**Answers to Problem Set #7**
Principles of Microeconomics
Professor Hungerman

1. Suppose that a firm in a perfectly competitive industry makes pizza and has a *marginal cost function* that equals q^2. Thus, the marginal cost of producing the fourth pizza is $4^2 = 16$.

  A. Is this marginal cost curve compatible with the law of diminishing returns?
  Yes it is. This marginal cost curve steadily rises, suggesting that the cost of making each additional pizza rises as output grows. The idea that marginal cost rises comes directly from the law of diminishing returns—as each unit of variable input (for example, labor) becomes less productive, it becomes more expensive to produce each successive unit of output.
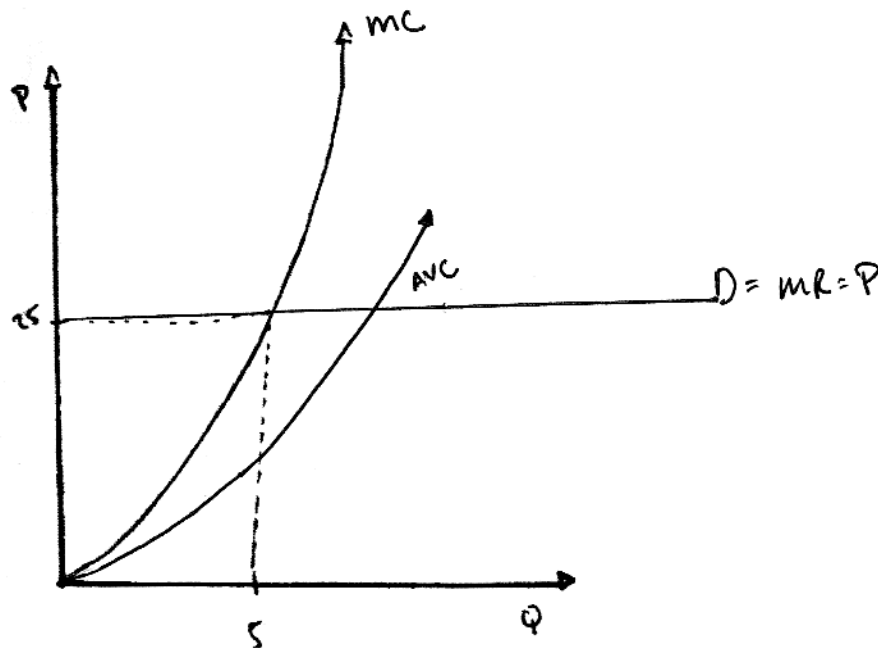

  B. Suppose the price of a pizza equals $25 (expensive pizza!). Suppose also that for this firm average variable cost (AVC) is always rising. With this in mind, what amount will the firm produce in the short run? (Assume fixed costs are zero.)

  If AVC is always rising, it is always below MC. Thus, at any price, the firm will produce where P = MC > AVC, so P > AVC, so TR > TVC, so by producing the firm will create more revenue than it creates costs. The firm will choose to operate in the short run.

  Given that the firm will not shut down, the firm will produce at the quantity where marginal revenue (or price) equals marginal cost (q^2). Solving $q^2 = 25$ yields q = 5.
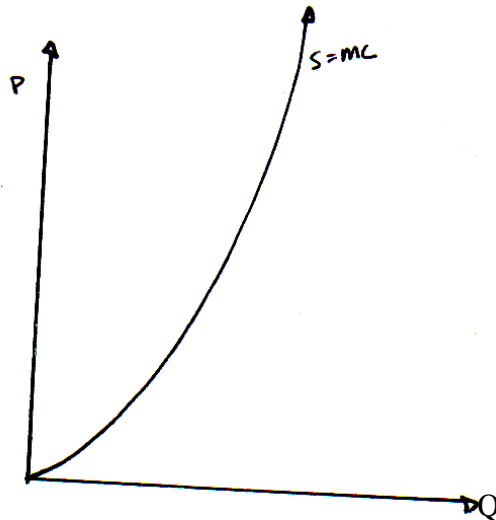
C. Draw a picture of what total variable costs look like for this firm, with quantity on the x axis and TVC on the y axis.
TVC starts at the origin and rises at an ever faster rate.
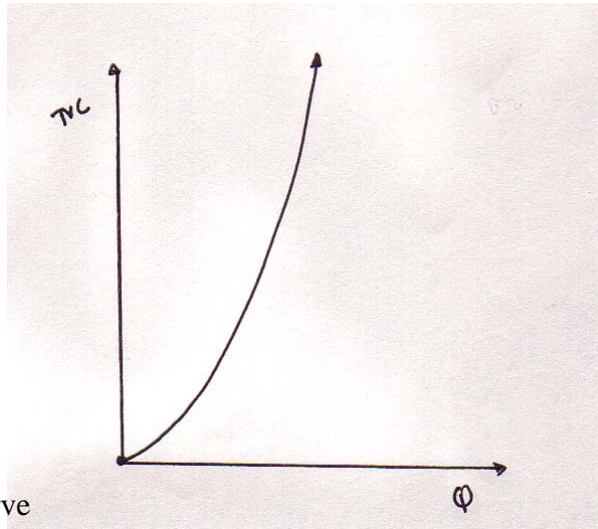
D. Draw this firm's supply curve
Since MC is always > AVC, by assumption, the supply curve is just the MC curve—the right half of a parabola that starts at the origin.

E. Suppose that the only variable input is labor, and that each unit of labor costs $3 (that is, $P_L = \$3$). What is the formula that relates marginal cost and marginal product of labor? Use this formula to come up with the formula for this firm's marginal product of labor. Explain what is going on with this firm's marginal product of labor.

The formula that relates these two things is $MC = P_L / MP_L$, where MP_L is the marginal product of labor. Thus, $MP_L = P_L / MC = 3/q^2$. Thus, as quantity increases, the marginal product of labor falls—as suggested by the law of diminishing returns. Each worker we hire raises output, but by decreasing

amounts. So as quantity rises, additional units of labor add less and less to our output.

2. Question 3 from the book, page 261
   a. (i) profit maximizing output is 4 pizzas an hour & profit is $2 an hour—I think online the answer is $10, but I also think that the answer really is $2.
   (ii) profit maximizing output is 3 pizzas an hour & profit is -$5.
   (iii) output is 2 pizzas and profit is -$10.
   b. Shutdown is at $10 a pizza and an output of 2 pizzas
   c. Supply equals MC above $10 and is zero below that
   d. Pat will exit if, in the long run, he (or she?) cannot make a profit—that is if in the long run price is below minimum ATC. This will be true if price is less than $13 a pizza. (You should try to show this to yourself.)

3. Question 4 from the book, page 261. (Note that answering *g* and *h* before *f* might be easier)
   a. Market price is $8.40 a paper box.
   b. Output is 350,000 boxes of paper
   c. Each firm makes 350 boxes of paper
   d. Each firm incurs a loss of $581.
   e. In the long run, some firms will exit the industry.
   f, g, and h. When the book says "in the long run" for this part of the question, what the book means is what we called in class "long run equilibrium. In the long run equilibrium, price and ATC will be the same (firms earn zero profit in the long run equilibrium). At an output level of 400, price and ATC are the same—so this is the long run quantity each firm will produce. At this price, demand is 300,000. So each firm makes 400, and 300,000/400 = 750. So there are 750 firms.

4. Suppose a firm in a perfectly competitive industry sells corn, and the firm's *average variable cost function* is $(q - 3)^2 + 3$. This is a parabola that reaches its minimum at the point $q = 3$.
   A. What is this firm's shutdown point? (The answer should be a price and a quantity.)
   *The shutdown point is where price and quantity both equal three—and price below this will be below AVC, and (in the short run) a firm will lose more than it gains by producing output.*

   B.   At the point $q = 3$, what is marginal cost?
   This is the point where AVC is minimized—hence, AVC and MC are the same at this point. It so happens that at this point AVC is 3, and so MC is also 3 at this point. Don't be confused that AVC has a minimum of 3 when q = 3. That is just coincidence. Note that if the AVC function above were a little difference, say,
   $$(q - 4)^2 + 3$$
   this would no longer be the case.
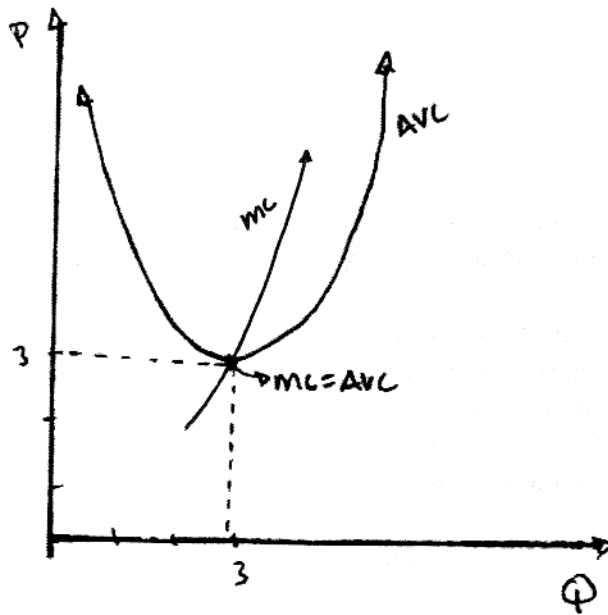
C. Suppose the firm has total fixed cost, in the short run, of $50. What is this
firm's average total cost function?

*Then the firms average fixed cost function is 50/q. So the firms average total cost
function is the sum average fixed costs and average variable costs, which we can
write as $50/q + (q - 3)^2 + 3$. By the way, total costs would be found by multiplying
this by q: $50 + q(q - 3)^2 + 3q$.*