Economics 101
Summer 2016
Answers to Homework #4
Due June 9, 2016

Directions: The homework will be collected in a box **before** the lecture. Please place your name, TA name and section number on top of the homework (legibly). Make sure you write your name as it appears on your ID so that you can receive the correct grade. Late homework will not be accepted so make plans ahead of time. **Please show your work.** Good luck!
Please realize that you are essentially creating "your brand" when you submit this homework. Do you want your homework to convey that you are competent, careful, professional? Or, do you want to convey the image that you are careless, sloppy, and less than professional. For the rest of your life you will be creating your brand: please think about what you are saying about yourself when you do any work for someone else!

1. Consider an aggregate production function

$$Q = 4K^{1/2}L^{1/2}$$

where Q is the number of widgets, K is the number of units of capital, and L is the number of units of labor. For this question assume K is initially fixed at 100 units. You also know that total cost, TC, is given as

$$TC = P_kK + P_lL$$

where P_k is the price of capital and P_l is the price of labor. Assume that the price of labor and the price of capital are both constant.

a) Fill in the missing cells of the table below based on the above information. (Hint: you might find it fun to do this with Excel: practice your spreadsheet skills and generate the numbers fast!). Calculate your answers to two places past the decimal. Note: the numbers you get may not generate U-shaped curves.

L	K	Q	VC	FC	TC	AVC	AFC	ATC	MC
0				$400		---	---	---	---
1									
4			$80						
9									
16									
25									
36									
49									

b) What is the price of capital? Explain how you got this answer.

c) What is the price of labor? Explain how you got this answer.

d) Given the above information and your work in (a), fill in the following table. Round your answers to two places past the decimal. (Hint: if you used Excel earlier, you can continue to use Excel in this part of the exercise-just a great way to keep building your spreadsheet skills!)

L	Q	MPL
0		---
1		
4		
9		

16		
25		
36		
49		

e) Given your work, does the production of this good show diminishing marginal returns to labor? Explain your answer.

f) Suppose that K doubles and L doubles. Without using numeric values, can you prove this production function has constant returns to scale? That is, can you show that if K and L both double that output, Q, will also double?

Answers:

a)

L	K	Q	VC	FC	TC	AVC	AFC	ATC	MC
0	100	0	0	400	400				
1	100	40	20	400	420	0.50	10.00	10.50	0.50
4	100	80	80	400	480	1.00	5.00	6.00	1.50
9	100	120	180	400	580	1.50	3.33	4.83	2.50
16	100	160	320	400	720	2.00	2.50	4.50	3.50
25	100	200	500	400	900	2.50	2.00	4.50	4.50
36	100	240	720	400	1120	3.00	1.67	4.67	5.50
49	100	280	980	400	1380	3.50	1.43	4.93	6.50

b) The price of capital can be found by recognizing that $FC = P_kK$ and from the table we see that FC = \$400, we are told that K = 100 and therefore $400 = P_k(100)$ or the P_k = \$4 per unit of capital.

c) The price of labor can be found by using the provided information in the table: when L = 4 we see that VC = \$80. We know that $VC = P_lL$ and so $80 = P_l(4)$ or P_l = \$20 per unit of labor.

d)

L	Q	MPL
0	0	
1	40	40.00
4	80	13.33
9	120	8.00
16	160	5.71
25	200	4.44
36	240	3.64
49	280	3.08

e) Yes. To see this calculate the MPL and see what happens to this measure as you increase your hiring of the variable input (in this case, labor) while holding constant your fixed input. From (d) we can see that the value of the MPL decreases as L increases: this indicates that the change in total product from hiring another unit of labor falls: this is diminishing marginal returns to labor.

f) $Q = 4K^{1/2}L^{1/2}$

Then K increases to 2K and L increases to 2L. So,

$Q' = 4(2K)^{1/2}(2L)^{1/2}$

$Q' = 4(2)K^{1/2}L^{1/2}$

$Q' = 8K^{1/2}L^{1/2}$ which is twice the original production function!

This production function exhibits constant returns to scale.

2. Consider a perfectly competitive industry composed of six identical firms that produce widgets. Suppose you are told that the representative firm has the following cost curves where TC is total cost measured in dollars and q is units of widgets produced by a particular firm:

Total Cost: $TC = 4 + 4q + q^2$

Marginal Cost: $MC = 4 + 2q$

Suppose you also know that the market demand curve is given by the following equation where P is the market price in dollars and Q is the market quantity of widgets:

Market Demand: $P = 19 - (1/2)Q$

Q represents market quantity and q represents firm quantity.

a) Given the above information write an equation for the market supply curve. Explain how you found this equation.

b) Given the market supply curve you found in (a), calculate the short run market equilibrium quantity and price in this market. How many units of output will the representative firm produce in the short run? Calculate the short-run profits for the representative firm. Explain your work.

c) Given your calculations in (b), will the representative firm produce in the short-run? Explain your answer.

d) Given your answer in (b), what do you predict will happen in the long-run in this industry?

e) Given no changes in the firm's cost curves or the market demand curve, calculate the following and explain how you found your answers:

Long-run equilibrium market price = _____ Long-run equilibrium market quantity = _____

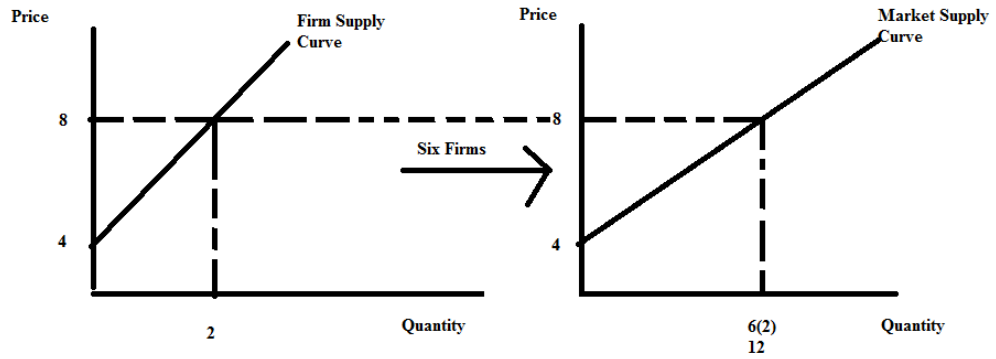
Level of production by the representative firm = _____

Approximate number of firms in industry in the long-run (this will not be a whole number) = _____

Answer:

a) We know that the firm's MC curve is its supply curve: technically speaking the firm's MC above its AVC curve is its supply curve, but for this exercise we can just take the MC curve as the firm's supply curve (this is because AVC and MC only intersect when q=0, so the shutdown

point is also where P = MC gives zero quantity anyway). We also know that there are six firms in the industry. So, let's put this together graphically to illustrate the connection between these two ideas:



Graphing the representative firm's MC curve we can see that the y-intercept is 4 and then choosing some cost per unit (in the graph I chose $8 per unit) we can see that the representative firm is willing to supply 2 units of output. Since there are six identical firms we can deduce that the total amount produced in the market when the cost for the additional unit is $8 per unit will be 12 units. The market supply curve can therefore be written as P = 4 + (1/3)Q.

b) We know that the market demand and market supply curves are as follows:

Market Demand: P = 19 – (1/2)Q

Market Supply: P = 4 + (1/3)Q

Set these two equations equal to one another:

19 – (1/2)Q = 4 + (1/3)Q

114 - (3)Q = 24+ (2)Q

90 = 5Q

Q = 18 widgets

P = 19 – (1/2)Q = 19 - (1/2)(18) = 19 - 9 = $10

Or, P = 4 + (1/3)Q = 4 + (1/3)(18) = $10

The representative firm is a price-taking firm, so it will charge $10 per widget and it will view this market price as equivalent to its MR curve. Thus, MR = 10. The representative firm will equate MR to MC to decide its profit maximizing output. The firm does this because it wants to equate the addition to total cost from producing the last unit of the good (the MC) to the addition to total revenue from selling the last unit of the good (the MR): when the firm produces that quantity where MR = MC the firm knows that it is profit maximizing. Thus,

10 = 4 + 2q

6 = 2q

q = 3 widgets

In the short run the firm will produce 3 widgets and charge $10 per widget.

Short-run profit for the firm can be computed as TR – TC. For the representative firm:

TR = P*q = ($10 per widget)(3 widgets) = $30

TC = 4 + 4q + q^2 = 4 + 4(3) + (3)(3) = 4 + 12 + 9 = $25

Profit in the Short-run for the firm = $30 - $25 = $5

c) The firm will produce in the short-run since its profits are greater than zero. This tells us that total revenue is greater than total cost and it assures us that this firm's revenue in the short run is sufficient to cover its variable costs of production in the short run. We know that the total revenue in the short run exceeds the sum of variable cost and fixed cost in the short run, so total revenue must exceed the short-run variable cost.

d) Since short-run profits are positive, you can predict that firms will enter the industry in the long-run. This will cause the market supply curve to shift to the right and result in a decrease in the market price, an increase in the market quantity, and a decrease in the level of production by firms in the industry.

e) In the long-run ATC = MC for the representative firm since the representative firm earns zero economic profit in the long-run. Thus,
$(4/q) + 4 + q = 4 + 2q$
$4/q = q$
$q = 2$ widgets
We also know that in the long-run, the firm continues to profit maximize by producing where MR = MC and we can use this idea to find the long-run market price. Thus,
MR = MC
$MR = 4 + 2q$
$MR = 4 + 2(2) = \$8$ per widget = Long-run market price
We can use this market price (the price that will result in all firms left in the industry earning zero economic profit) and the market demand curve to calculate the long-run market equilibrium quantity. Thus,
$P = 19 – (1/2)Q$
$8 = 19 – (1/2)Q$
$Q = 22$ widgets
To find the number of firms in the industry in the long-run we can divide the market quantity, Q, by the representative firm's production, q: thus,
Q/q = (22 widgets)/(2 widgets per firm) = 11 firms in the industry

To sum up:
Long-run equilibrium market price = $8
Long-run equilibrium market quantity = 22 widgets
Level of production by representative firm = 2 widgets
Number of firms in industry in the long-run = 11 firms

3. Consider a monopoly that produces widgets. Suppose you are told that the monopoly has the following cost curves where TC is total cost measured in dollars, Q is the quantity of widgets, and P is the price per widget in dollars:

Total Cost: $TC = 4 + 4Q + Q^2$
Marginal Cost: $MC = 4 + 2Q$

Suppose you also know that the market demand curve is given by the following equation:

Market Demand: $P = 19 – (1/2)Q$

a) Given the above information, what is this monopolist's equation for MR?

b) Determine the profit maximizing level of production for this monopolist as well as the price that will be charged for each unit of the good. Assume that this is a single price monopolist, i.e. the monopolist cannot engage in price discrimination. Explain how you found your answer.

c) Given the above information and your answer in (b) calculate the level of profit in the short-run for this monopolist. Explain how you found your answer.

d) Given your answer in (c), what do you predict will happen to this monopolist in the long-run?

e) Calculate the deadweight loss that results from this market being served by a monopolist. Show how you found your answer. Provide a graph that is well labeled to illustrate your answer.

Answers:
a) The monopolist's MR curve has the same y-intercept as the firm's demand curve and for a linear demand curve, has a slope that is twice the slope of the demand curve. The monopolist is the only firm in the market so the market demand curve is the monopolist's demand curve. Thus, the monopolist's MR curve can be written as MR = 19 – Q.

b) The profit maximizing amount of output for the monopolist is that level of output where MR = MC. Thus,
19 – Q = 4 + 2Q
15 = 3Q
Q = 5 widgets
The price the monopolist will charge can be found by plugging in the profit maximizing quantity into the demand curve. Thus,
P = 19 – (1/2)(5) = $16.50 per widget

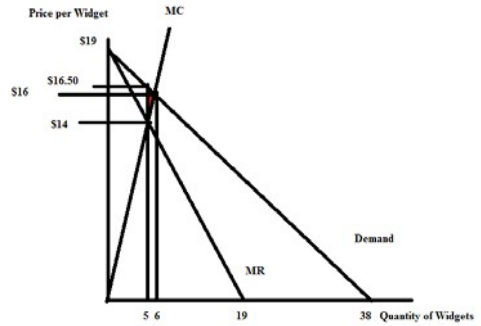
c) To find the monopolist's profit we need to calculate the monopolist's total revenue and its total cost:
TR = P*Q = ($16.50 per widget)(5 widgets) = $82.50
TC = 4 + 4Q + Q^2 = 4 + 4(5) + (5)(5) = 4 + 20 + 25 = $49
Profit for the monopolist = TR – TC = $82.50 - $49.00 = $33.50

d) This monopolist will continue to earn positive economic profits in the long-run if there are effective barriers to entry that result in the monopoly continuing to operate as a monopoly and, therefore, be safe from competition.

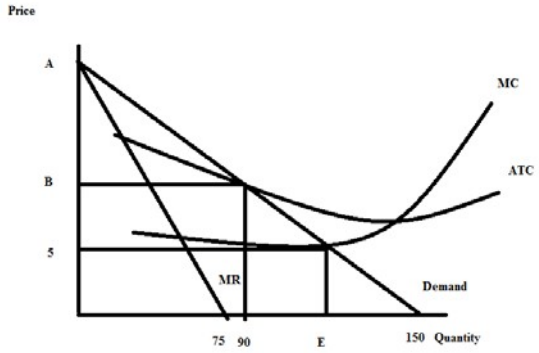
e) To find the deadweight loss we need to first figure out the socially optimal amount of the good: this would be the amount of output where the MC equals the demand curve since for the last unit of output we have the addition to total cost from producing this last unit is equal to the value the consumer places on consuming the last unit (the price they would be willing to pay). So, setting MC equal to the demand curve we have:
4 + 2Q = 19 – (1/2)Q
(5/2)Q = 15
Q = 6 widgets
Q socially optimal = 6 widgets.

We will also need to find the value of MC when Q = 6: so,
MC = 4 + 2Q = 4 + 2(6) = $16.00

Deadweight Loss from the monopoly = (1/2)($16.50 per widget - $14 per widget)(6 widgets – 5 widgets)
Deadweight Loss from the monopoly = $1.25
The deadweight loss is shown in the graph below as (the very small) red triangle.



4. Use the following graph of a natural monopolist to answer this next question. The graph depicts the market for a monopolist where LRATC is the long-run average total cost curve, MC is the marginal cost curve, and Demand is the market demand for the product. You are also told that the reciprocal of the slope of the market demand curve is -5.



a) Given the above information and the graph, write the equation for the market demand curve in slope intercept form. Explain how you found your answer. You will need to provide a numeric value for "A" in the above graph.

b) Suppose that this monopolist is not regulated. Explain how this monopolist will determine its profit maximizing output and price. Assume that the monopolist is a single price monopolist. After explaining the process, identify the unregulated monopolist's quantity and price on the graph labeling the quantity (F) and the price (G). Note: you will not be able to actually compute F and G – just label them on a well-drawn diagram.

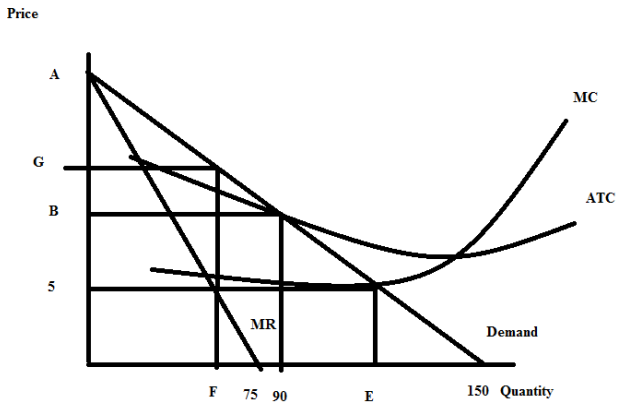
c) Will the monopolist described in (b) earn positive, negative, or zero economic profits? Explain your answer.

d) Suppose that this monopolist is regulated with a MC pricing regulation. This insures that the monopolist produces the socially optimal amount of the good, but will require a subsidy for the producer since economic profits will be negative. From the graph and your prior work, identify (that is, provide a numeric value) the socially optimal amount of the good. Then amend the graph to show the amount of total subsidy this monopolist will need to receive if they are to produce the socially optimal amount of the good.
e) Suppose that this monopolist is regulated with AC pricing regulation. This insures that the monopolist produces the level of output where its economic profit is equal to zero. From the graph and your prior work, identify (that is, provide a numeric value) of the price the monopolist will charge if it is regulated to produce that level of output where the monopolist breaks even. Amend the graph to provide this numeric value.

Answer:
a) You are told that the reciprocal of the slope of the demand curve is -5: this implies that the slope of the demand curve is -1/5. You know from the provided figure that the x-intercept is 150 for the market demand curve so you need to figure out the y-intercept that will result in the slope of the line being - 1/5. Thus, (change in price)/(change in quantity) = - 1/5. Since change in quantity is equal to 150, this implies that change in price must be a negative 30: so the value of "A" is 30.

Once we have the value for "A" and the slope of the line it is easy to write the equation for the market demand curve in slope intercept form: P = 30 – (1/5)Q.

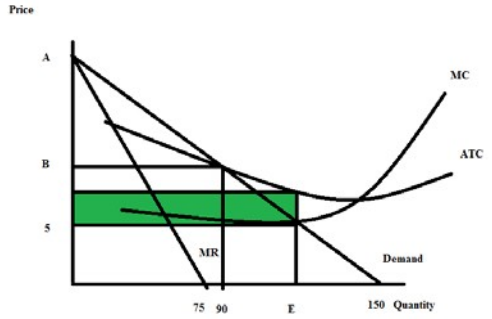
b) The unregulated single price monopolist will equate its MR curve to its MC curve and produce that quantity. It will go vertically up from this quantity to the demand curve to determine the price it will charge for the good. Here's the altered graph:



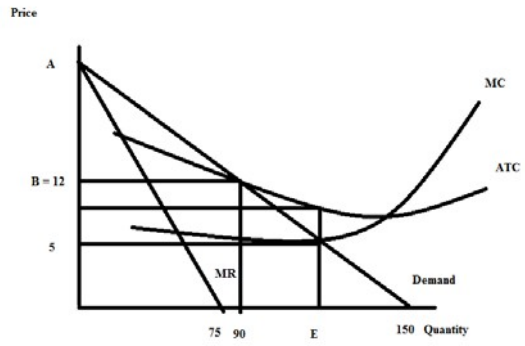
c) The single price unregulated monopolist will earn positive economic profits since when it produces "F" amount of the good, the price it sells the good for ("G") is greater than the average cost per unit of producing this level of output. Since the price exceeds the ATC at this level of output then the firm must be earning positive economic profit.

d) The socially optimal amount of the good is that quantity where the demand curve intersects the MC curve. From the graph we can locate this point and see that we have the following: (Q, P) = (E, 5). Let's use the demand curve equation to solve for the value of "E":

P = 30 – (1/5)Q but Q = E in this case, so
P = 30 – (1/5)E
5 = 30 – (1/5)E
E = 125 units of output
Here's the amended graph where the shaded area shows the total subsidy that the monopolist must receive if they are to produce the socially optimal amount of the good, "E".



e) If the monopolist is regulated by AC pricing regulation the monopolist will produce where P = ATC and this will occur at that quantity where the LRATC curve intersects the demand curve. In the provided graph we can see that this is at a quantity of 90 units. We can find the regulated price by using this quantity in the market demand curve: thus,
P = 30 – (1/5)(Q) where Q is set to 90 units, the quantity where the firm will break even.
P = 30 – (1/5)(90)
P = 12
Here's the amended graph:



5. Consider a market that is served by a single producer. This market has significant barriers to entry so the single producer has market power and is not likely to face any competition due to these barriers of entry. You are given the following information about this market:

Market Demand: Q = 450 – 3P
MC = 30
Fixed Cost for the Producer: FC = 50

a) Given the above information, if this producer acts as a single price monopolist, calculate the following:

Profit maximizing quantity = _____

Profit maximizing price = _____

Level of profits =_____Consumer

Surplus = CS = _____

Producer Surplus (remember you will need to adjust this to take into account FC) = PS = _____

Deadweight Loss = _____

Show your work and provide a graph to illustrate your answer.

b) Suppose that this monopolist decides to practice second degree price discrimination. The monopolist decides that it will sell its first 90 units of the good produced for a price of $120 per unit, its next thirty units for a price of $110 per unit, its next sixty units for a price of $90 per unit, and a final thirty units for a price of $80 per unit. Given this information and the initial information, calculate the following for the monopolist who practices this second degree price discrimination:

Total quantity produced by the second degree price discriminator = _____

Prices charged by the second degree price discriminator = _____

Level of profits for the second degree price discriminator = _____

Consumer Surplus in this case of second degree price discrimination = CS' = _____

Producer Surplus (remember you will need to adjust this to take into account FC) in this case of second degree price discrimination = PS' = _____

Deadweight Loss in this case of second degree price discrimination = _____

Show your work and provide a graph to illustrate your answer.

c) Compare your answers in (a) and (b). Does second degree price discrimination benefit consumers in this case? Explain your answer here and provide evidence to support your answer. Does second degree price discrimination benefit the producer? Explain your answer here and provide evidence to support your answer.

d) Suppose this monopolist is able to practice first degree price discrimination in this market. Compute the following if this monopolist successfully implements first degree price discrimination.

Total amount of the good produced in the market =_____PS"

with perfect price discrimination (remember to account for those fixed costs) = _____

CS" with perfect price discrimination = _____

Profit for firm with perfect price discrimination = _____

DWL with perfect price discrimination = _____

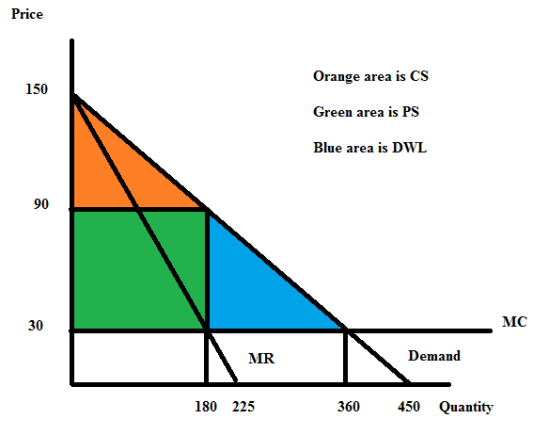
Show your work and provide a graph to illustrate your answer.

Answer:

a) The firm if it acts as a single price monopolist will produce that quantity where MR = MC and then charge the price associated with this quantity from the demand curve. So, we need to find

MR first. Rewrite the demand curve in slope-intercept form: P = 150 – (1/3)Q. Recall that MR for the monopolist facing a linear demand curve shares the same y-intercept as the demand curve and has twice the slope of the demand curve. Thus, MR = 150 – (2/3)Q. Now, equate MR to MC:
150 – (2/3)Q = 30
120 = (2/3)Q
Q = 180 units
Go to the demand curve with this quantity to find the price the single price monopolist will charge:
P = 150 – (1/3)Q = 150 – (1/3)(180) = $90 per unit
Now, to calculate profit, we need TR and TC:
Thus, TR = P*Q = 90(180) = $16,200
TC = FC + VC = 50 + 30(180) = $5450
Profit for the single price monopolist = $16,200 - $5450 = $10,750
CS = (1/2)($150 per unit - $90 per unit)(180 units) = $5400
PS = ($90 per unit - $30 per unit)(180 units) = $10,800
To calculate DWL we need to know the quantity which is socially optimal: to find this quantity locate where the MC intersects the demand curve and determine this quantity. Thus, 150 – (1/3)Q = 30 and Qsocially optimal = 360 units.
DWL = (1/2)($90 per unit - $30 per unit)(360 units – 180 units) = $5400

To summarize for the single price monopolist:
Profit maximizing quantity = 180 units
Profit maximizing price = $90 per unit
Level of profits = $10,750
Consumer Surplus = CS = $5400
Producer Surplus = PS = $10,800
Deadweight Loss = $5400
Here's the graph to illustrate this outcome:



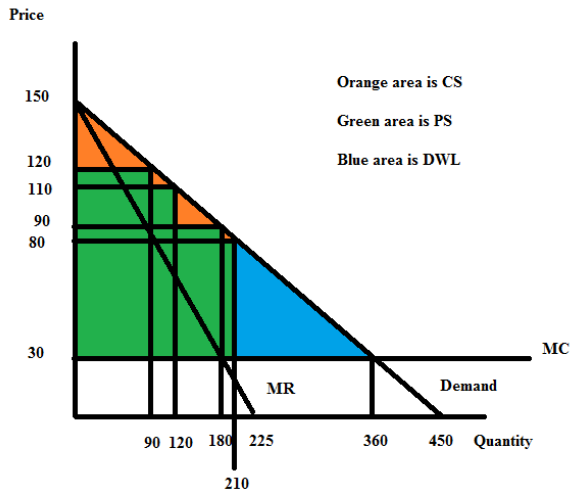
b) When this firm is a second degree price discriminator it chooses to produce 210 units in all. It will charge $120 per unit for the first 90 units sold, $110 per unit for the next 30 units, $90 per unit for the next 60 units, and $80 for the final thirty units. To calculate the level of profits the firm earns when it practices second degree price discrimination we need to calculate its TR and its TC:

TR = P*Q = ($120 per unit)(90 units) + ($110 per unit)(30 units) + ($90 per unit)(60 units) + ($80 per unit)(30 Units) = $10,800 + $3300 + $5400 = $21,900
TC = FC + VC = $50 + ($30 per unit)(210 units) = $6350
Profits for this second degree price discriminator = $21,900 - $6350 = $15,550
CS' = (1/2)($150 per unit - $120 per unit)(90 units) + (1/2)($120 per unit - $110 per unit)(120 units – 90 units) + (1/2)($110 per unit - $90 per unit)(180 units – 120 units) + (1/2)($90 per unit - $80 per unit)(210 units – 180 units) = $2250
PS' = ($120 per unit - $30 per unit)(90 units) + ($110 per unit - $30 per unit)(120 units – 90 units) + ($90 per unit - $30 per unit)(180 units – 120 units)+ ($80 per unit - $30 per unit)(210 units – 180 units) = $15,600
DWL' = (1/2)($80 per unit - $30 per unit)(360 units – 210 units) = $3750

To summarize our findings:

Total quantity produced by the second degree price discriminator = 210 units
Prices charged by the second degree price discriminator = $120 per unit for the first 90 units, $110 per unit for the next 30 units, $90 per unit for the next sixty units, and $80 per unit for the final 30 units
Level of profits for the second degree price discriminator = $15,550
Consumer Surplus in this case of second degree price discrimination = CS' = $2250
Producer Surplus = PS' = $15,600
Deadweight Loss in this case of second degree price discrimination = $3750

Here's the graph to illustrate the second degree price discrimination case:



c) Second degree price discrimination benefits consumers by allowing them to consume more units of the good: in this case, 210 units instead of 180 units. And, some of these units are cheaper-30 units are now selling for $80 per unit. But, we can also see that second degree price discrimination in this case is shrinking CS from $5400 to $2250. We can also see that the area of DWL is shrinking from $5400 to $3750.

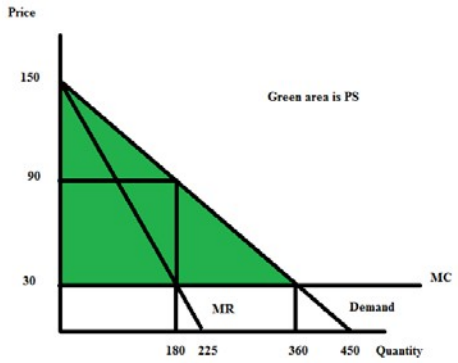
Second degree price discrimination benefits the producer: they sell more of the good and their total profit goes up from $10,750 to $15,550. We can also see that PS increases from $10,800 to $15,600.

d) When the firm practices perfect price discrimination it charges a different price for every unit it sells. This results in the market demand curve also being the firm's marginal revenue curve. To find the quantity the firm will produce we still set MR = MC but this time the MR is the firm's demand curve. Thus,
MR = MC
150 – (1/3)Q = 30
Qsocially optimal = 360 = the amount that the perfect price discriminator will produce. This is the socially optimal amount of the good because the MC of producing the last unit is equal to the price the consumer pays for this last unit: that is, the cost to society of producing this last unit equals the value to the consumer of consuming this last unit.
CS" = 0 since the producer captures all of the consumer surplus when they practice perfect price discrimination
PS" = (1/2)($150 per unit - $30 per unit)(360 units) = $21,600
TR = (1/2)($150 per unit - $30 per unit)(360 units) + ($30 per unit)(360 units) = $32,400
TC = FC + VC = 50 + ($30 per units)(360 units) = $10,850
Profit for the perfect price discriminator = $32,400 - $10,850 = $21,550
DWL" = 0 since the firm is now producing the socially optimal amount of the good

To summarize our findings:

Total amount of the good produced in the market = 360 units
PS" with perfect price discrimination = $21,600
CS" with perfect price discrimination = $0
Profit for firm with perfect price discrimination = $21,550
DWL with perfect price discrimination = $0

Here's the graph:



6. Karen is a supplier of dry cleaning services in her small town. She operates the only dry cleaning service and therefore has significant market power. She knows that she has two types of clients: business clients who come in regularly to have their clothing cleaned and non-business clients who have occasional garments to clean. She knows the following information where Q is the quantity of dry cleaning units and P is the price per unit of dry cleaning:

Demand for dry cleaning services from business clients: Q = 20 – (1/2)P

Demand for dry cleaning services from non-business clients: Q = 30 - P
MC of providing dry cleaning services: MC = 4
Fixed Costs of providing dry cleaning services: FC = 10

Suppose that Karen decides to treat her dry cleaning business as two separate monopolies: one providing dry cleaning services to business clients and one providing dry cleaning services to non-business clients. She can readily identify the status of each of her clients since she has been in business in this small town for a long, long time and she knows her customers well.

a) Given that Karen is going to treat these two types of customers as separate entities, what will be the profit maximizing price and quantity of the good for each type of customer? And, what will total profits be equal to? Show how you found your answers to this set of questions clearly and logically! Provide a set of graphs to illustrate your answer.

b) Now, suppose Karen would like to verify that this two pricing scheme idea in (a) actually results in her earning greater profits than if she were to simply follow a single pricing monopoly model. So, find the market demand curve. Then determine the profit maximizing quantity and price if Karen treats this market as a single market with one price for dry cleaning. What happens to the level of profits Karen earns under this pricing decision? Provide numeric values for all your work and clearly and logically explain how you found your answers. Also, provide a graph to illustrate your answer.

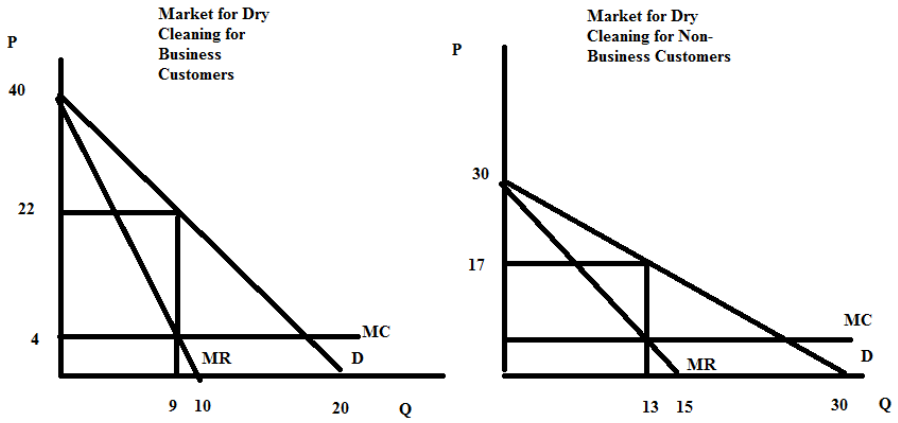
Answers:
a) Karen has decided to treat this pricing and production decision as two separate monopolies: so she needs to find the MR curves for each sub-market and then equate MR to MC to identify the profit maximizing quantity for each market. She will then take these quantities and use the respective demand curve to find the profit maximizing price for each market. Once she has the price and quantity for each sub-market she can calculate the total profit she will earn by treating this market as two separate monopolies. So, let's go through this process:

Business Client Market Analysis:
Demand for this market: Q = 20 – (1/2)P or P = 40 – 2Q
MR for this market: MR = 40 – 4Q
MC for this market: MC = 4
Set MR = MC: 40 – 4Q = 4
Q for business client market = 9 units of dry cleaning
Use this quantity in the demand curve to find the profit maximizing price for this sub-market:
P = 40 – 2(9) = $22 = price for a unit of dry cleaning for the business clients

Non-business Client Market Analysis:
Demand for this market: P = 30 – Q
MR for this market: MR = 30 – 2Q
MC for this market: MC = 4
Set MR = MC: 30 – 2Q = 4
Q for non-business client market = 13 units

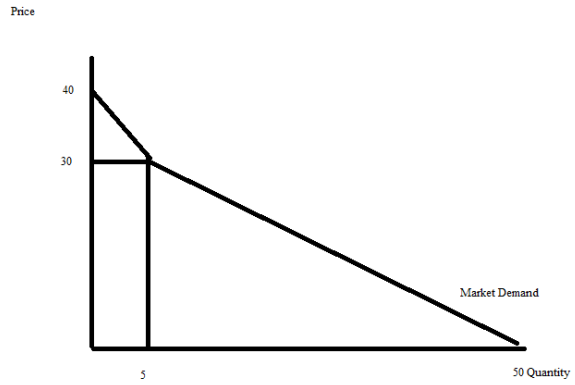
Use this quantity in the demand curve to find the profit maximizing price for this sub-market:
P = 30 – 13 = $17 = price for a unit of dry cleaning for the non-business clients

Here's the set of graphs:



b) First let's calculate profits under the pricing scheme in (a).
TR from business customers = ($22 per unit of dry cleaning)(9 units of dry cleaning) = $198
TR from non-business customers = ($17 per unit of dry cleaning)(13 units of dry cleaning) = $221
Total TR from the two markets = $198 + $221 = $419
TC from production of 22 units of dry cleaning = VC + FC = ($4 per unit)(22 units) + 10 = $98
Profits from this pricing scheme = $419 - $98 = $321

Now, let's consider if this market is treated as a single price monopolist. We will need the market demand curve. Here's the picture of this market demand curve:



We can write the equations for the two segments of the market demand curve as:
Top segment: P = 40 – 2Q for quantities less than or equal to 5

Lower segment: P = (100/3) – (2/3)Q for quantities greater than or equal to 5

The MR curves for these two segments are:

Top segment: MR = 40 – 4Q for quantities less than or equal to 5
Lower segment: MR = (100/3) – (4/3)Q for quantities greater than or equal to 5

But, which MR to use? Let's try both and decide which gives us greater profits!

Using the top segment:

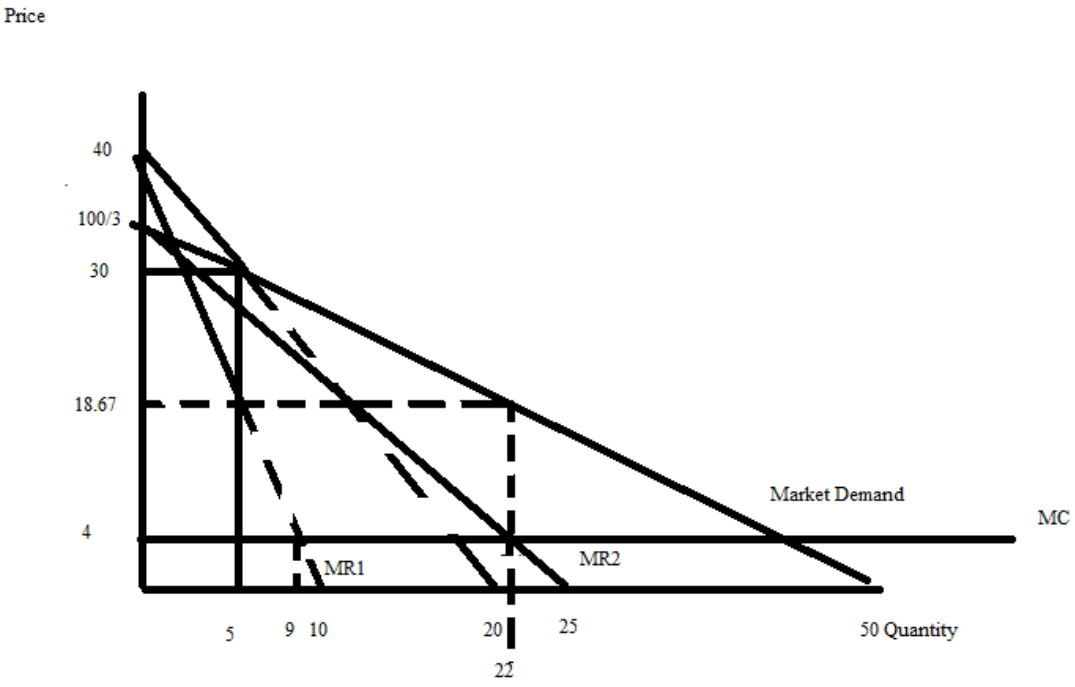
MR = MC
40 – 4Q = 4
4Q = 36
Q = 9 units of dry cleaning….but this quantity is beyond the domain of this segment of the market demand curve

Using the lower segment:

MR = MC
(100/3) – (4/3)Q = 4
100 – 4Q = 12
4Q = 88
Q = 22 units of dry cleaning
P = (100/3) – (2/3)Q = (100/3) – (2/3)(22) = $18.67 per unit of dry cleaning
TR = ($18.67 per unit of dry cleaning)(22 units of dry cleaning) = $410.74
TC = ($4 per unit of dry cleaning)(22 units of dry cleaning) + 10 = $98
Profit with this output and price combination = 410.74 – 98.00 = $312.74

Comparison of the profits from the pricing scheme in (a) versus that in (c) reveals that charging different prices to business customers and non-business customers results in greater profits: $321 in profits versus $312.74. Price discrimination does pay off!

Here's a graph to illustrate this second possibility:


Price
40
100/3
30
18.67
4
Market Demand
MC
MR1
MR2
5
9
10
20
25
50 Quantity
22