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8. A fruit grower can use two types of fertilizer in his garden, brand P and brand Q. The amounts (in kg) of nitrogen, phosphoric acid, potash, and chlorine in a bag of each brand are given in the table, Tests indicate that the garden needs at least 240 kg of phosphoric acid, at least 270 kg of potash and at most 310 kg of chlorine.

If the grower wants to minimize the amount of nitrogen added to the garden, how many bags of each brand should be used? What is the minimum amount of nitrogen added in the garden?

Kg per bag

	Brand P	Brand Q
Nitrogen	3	3.5
Phosphoric acid	1	2
Potash	3	1.5
Chlorine	1.5	2

Solution:

Let the fruit grower use x bags of brand P and y bags of brand Q respectively

The problem can be formulated as given below

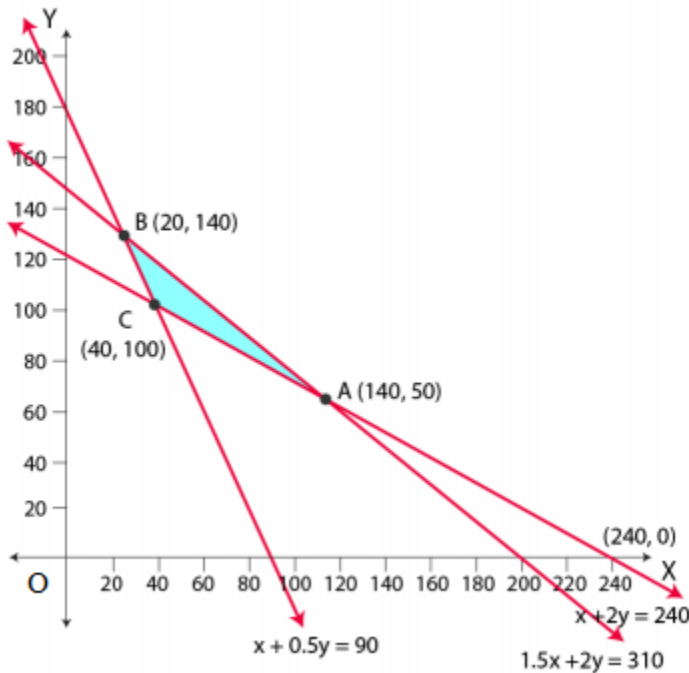Minimize z = 3x + 3.5y …………. (i)

Subject to the constraints,

x + 2y ≥ 240 ……….. (ii)

x + 0.5y ≥ 90 …….. (iii)

1.5x + 2y ≤ 310 ……….. (iv)

x, y ≥ 0 …………. (v)

The feasible region determined by the system of constraints is given below

A (240, 0), B (140, 50) and C (20, 140) are the corner points of the feasible region

The value of z at these corner points are given below

Corner point	z = 3x + 3.5y	
A (140, 50)	595	
B (20, 140)	550	
C (40, 100)	470	Minimum

The maximum value of z is 470 at (40, 100)

Therefore, 40 bags of brand P and 100 bags of brand Q should be added to the garden to minimize the amount of nitrogen

Hence, the minimum amount of nitrogen added to the garden is 470 kg.

9. Refer to Question 8. If the grower wants to maximize the amount of nitrogen added to the garden, how many bags of each brand should be added? What is the maximum amount of nitrogen added?

Solution:

Let the fruit grower use x bags of brand P and y bags of brand Q respectively

The problem can be formulated as given below

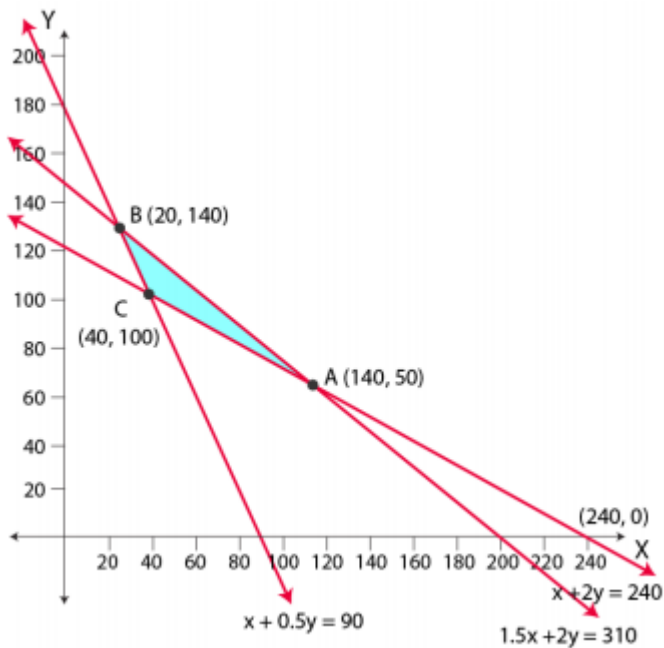Maximize $z = 3x + 3.5y$ ……….. (i)

Subject to the constraints,

$x + 2y \geq 240$ ……….. (ii)

$x + 0.5y \geq 90$ ……….. (iii)

$1.5x + 2y \leq 310$ ……….. (iv)

$x, y \geq 0$ …………. (v)

The feasible region determined by the system of constraints is given below

A (140, 50), B (20, 140) and C (40, 100) are the corner points of the feasible region

The values of z at these corner points are given below

Corner point	z = 3x + 3.5y	
A (140, 50)	595	Maximum
B (20, 140)	550	
C (40, 100)	470	

The maximum value of z is 595 at (140, 50)

Hence, 140 bags of brand P and 50 bags of brand Q should be used to maximize the amount of nitrogen.

Thus, the maximum amount of nitrogen added to the garden is 595 kg.