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#5) A salesperson finds that her sales average 40 cases per store when she visits 20 stores a week. Each time she visits 3 additional stores per week, the average sales per store decrease by 2 cases. How many stores should she visit if she wants to maximize her sales?

We need to make an equation from this information.
stores $_x$ avg # cases = total sales

(20+3x) $_x$ (40-2x) = **total sales** ←We want to maximize this number
stores $_x$ # cases = total sales

We are given the information that the salesperson averages 40 cases per store when she visits 20 stores per week. We are also told that for every 3 additional stores she visits, the average cases sold per store decrease by 2. We use "x" as our variable to show the incremental 2 case decline in average sales corresponding to every increase of 3 stores visited. In other words, "x" is the number of changes made.

This is a quadratic equation. The graph will look like a parabola. The maximum total sales will be the vertex point. After that point, sales will actually decline for each additional store visited.

We need to get our equation into vertex form.

$(20+3x)_x(40-2x) = y$ Foil
$800 - 40x + 120x - 6x^2 = y$ Combine like terms & rearrange
$-6x^2 + 80x + 800 = y$ "Bury" the -6
$x^2 + \frac{80x}{-6} + \frac{800}{-6} = \frac{y}{-6}$ For time's sake, we will convert to decimals
$x^2 + (-13.3x) + (-133.3) = \frac{y}{-6}$
$x^2 - 13.3x - 133.3 = \frac{y}{-6}$ Add $(b/2)^2$ to both sides. b=-13.3 →$(-13.3/2)^2 = (-6.6667)^2 = 44.4$
$x^2 - 13.3x + (6.6667)^2 - 133.3 = \frac{y}{-6} + (6.6667)^2$
$(x - 6.6667)^2 - 133.3 = \frac{y}{-6} + (6.6667)^2$ Factor and solve for "y"
$(x - 6.6667)^2 - 133.3 = \frac{y}{-6} + (6.6667)^2$ Subtract $(6.6667)^2$ from both sides
$-(6.6667)^2 \quad -6 - (6.6667)^2$
$(x - 6.6667)^2 - 177.7 = \frac{y}{-6}$ Multiply both sides by -6
$_x-6 \quad _x-6 \quad -6$
$-6(x - \mathbf{6.6667})^2 + \mathbf{1066.67} = y$ Now, we are able to extract the vertex!
Vertex: **(6.6667, 1066.67)**

What does this mean?
Lets go back to our original formula:
(20+3x) $_x$ (40-2x) = **total sales**
Plug in 6.6667 for x
[20+3(6.6667)] $_x$ [40-2(6.6667)] = total sales
= (20 + 20) $_x$ (40 – 13.3334) = total sales

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= (40) $_x$ (26.66667) = **1066.67**

This means: 40 is the number of stores the salesperson must visit to maximize sales. At this point, she will average 26.66667 cases per store, maximizing sales at a total of about 1066.67 cases.

Finally, graph the parabola to get a visual: