The following problem has to do with the concepts of diminishing marginal productivity. In our previous examples we fixed all other factor inputs and only varied one input (labor). We had not covered on how to optimize when we vary multiple factor inputs.

Recall we said that it is optimal to add factor inputs until the value of its marginal product equals the amount we pay for each unit of that input, or in our case with labor, until:

$$VMP_l = w_l$$

At this point the increase in the value of output produced equals the cost of the additional worker.

Suppose we vary another input while holding labor constant, for simplicity we'll just refer to that as capital. It would be optimal to add capital until

$$VMP_K = w_K$$

Note:

$VMP_K = w_K \Rightarrow \frac{VMP_K}{w_K} = 1$ and $VMP_L = w_L \Rightarrow \frac{VMP_L}{w_L} = 1$

From this we can see, when we are varying two factor inputs it must be efficient when we have the following:

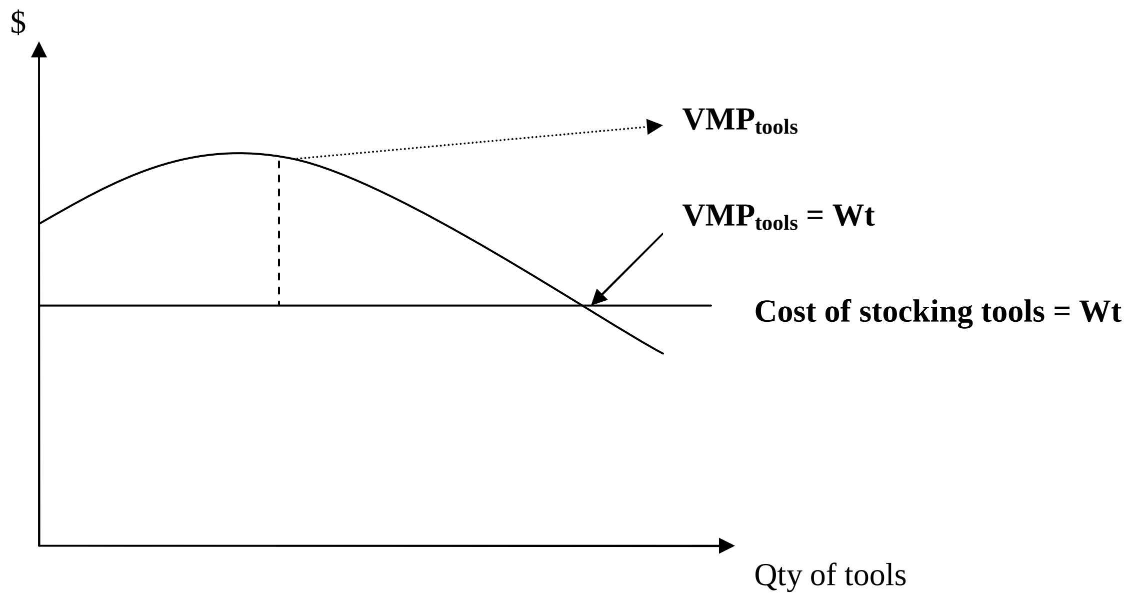
$$\frac{VMP_L}{w_L} = \frac{VMP_K}{w_K}$$

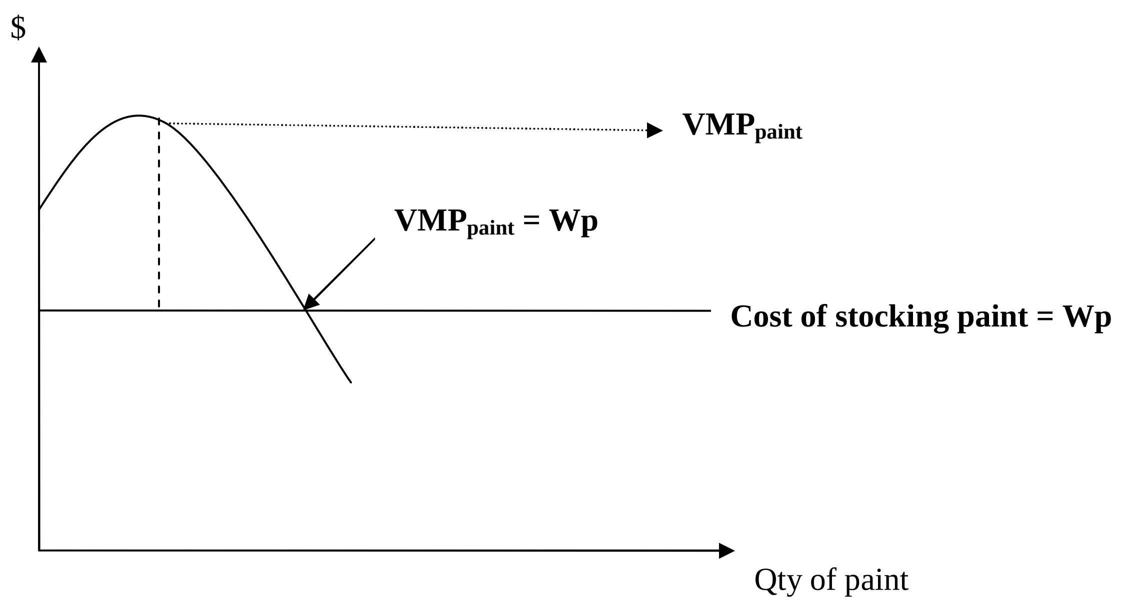
In order to maximize net benefits produced by the firm, the ratio of the marginal products of each factor to its wage must be the same for all factors. When the VMP per dollar spent on each factor are the same, no rearrangement of inputs to production can increase output; net rents are as large as possible. Maximization of net benefits requires equalization of net benefits at every margin.

4. You are the owner of a large hardware store. Your accountants point out to you that you make twice as much profits selling tools as you do selling paint, but your profit per gallon of paint is more than your profit per tool sold.

a. Is this possible? Explain why or why not, perhaps with a diagram.
b. Would these data indicate that you should reduce or eliminate one of these items from your shelves, and if so, which one?
c. The accountants further point out that both these items have higher profits over-all and per unit than metric screws. Should you be selling metric screws?

a)





These graphs show the case where we have higher profit per paint sold (higher average profit per paint) but we have higher total profit when selling tools. A few things to note on the graphs: The curve represents the **v**alue of **m**arginal **p**roduct of each good. Comparing the graphs to the previous problems with tables, we can see an increase in productivity, but eventually we see it continually diminish. (DON'T LET CLUE TELL YOU OTHERWISE!!!)

The dashed line represents the average profit (**v**alue of **a**verage **p**roduct) of each good, note that the profit per paint is higher than the profit per tool.

The area below the VMP curve, and above the constant cost of stocking each good is the total profit (**v**alue of **t**otal **p**roduct). We can see that the area for tools is larger than the area for paint. We must be selling a much higher volume of tools than paint.

b) Should we reduce either good? Well, given the above graphs we are at the following point:

$$\frac{VMP_P}{w_P} = \frac{VMP_T}{w_T}$$

No rearrangement of goods on stock will increase the profits from the hardware store. We've equated at the margin. Suppose we stock more paint and reduce the amount of tools. Looking at the graph, the profit received by that marginal paint will be less than the cost of stocking the paint, thus the store will lose profit.

c) We should stock metric screws. Even if the total profit is less than both paint and tools, there can be profits realized at the margin. We would likely devote very little shelf space to those screws, but we'd stock until:

$$\frac{VMP_L}{w_L} = \frac{VMP_K}{w_K} = \frac{VMP_S}{w_S}$$