Directions: Please answer all items on this homework. This homework must be typed except for anything that needs to be graphed. No handwritten assignments will be accepted. You may do all graphing on a computer. But, realize you will not have a computer for the exam, so do not blindly trust the computer to do most of your work. You must show all your work.

1. How do you know if a production function is concave or convex? Please explain. **(5 points)**

2. Please classify and explain what each stage of production you are in for each of the given scenarios: **(5 points)**

   a. Average physical product is 45 and the marginal physical product is -60,
   b. Average physical product is 27 and the marginal physical product is 47,
   c. Average physical product is 46 and the marginal physical product is 26.

3. Please explain the relationship between average physical product (APP) and marginal physical product (MPP). **(5 points)**

4. If your average physical product (APP) is equal to 3 using 5 inputs, what do you expect to happen to your current APP when your marginal physical product (MPP) is 9 when you move to 6 inputs? What is your new APP given this new MPP? Please show how you found your answer. **(5 points)**

5. Given that your total cost is $1,000,000, your total fixed cost is $200,000, and your output is 50,000, what are your a) total variable cost, b) average variable cost, c) average fixed cost, and d) average total cost? Please show how you found your answer. **(5 points)**

6. Suppose you have the following cost function: $c(y) = 16y^2 + 200,000$. Please sketch the Average Fixed Cost, the Average Variable Cost, and the Average Total Cost curves where y represents the output and c(y) represents the total cost at output y. You may want to focus sketching these curves for outputs of 10, 20, 40, 50, 80, 100, 160, 200, 250, and 320. It is acceptable to sketch these curves using excel, but you should be able to sketch the curves by hand. **(5 points)**

7. Please explain the argument why marginal cost can equal both the change in total cost divided by the change in output and the change in total variable cost divided by the change in output when total cost and variable cost are not equal? **(5 points)**

8. Please derive AVC = w / APP, using the production and cost relationships. (Hint: define and apply the definition of AVC.) **(5 points)**

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9. Please derive MC = w / MPP, using the production and cost relationships. (Hint: define and apply the definition of MC.) **(5 points)**

10. What is the short-run decision rule for producing an output? Please explain. **(5 points)**

11. Explain the intuition of why the optimal output occurs when marginal revenue equals marginal cost. **(5 points)**

12. Please explain the shutdown rule. Using the profit function, please create an example not presented in class of a situation when you would shut down and when you would produce. Use a table to discuss why you would shut down or produce under each situation. **(5 points)**

13. Please explain how you decide what level of inputs you use to produce an output. Show this on a graph. **(5 points)**

14. Please explain how you decide what level of outputs you produce given a fixed level of an input. Show this on a graph. **(5 points)**

15. Suppose your goal this year is to produce 6,400 bushels of organic corn. Suppose your production technology has the following relationship for producing bushels of corn $Q = f(L,T) = LT$ where Q is the number of bushels of corn you produce, L is the number of labor hours you utilize, and T is the number of tractor hours you utilize. You know that the cost per hour of labor is $20 and the cost per hour of tractor time is $500. Assume that you are a cost minimizing producer. **(30 points)**

   a. Theoretically, tell me how you would figure out what your minimum cost is for producing a quantity of 6,400 bushels of corn.

   b. How much money will you need to ask from your banker to achieve your goal? (Note: when given your particular production function, the optimal amount of input formulas are
   $$L = \sqrt{Q\frac{p_T}{p_L}} \text{ and } T = \sqrt{Q\frac{p_L}{p_T}},$$ where p_L is the cost of labor and p_T is the cost of tractor time.)

   c. Please sketch a graph of this solution. Include the isoquant and iso-cost line.

   d. Suppose after reviewing your business plan, your banker tells you she is only willing to give you $8,000. Theoretically, tell me how you would figure out what your maximum production is when you have only $8,000 to work with and you are a cost minimizer.

   e. What is the maximum amount you can produce? (Note: when given a particular expenditure E and you are trying to maximize output, the optimal amount of input formulas are $L = \dfrac{E}{2p_L}$ and $T = \dfrac{E}{2p_T}$, where p_L is the cost of labor and p_T is the cost of tractor time.)

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f.   Please sketch this new answer on the graph from answer c. Please include the isoquant and the iso-cost line.