

**Homework Quiz: Wednesday, March 19**

1. A firm has the production function  $\sqrt{KL}$ . Using calculus, the  $MPL = 1/2L^{-1/2}K^{1/2}$ , and the  $MPK = 1/2L^{1/2}K^{-1/2}$ . The wage rate is \$8 per hour and the rental rate is \$2 per hour. The firm decides to set output equal to 8 units.

$$MPL/MPK = P/P_k, \text{ so } [.5L^{(-1/2)}K^{(1/2)}] / [.5L^{(1/2)}K^{(-1/2)}] = 8/2$$

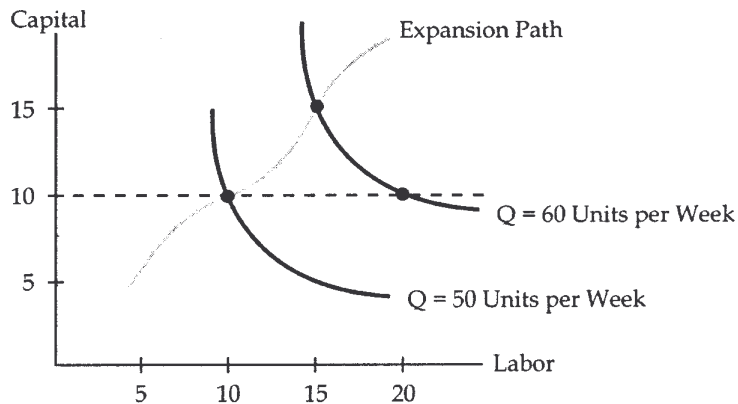
So,  $K/L = 8/2$ , or  $2K=8L$ , so  $4L=K$  (Equation #1)

$$\text{And, we want 8 units so, } \sqrt{KL} = 8 \text{ (equation \#2)}$$

$$\text{Substitute equation \#1 into \#2 to get, } \sqrt{L * (4L)} = \sqrt{4L^2} = 8, \text{ or } 2L=8, \text{ so } L=4 \text{ and } K=4*4=16$$

- What is the optimal level of K? 16
- What is the optimal level of L? 4
- What are the firm's total costs? TC = 8\*4 + 2\*16 = \$64

2. Refer to the diagram below. The wage rate ( $P_L$ ) is assumed to be \$30 per hour, the capital rental rate ( $P_K$ ) is assumed to be \$15 per hour, and capital is assumed to be fixed in the short run at 10 units.



- What is the short-run *total cost* of producing 60 units of output per week?  
In SR, must use 10 K and 20 L, so  $TC = 10*15 + 20*30 = \$750$
- What is the long-run *average cost* of producing 60 units of output per week?  
In LR, you are on expansion path, so you can use 15 K and 15 L.  
 $LRAC = [15*15 + 15*30]/60 = \$675/60 = \$11.25$
- By comparing the two points on the expansion path, we can conclude that this technology exhibits
  - decreasing returns to scale.**
  - constant returns to scale.
  - increasing returns to scale.
  - zero returns to scale.

## 3. Chapter 7, Numerical Exercises N1, N2

N1.

a. Since firms will produce where  $P=MC$ , each firm will produce 5 units at a price of \$10. The firms will earn a profit of  $5*\$10 - \$36 = \$14$ . The industry is not in the long-run, because the firms are making a positive economic profit.

b. In the long-run there will be entry into this industry. The firms will earn zero profit and will produce where  $P=MC=ATC$ . This happens when  $q=3$  and  $p=6$ .

N2.

a. Since the industry is in long-run equilibrium,  $P=MC=ATC$ . This happens at  $P=\$15$ .

b. At  $P=\$15$ , industry demand is 450 and each firm produces 3 units, so there are  $450/3=150$  firms.

c. At  $P=\$10$ , each firm produces 2 units. Since there are 150 firms, the quantity  $150*2=300$  will correspond to a price of  $\$10$ .

4. Widgets are provided by a competitive constant-cost industry where each firm has fixed costs of  $\$30$ . The following chart shows the industry-wide demand curve and the marginal cost curve of a typical firm.

Industry Wide Demand		Firm's Marginal Cost Curve	
Price	Quantity	q	MC
\$5	1500	1	\$5
10	1200	2	10
15	900	3	15
20	600	4	20
25	300	5	25
30	200	6	30
35	140	7	35
40	50	8	40

a. Assume the industry is at its long-run competitive equilibrium. What is the price of a widget?

$$P=MC=ATC=\$20$$

b. How many firms are in the industry?

$$\text{At } P=\$20, \text{ each firm produces 4 units (q). Industry-wide demand is 600 (Q). \# firms} = Q/q = 600/4 = 150 \text{ firms}$$

Suppose there is a SALES tax of  $\$15$  per widget.

c. In the short run, what is the new price of widgets?

*Need to put in industry supply curve: get this by multiplying 150 firms by q at each price. Change demand prices to reflect the tax- remember a sales tax lowers the corresponding price by the amount of the tax. So, lower each price by  $\$15$ . Now, find where new industry demand equals industry supply. This happens where  $p=\$10$  and  $Q=300$ .*

d. In the short run, how many firms leave the industry?

*In the SR, the number of firms is fixed. So, no firms leave!*

e. In the long-run what is the new price of widgets?

*Our MC hasn't changed with sales tax. So, our original condition,  $P=MC=ATC=\$20$  must hold in any LR equilibrium. In LR, price goes back up to  $\$20$ .*

f. In the long-run, how many firms leave the industry?

*At a price of  $\$20$ , industry demand is now only 140. Each firm is producing 4 units. So, new  $Q/q = 140/4 = 35$  firms. Thus,  $150-35 = 115$  firms have left the industry in the LR.*

5. The marginal revenue curve of a competitive firm is

- U-shaped.
- a ray from the origin.
- a horizontal line at the market price.**
- downward sloping.

6. A firm will shut down in the short run if its revenues fail to cover its

- fixed costs.
- variable costs.**
- total costs.
- sunk costs.

7. A competitive firm will exit an industry in the long run when the market price falls below its

- marginal revenue.
- marginal cost.
- average cost.**
- average variable cost.

8. Suppose all firms in an industry are identical. In the long run, entry and exit guarantee that all firms will have zero
- marginal cost.
  - average cost.
  - economic profit.**
  - accounting profit.

9. In assignment #1, problem 2, the demand curve for a good was given by the equation  $Q = -4P + 2500$  ( $P = -1/4Q + 125$ ) and the supply curve was given by  $Q = 2P - 100$  ( $P = 1/2Q + 50$ ). We found the equilibrium price and quantity to be \$100 and 700 units.

- Calculate consumer surplus at this equilibrium price and quantity.  
 $CS = [125 - 100] * 100 / 2 = \$1250$
- Calculate producer surplus at this equilibrium price and quantity.  
 $PS = [100 - 50] * 100 / 2 = \$2500$
- Calculate total social gain at this equilibrium price and quantity.  
 $SG = CS + PS = \$3750$

In another part of the problem, we assumed the government imposed a sales tax of \$6 per unit. With this tax, we found the new market price to be \$96 and the new quantity to be 92 units.

- Calculate the post-tax consumer surplus at this new equilibrium price and quantity.  
 $CS = [125 - 102] * 92 / 2 = \$1058$
- Calculate the post-tax producer surplus at this new equilibrium price and quantity.  
 $PS = [96 - 50] * 92 / 2 = \$2116$
- Calculate the tax revenue collected from the government.  
 $TAX = \$6 * 92 = \$552$
- Calculate the post-tax total social gain assuming the tax revenue is re-distributed to support public education.  
 $SG = CS + PS + TAX = \$3726$
- Calculate deadweight loss.  
 $DWL = SG \text{ before tax} - SG \text{ after tax} = \$24$
- Illustrate the effect of this tax graphically. Label the following areas as follows:
  - A- consumer surplus  
*Triangle: Height: On y-axis- distance between 125 and 102.  
Base: out to 92 units*
  - B- producer surplus  
*Triangle: Height: On y-axis from 96 down to 50.  
Base: out to 92 units*
  - C- tax revenue  
*Rectangle: Height: distance on y-axis from 102 down to 96.  
Base: out to 92 units*
  - D- deadweight loss  
*Triangle: Base: from 102 to 96 on y-axis  
Height: from 92 to 100 units on x-axis*