VOLUME	PRIORITY WT.	
3		Food	1	1	3	
4		First-aid	2	1/4	4	
5		Clothes	3	1/2	5	
6						
7				SOLUTION		
8			x1	1	1	X1>=1
9		2	x2	2	1	X2>=1, X2<=2
10			x3	3	1	X3>=1
11					0	X1,X2,X3 >=0
12						
13			3 <=		3	SPACE CONSTRAINT
14						
15				Z	26	OBJECTIVE FUNCTION
16						
17						
18						

Hence, We can conclude that the hiker needs 1 unit of food, 2 units of first-aid and 3 units of Clothes and the maximum z value (Objective function value) obtained is 26.

			SOLUTION
FOOD		**x1**	1
FIRST AID		**x2**	2
CLOTHES		**x3**	3
Z	26	OBJECTIVE FUNCTION	