Discussion 9 - Solutions

Important Topics

- Short and Long Run Equilibrium
- Input Markets

Quick Review

1 What is the fixed cost for a firm with costs $TC = 5 + \frac{5+5q+5q^2}{q+1}$?

Solution: $FC = TC(q = 0) = 10$

2 A firm should operate in the short run only when it can cover its ...

a.) Variable costs
b.) Fixed costs
c.) Total costs

Solution: Variable costs. In the short run, fixed costs should not affect decision-making. This rules out choice b and c.

Exercise 1 Find the short run supply curve for a firm with $TC = 10 + 10\sqrt{q} + 5q^2$ and $MC = 10q + \frac{5}{\sqrt{q}}$.

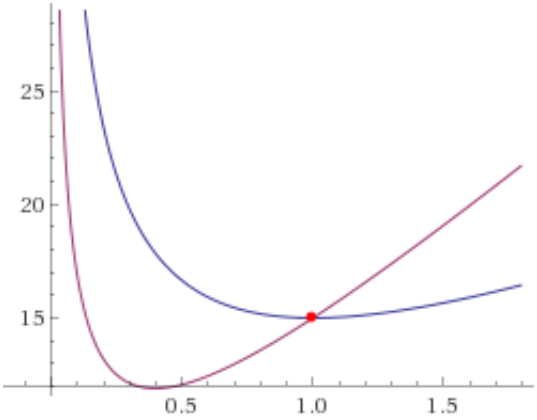
Solution: We know that a firm's short run supply curve is the MC curve above the shutdown price.

The shutdown price is found by solving $AVC = MC$.

$$TVC = 10\sqrt{q} + 5q^2$$
$$AVC = TVC/q = \frac{10}{\sqrt{q}} + 5q$$
$$AVC = MC \iff \frac{10}{\sqrt{q}} + 5q = 10q + \frac{5}{\sqrt{q}}$$
$$\iff \frac{5}{\sqrt{q}} = 5q$$
$$\iff \frac{1}{\sqrt{q}} = q$$
$$\iff q = 1$$

Thus, the shutdown price is $P = 15$.

Now we have supply $P = 10q + \frac{5}{\sqrt{q}}$ for $P \geq 15$ and $q = 0$ for $P < 15$.



Exercise 2 Initially, the hoverboard market is served by 10 firms. Suppose all firms are identical and face the following costs and market demand:

$$MC = 10 + 10q$$

$$TC = 20 + 10q + 5q^2$$

$$Q^D = 30 - P$$

a.) What is the market supply curve? *Solution: We find the supply curve by aggregating the MC curves.*

Each firm sets $P = MC = 10 + 10q$. *So,*

$$q^s_{firm} = \frac{P - 10}{10}$$

and

$$Q^S_{market} = 10 \times q^s_{firm} = P - 10.$$

Here, the shutdown price is 10, so we say $Q^S_{market} = 0$ *for* $P \leq 10$ *and* $Q^S_{market} = P - 10$ *else.*

b.) Draw the usual graphs (demand, costs, etc) for the individual firm and the market. Label the break-even and shutdown prices. What is the short run equilibrium price and quantity?

Solution: Graph omitted. Breakeven price at MC=ATC. Shutdown price at P=AVC.

SR Equilibrium:

$$Q^S_{market} = Q^D$$

$$P - 10 = 30 - P \iff P = 20 \implies Q = 10$$

c.) How much does each firm produce? Will any firms exit in the short run?

Solution: (Dropping the subscript notation, we let q be the firm output and Q be the market output.)

Because the firms are identical, $Q = n \times q$ where n is the number of firms. Therefore with 10 firms, $q = 1$.

Firms will not exit because $TR = 20 > VC = 15$.

d.) Is this a long run equilibrium? Find the long run equilibrium price and quantity.

Solution: This is not a LR equilibrium with $TR = 20 < TC = 35$. In the LR, $TR = TC \iff P = ATC$. Now we solve for this,

$$P = MC = 10 + 10q = ATC = \frac{20 + 10q + 5q^2}{q} = \frac{20}{q} + 10 + 5q$$

$$5q = \frac{20}{q}$$

$$q^2 = \frac{20}{5} = 4 \implies q = 2.$$

Plug this into the MC curve to find the price,

$$P = 10 + 10(2) = 30.$$

e.) How many firms will be in the market in the long run? *Solution:*

We know that, in the LR, $P = 30$ and each firm will produce $q = 2$. Using $P = 30$, we know $Q^D = 30 - 30 = 0$. No transactions will occur, there will be zero firms. This wouldn't be the case if we made fixed costs lower or increased demand.

Exercise 3 The market for plastic chairs in Madison is perfectly competitive. The market demand for plastic chairs is given as $P = 130 - Q$. The market supply for plastic chairs is given as $P = 2 + Q$. Each firm faces the cost functions $TC = 4q^2 + 2q + 64$ and $MC = 8q + 2$.

a.) Determine the equilibrium quantity and price for this plastic chair market.

Solution: Equating market demand and market supply,

$$130 - Q = 2 + Q$$

$$\implies Q = 64, P = 66$$

b.) What are the break-even price and the shut-down prices for a representative firm in the short run?

Solution:

First we find the break-even price.

$$ATC = MC \iff 4q + 2 + 64/q = 8q + 2$$

$$q = 4, P = 34$$

Now, we find the shut-down price.

$$AVC = MC \iff 4q + 2 = 8q + 2$$

$$q = 0, P = 2$$

c.) At the current equilibrium price, what is the quantity of chairs provided by a representative firm? Calculate a representative firm's profit.

Solution: We solved that $P = 66$. Using the firm supply curve, $MC = P = 8q + 2$, we have

$$66 = 8q + 2.$$

$$\implies q = 8.$$

Profit is found by calculating $TR - TC$. For a firm, $TR = 8 \times 66 = 528$. We use the total cost function, $TC = 4(8)^2 + 2(8) + 64 = 336$. Thus, profit $= \pi = 192$.

d.) How many firms are in the market in the short run?

Solution: With market quantity $Q = 64$ and firm quantity $q = 8$, there must be $Q/q = 8$ firms.

e.) What is the long-run profit maximizing level of output for a representative firm? What is the long-run profit?

Solution: In the long-run, the equilibrium price must be the break-even price, $P = 34$. Every firm will produce $q = 4$ (from part b). All firms earn zero profit.

f.) What is the long-run equilibrium price in the market?

Solution: $P = 34$.

g.) How many firms are in the market in the long run?

Solution: Each firm must produce $q = 4$. With a market price of $P = 34$, we can find the market quantity by plugging this break-even (and therefore long run equilibrium price) into the market demand. Therefore, $Q = 96$. Now $\#firms = 96/4 = 24$.

Exercise 4 If profits are negative in the short run in a perfectly competitive industry, which of the following would you not expect to happen as the market moves to the long run (assuming no external economies or external diseconomies of scale)?
a.) The market price will increase.
b.) Firms will exit the market.
c.) Total market output will fall.
d.) Each firm's individual demand curve will shift down.

Solution: d.) In the long run, the price must rise. Each firm's demand curve is perfectly elastic at the market price. Therefore, the firm's demand curve will shift up.

Exercise 5 Consider the following information for a T-shirt manufacturing firm that can sell as many T-shirts as it wants for \$3 per shirt.

Number of Workers	Quantity of Shirts	MPL	TR	MRPL
0	0			
1	30			
2	80			
3	110			
4	135			
5		20		
6	170			
7				30
8				15

a.) Fill in all the blanks in the table.
b.) Verify that MRPL for this firm can be calculated in two ways: (1) change in the TR from adding another worker and (2) MPL times the price of the output.
c.) If this firm must pay a wage rate of $40 per worker per day, how many workers should be hired now? Why?
d.) Suppose the wage rate rises to $50 per worker. How many workers should be hired now?
e.) Suppose the firm adopts a new technology that doubles output at each level of employment and the price of shirts remains at $3. What is the effect of this new technology on MPL and MPRL? At a wage of $50, how many workers should the firm hire now?

Solution:

Number of Workers	*Quantity of Shirts*	*MPL*	*TR*	*MRPL*
0	*0*	-	-	-
1	*30*	*30*	*90*	*90*
2	*80*	*50*	*240*	*150*
3	*110*	*30*	*330*	*90*
4	*135*	*25*	*405*	*75*
5	*155*	*20*	*465*	*60*
6	*170*	*15*	*510*	*45*
7	*180*	*10*	*540*	*30*
8	*185*	*5*	*555*	*15*

When the wage is $40, the firm should hire 6 workers. When the wage is $50, the firm should hire 5 workers.

With the new technology, the MPL and therefore MRPL double. Now, the firm should hire 7 workers.