Economics 101
Spring 2019
Answers to Homework #5
Due Tuesday, May 2, 2019

Directions:

- The homework will be collected in a box labeled with your TA's name **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.
- Please **staple** your homework: we expect you to take care of this prior to coming to the large lecture. You do not need to turn in the homework questions, but your homework should be neat, orderly, and easy for the TAs to see the answers to each question.
- Late homework will not be accepted so make plans ahead of time.
- Show your work. Good luck!

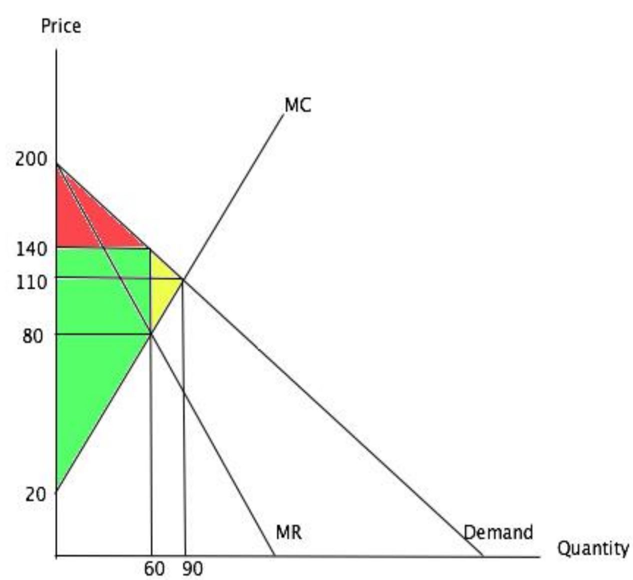
Part I: Monopoly and Price Discrimination

1. Because of a patent, the market for a new technology is a monopoly. Suppose the market demand is given by P = 200 – Q and the marginal cost is given by MC = 20 + Q.

a. What is the marginal revenue curve of this monopolist?

Take the demand curve and double the slope to find the marginal revenue MR = 200 – 2Q.

b. Graph the demand, marginal revenue and marginal cost curves. Shade the areas of consumer surplus, producer surplus and deadweight loss.



On the graph above, red is the CS area, green is the PS area and yellow is a DWL.

c. What is the socially optimal level of production?

Socially optimal level of production is where MC = Demand:
20 + Q = 200 – Q, 2Q = 180, Q = 90 and P = $110 after plugging it into the demand equation.

d. What are the consumer and producer surpluses, total surplus and DWL if the market was competitive?

CS = (½)(200 - 110)(90) = $4050
PS = (½)(110 – 20)(90) = $4050
TS = $8100
DWL = $0

e. What is the monopolist's quantity of production and what price will the monopolist charge?

Monopolist's ideal quantity of production is where MC = MR:
20 + Q = 200 – 2Q, 3Q = 180, Q = 60 and P = $140 after plugging it into the demand equation.

f. What are the consumer and producer surpluses and the DWL from having a monopolistic market?

CS = (½)(200 - 140)(60) = $1800
PS = (140 - 80)(60) + (½)(80 – 20)(60) = 3600 + 1800 = $5400
DWL = (½)(140 - 80)(90 - 60) = $900

g. If the total cost curve is given by TC = 30 + 20Q + (½) Q^2, what is the monopolist's ATC? What is the monopolist's profit? In the long run, can the monopolist stay in business?

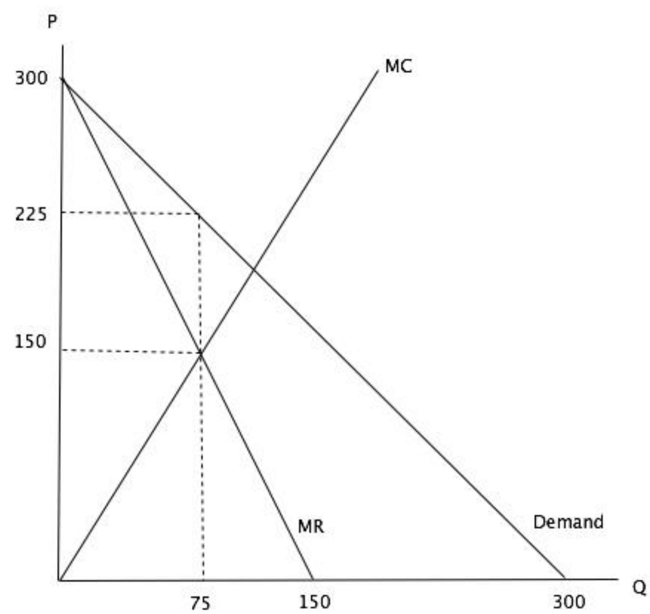
ATC = TC/Q = 30/Q + 20 + ½Q. This monopolist produces Q = 60, so ATC = 30/60 + 20 + 30 = $50.5 per unit of output and TC = 30 + 20*60 + 1800 = $3030.
Total Revenue = P*Q = 60*140 = $8400.
Profit = Total Revenue – Total Cost = 8400 – 3030 = $5370.
The monopolist is earning positive profit, so the monopolist will stay in business.

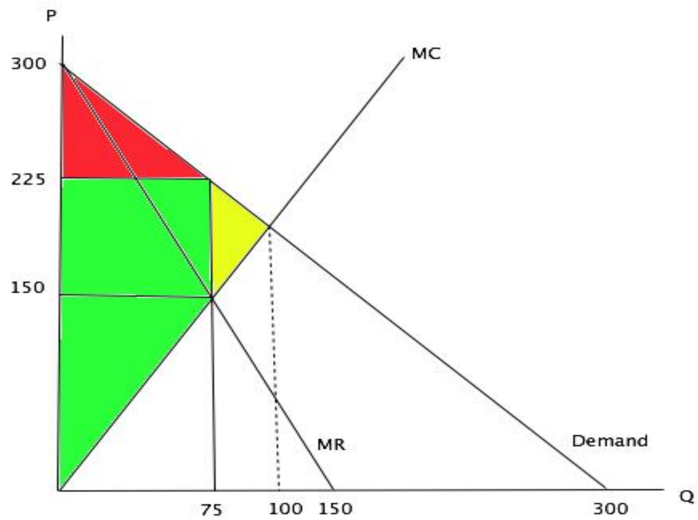
2. Wenbo is a monopolist in the market for peppa pig figurines within the economics department. He has the following information, where Q is the quantity of peppa pig figurines and P is the price:

   Market Demand: P = 300 – Q
   Marginal Cost: MC = 2Q
   Total Cost: TC = 2 + Q^2

a. Suppose Wenbo cannot price discriminate. What is the profit maximizing price and quantity for Wenbo? What is Wenbo's profit? What is CS, PS, and DWL? Illustrate this in a clearly labeled graph.

First, we need to find Wenbo's MR curve. It will have the same P-intercept as the demand curve, but twice the slope, so MR = 300 – 2Q. Then, we set MR = MC: 300 – 2Q = 2Q → Q* = 75
Next, we plug Q* = 75 into demand to get P*: P = 300 – 75 → P* = $225.
Thus, profits = TR – TC = 75*225 – (2 + 75*75) = $16,875 – $5,627 = $11,248
CS = (1/2)*($300 – $225)*(75) = $5,625/2 = $2,812.5
PS = (1/2)*($150 – $0)*(75) + ($225 – $150)*(75) = $5,625 +$5,625 = $11,250
DWL = (1/2)*(100 – 75)*($225 – $150) = $1,875/2 = $937.5





On the graph above the red area is a CS area, green is a PS area and yellow is a DWL.

b. Suppose Wenbo is able to perfectly price discriminate (also known as first degree price discrimination). What quantity will Wenbo sell? What will be his profit? What is the CS, PS, and DWL? Illustrate this in a clearly labeled graph.

Under perfect price discrimination, Wenbo charges customers their willingness to pay (this "willingness to pay" is described by the demand curve). He continues to do this until he reaches the point where the demand curve intersects MC (because since demand is the marginal revenue curve in this case, and we know he wants to set MR = MC). That is, where 300 – Q = 2Q → Q = 100

TR = (1/2)*($300 – $200)*100 + ($200 – $0)*100 = $5,000 + $20,000 = $25,000

TC = 2 + 100* 100 = $10,002

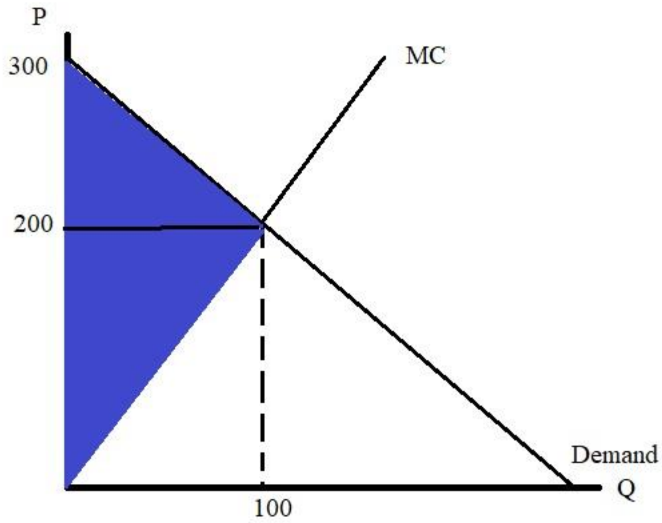
Profit = TR – TC = $25,000 – $10,002 = $14,998

CS = $0

PS = (1/2)*(300 – 0)*100 = $15,000

DWL = $0

Wenbo captures the entire social surplus and we have the socially optimal outcome!



c. Suppose instead Wenbo decides to practice second degree price discrimination: he charges $275 for the first 25 units, and then decreases his price by a certain amount each time he sells another 25 units. What is that amount? What is Wenbo's profit? What is CS, PS, and DWL? Illustrate this in a clearly labeled graph.

At Q = 25, P = 300 – 25 = $275. Then, at Q = 50, P = 300 – 50 = $250, at Q = 75, P = 300 – 75 = $225, and at Q = 100, P = 300 – 100 = $200. We know from above that this is where P = MC, so Wenbo will not sell more than this. Thus, Q = 100. Wenbo decreases the price by $25 each time he sells an additional 25 units (think critically about why the result is like this, because it is not necessarily generalizable!).

TR = $275*25 + $250*25 + $225*25 + $200*25 = $6,875 + $6,250 + $5,625 + $5,000 = $23,750

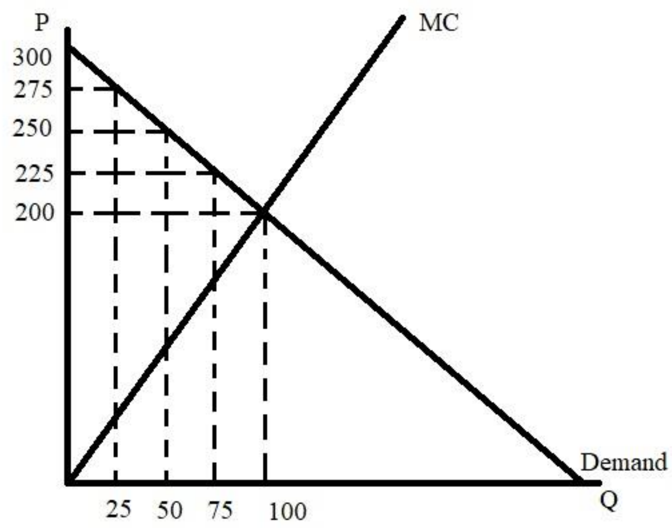
TC = 2 + 100*100 = $10,002

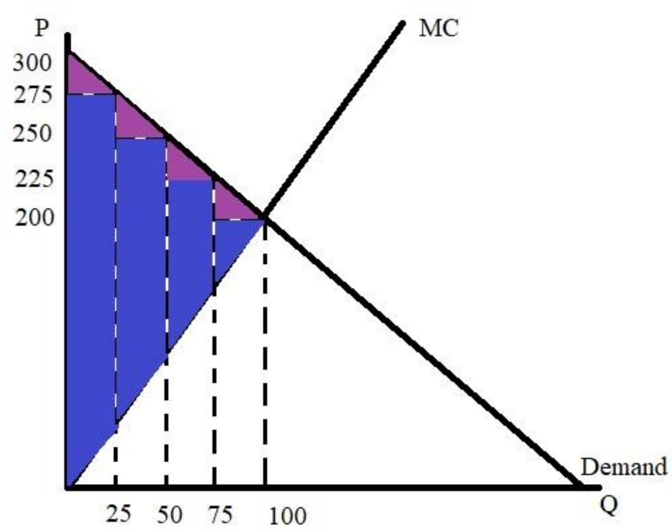
Profit = $23,750 - $10,002 = $13,748

CS = (1/2)(300 – 275)*25 + (1/2)(275 - 250)*25 + (1/2)(250 - 225)*25 + (1/2)(225 - 200)*25 = 2*25*25 = $625/2 + $625/2 + $625/2 + $625/2 = $1,250

PS = [(275 – 50)*25 + (1/2)*50*25] + [(250 – 100)*(50 – 25) + (1/2)*(100 – 50)*25] + [(225 – 150)*(75 – 50) + (1/2)*(150 – 100)*25] + [(1/2)*(200 – 150)*25] = [$5,625 + $625] + [$3,750 + $625] + [$1,875 + $625] + [$625] = $6,250 + $4,375 + $2,500 + $625 = $13,750

DWL = $0





d. Comparing (a), (b), and (c), which pricing structure do you think Wenbo prefers? Is this what you expected? Explain.

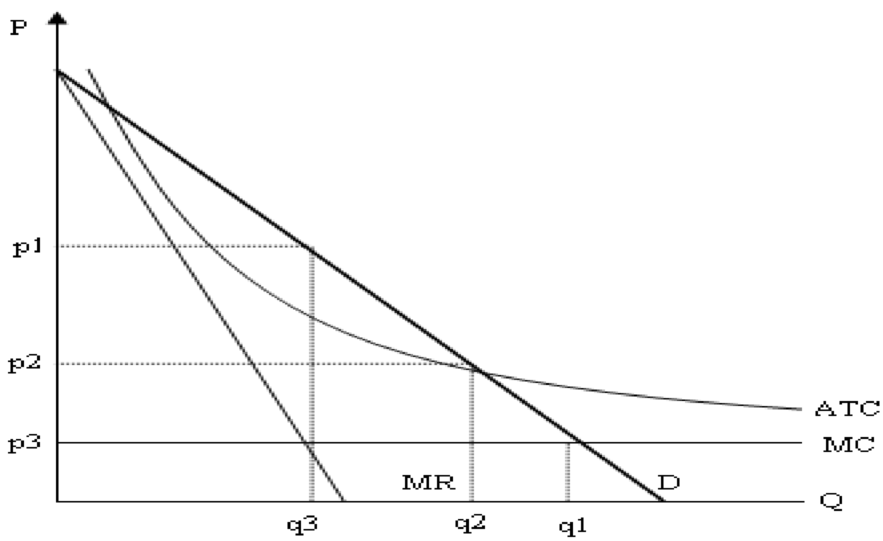
Looking at Wenbo's producer surplus, it is highest under perfect price discrimination ($15,000), so he prefers this option. No price discrimination gives him a surplus of $11,250; second degree price discrimination gives him a surplus of $13,750.

3. Natural Monopoly.

a. Why do Natural Monopolies arise? Give some examples.

Natural Monopoly emerges if the firm's Long Run Average Total Cost is declining (there are economies of scale) and the firm can produce the entire quantity demanded in the market at a cost lower than if there were multiple firms producing. Natural Monopolies arise when there are large fixed costs, so a good example would be local electricity or gas providers.

b. On the graph below, what is the price in the unregulated market? What is the price if the government decides to regulate the natural monopoly by setting the price to the competitive market level? Does that regulation work? What is the lowest price at which the natural monopoly is efficiently regulated?



If the natural monopolist is not regulated, the price is set by MR = MC, so the price is p1 and the quantity is q3.

If the government sets the price to a competitive market level, it is determined by MC = Demand, so the price is p3 and quantity is q1. However, since p3 is lower than the monopolist's ATC, natural monopolist will incur losses. It will stop producing and since it is the only firm in the industry the good will not be produced.
The lowest price that allows the natural monopolist to stay in business is where ATC = Demand, p2 and quantity is q2.

4. A local monopolist likes to practice 3rd-degree price discrimination. The monopolist faces the following demand curves where P is the price per unit of the good and Q is the quantity of units of the good, and has a MC described by the following:

Demand from Students: $P = 200 – (1/2)Q$
Demand from Non-student Buyers: $P = 120 – 2Q$
$MC = \$4$

a. What price will each group face, and what quantity will they purchase? What are the monopolist's profits?

The monopolist will set MR of each group equal to MC, so we first need to find the two marginal revenue curves, and then set MC = MR to find the quantity each group will purchase:

$MR = 200 – Q \rightarrow 4 = 200 – Q \rightarrow Q = 196$
$MR = 120 – 4Q \rightarrow 4 = 120 – 4Q \rightarrow Q = 116/4 = 29$

Then, we plug these values into the respective demand curves to find the price that the monopolist charges:

$P = 200 – (1/2)*196 = 200 – 98 = \$102$
$P = 120 – 2*29 = 120 – 58 = \$62$

$TR = \$102*196 + \$62*29 = \$19{,}992 + \$1{,}798 = \$21{,}790$
$TC = \$4*(196 + 29) = \$900$
$Profit = \$21{,}790 - \$900 = \$20{,}890$

b. Suppose the monopolist is not able to price discriminate. What is the profit maximizing price and quantity? What is his profit? Compare this answer to your answer in part (a).

We first need to find the market demand curve: For $120 \leq P \leq 200$, only the first group is willing to buy, so $P = 200 – (1/2)Q$. For $P \leq 120$, we need to horizontally sum the two groups. Writing the demand curves in Q-intercept form:

$Q = 400 – 2P$
$Q = 60 – (1/2)P$

So $Q = 460 – (5/2)P \rightarrow P = 184 – (2/5)Q$

Next, we need to find the MR curve. It will again consist of two segments:

$MR = 200 – Q$ for $120 \leq P \leq 200$, and
$MR = 184 – (4/5)Q$ for $P \leq 120$

Since our MC is $4, we know we are on the second segment when MC = MR:
4 = 184 – (4/5)Q → Q = 180*(5/4) = 225

Plugging into market demand, P = 184 – (2/5)*225 = 184 – 90 = $94

TR = $94*225 = $21,150
TC = $4*225 = $900
Profit = $21,150 - $900 = $20,250

Compared to part a, the profit is slightly lower.

Part 2. Game Theory

5. Consider the following games:

a. April and Erika want to get sushi for dinner this Friday at 6:30 pm to celebrate the end of a great semester. They are debating going to Sushi Express or Muramoto. When Friday rolls around, neither of them remember where they agreed to go. Without contacting each other, they independently decide between the two options. The payoff matrix is shown below, with the left number in each cell referring to April's payoff, and the right number referring to Erika's payoff.

	Erika		
April		Sushi Express	Muramoto
	Sushi Express	1,2	0,-1
	Muramoto	2,-1	3,3

i. Does April have a dominant strategy?
ii. Does Erika have a dominant strategy?
iii. What do you think the outcome of this game will be?

i. If Erika goes to Sushi Express, April's best choice is to go to Muramoto (2>1). If Erika goes to Muramoto, April's best choice is to go to Muramoto (3>0). Thus, April's dominant strategy is to go to Muramoto.

ii. If April goes to Sushi Express, Erika's best choice is to go to Sushi Express (2>-1). If April goes to Muramoto, Erika's best choice is to go to Muramoto (3>-1). Thus, Erika does not have a dominant strategy.

iii. Since April's dominant strategy is to go to Muramoto, we expect her to go there. And we know that if April goes to Muramoto, Erika's best choice is to also go to Muramoto, so we expect the outcome to be both go to Muramoto.

b. Natalia is eating dinner at Sushi Express when she sees Jason enter the restaurant to order take out. Jason also sees Natalia. They both choose between talking or not talking. If both choose to talk, then they eat together in the restaurant and both get a payoff of 0. If Natalia chooses to talk and Jason chooses to not talk, Natalia gets a payoff of -2 and Jason gets a payoff of 1. If Jason chooses to talk and Natalia chooses to not talk, Jason gets a payoff of -3 and Natalia gets a payoff of 1. If both choose to not talk, they both get a payoff of 4. Represent this game in a payoff matrix that resembles the one in part (a).

	Jason		
Natalia		Talk	Don't Talk
	Talk	0,0	-2,1
	Don't Talk	1,-3	4,4

i. Does Natalia have a dominant strategy?
ii. Does Jason have a dominant strategy?
iii. What do you think the outcome of this game will be?
iv. If we change the payoff Natalia and Jason get from both choosing talk to 3, do you still expect the same outcome of this game? Explain.

i. If Jason talks, Natalia's best choice is don't talk (1>0). If Jason doesn't talk, Natalia's best choice is don't talk (4>-2). Thus, Natalia's dominant strategy is "don't talk".

ii. If Natalia talks, Jason's best choice is don't talk (1>0). If Natalia doesn't talk, Jason's best choice is don't talk (4>-3). Thus, Jason's dominant strategy is "don't talk".

iii. We expect Natalia and Jason to play their dominant strategies "don't talk".

iv.

	Jason		
Natalia		Talk	Don't Talk
	Talk	3,3	-2,1
	Don't Talk	1,-3	4,4

If Jason talks, Natalia's best choice is talk (3>1). If Jason doesn't talk, Natalia's best choice is don't talk (4>-2). Thus, Natalia does not have a dominant strategy.

If Natalia talks, Jason's best choice is talk (3>1). If Natalia doesn't talk, Jason's best choice is don't talk (4>-3). Thus, Jason does not have a dominant strategy either.

We should not expect the same outcome as above, because anything could happen now.

Part 3. Externality and Public Goods

6. Consider a market where the demand and supply curves are given by the following equations:
   Supply (MPC): $P = (1/2)Q + 20$
   Demand (MPB): $P = 160 – 3Q$

   Externality Cost: additional $14 per unit produced

a. What is the competitive equilibrium, that is, the equilibrium without any government intervention?

Without any intervention, we simply equate demand and supply:
$(1/2)Q + 20 = 160 – 3Q \rightarrow (7/2)Q = 140 \rightarrow Q = 40$
$P = 160 – 3*40 = 160 – 120 = \$40$

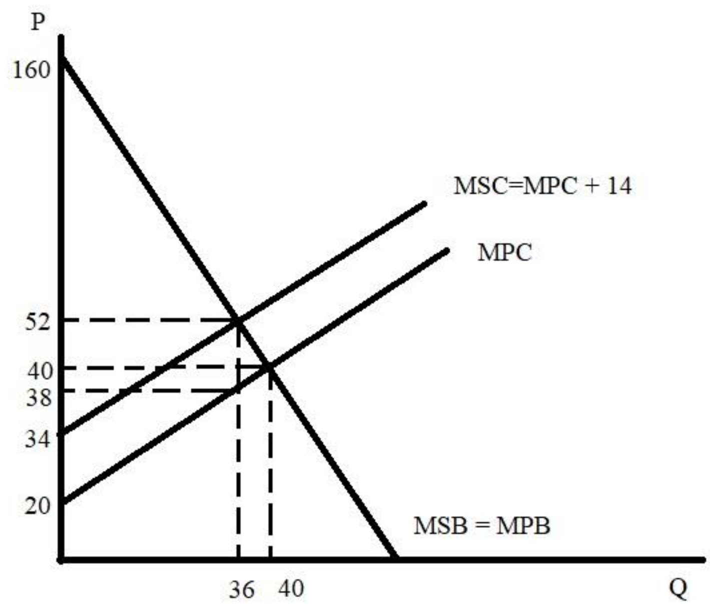
b. Is there a positive or negative externality? Why? Write the equations for the MSC and MSB curves.

This is a negative externality since there is an additional hidden social cost that is not incorporated in the supply curve.

MSC: $P = (1/2)Q + 34$
MSB: $P = 160 – 3Q$

c. Find the socially optimal solution. Construct a graph with MSC, MPC, MSB, MPB that illustrates this equilibrium.

The socially optimal quantity is where MSB = MSC:
$(1/2)Q + 34 = 160 – 3Q \rightarrow (7/2)Q = 126 \rightarrow Q = 36$
$P = 160 – 3*36 = 160 – 108 = \$52$



d. Suppose the government wants to impose a tax to achieve the socially optimal quantity. What should the tax be? Why?

Tax should be the amount of the externality ($14), so supply curve becomes P = (1/2)Q + 34 and thus Q = 36. Consumers pay $52, and producers receive $52 - $14 = $38.

7. Three Econ 101 students, Alvin, Briton, and Charlie would like to hire a tutor to help them review together for the final. Their demands for tutoring are given by the following equations, where Q is the quantity of hours and P is the price per hour:

   Alvin's Demand: P = 100 – Q
   Briton's Demand: P = 120 – 2Q
   Charlie's Demand: P = 80 – 4Q

   The marginal cost of tutoring is constant at $70.

a. Suppose the market is perfectly competitive. Find the quantity demanded by each individual and the price per unit paid. Are there any free-riders?

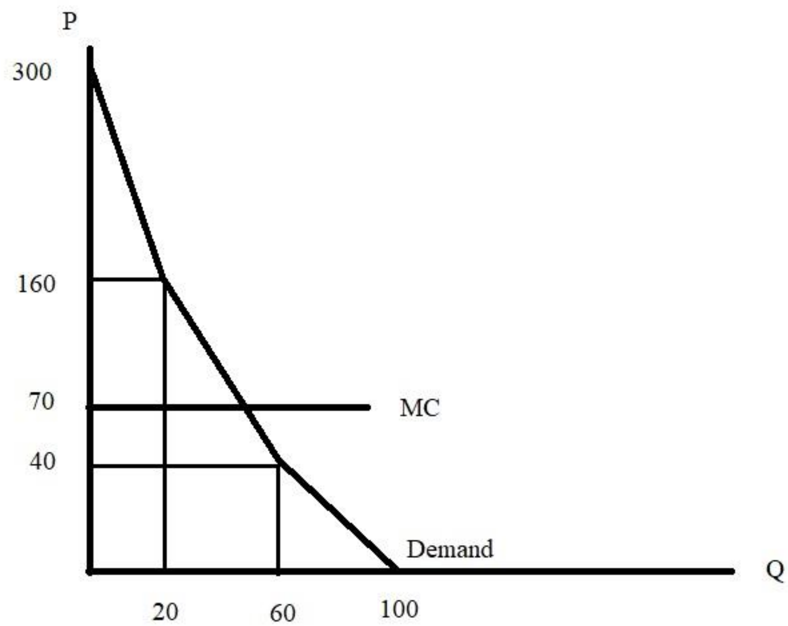
If the market is competitive, then each individual should consume the quantity where their demand curve intersects the marginal cost curve at $70.

70 = 100 – Q → Q = 30
70 = 120 – 2Q → Q = 25
70 = 80 – 4Q → Q = 2.5

Notice that Alvin will buy 30 units, which is more than the other two individuals would buy. Since this is a public good, the other two individuals have no reason to buy it, since the units Alvin buys cover them as well. Hence, they are free-riders.

b. Find the aggregate demand for this public good. Draw the aggregate demand curve, and label any kink points.

We want to sum the demand curves vertically. For $0 \leq Q \leq 20$, all three individuals consume, so $P = 300 - 7Q$. For $20 \leq Q \leq 60$, only Alvin and Briton consume, so $P = 220 - 3Q$. For $60 \leq Q$, only Alvin consumes, so $P = 100 - Q$. The kink points are (20, 160) and (60,40).



c. What is the socially optimal quantity of this public good? How much should each individual contribute?

The socially optimal quantity is where $P = 70$ intersects the aggregate demand curve. From our kink points in the above graph, it is clear that $P = 70$ will intersect the aggregate demand curve in the middle segment where $20 \leq Q \leq 60$,

$70 = 220 - 3Q \rightarrow Q = 50$
P_1 = 100 – 50 = 50 so Alvin should pay $50
P_2 = 120 – 2(50) = 20 so Briton should pay $20
P_3 = 0 (free-rider) so Charlie should pay $0