Economics 101
Fall 2018
Answers to Homework #5
Due Tuesday, December 11, 2018

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!

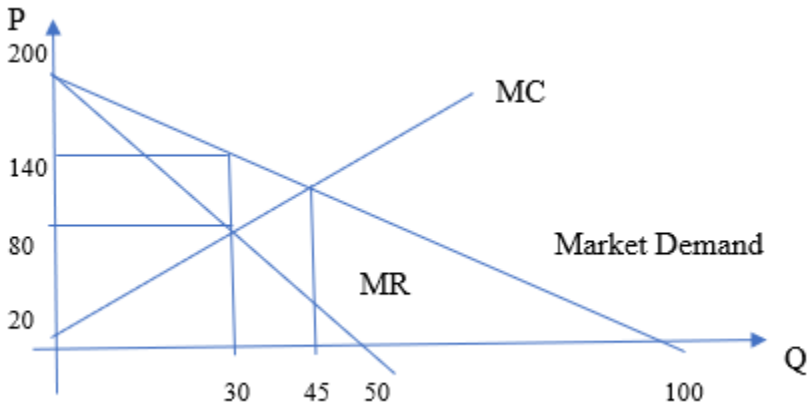
Part 1. Monopoly and Price Discrimination

1. Suppose you are given the following information about a monopolist:
   Market Demand Curve: $P = 200 – 2Q$
   MC for the monopolist: $MC = 20 + 2Q$
   Total Cost for the monopolist: $TC = 20Q + Q^2 + 100$
   Use this information to answer this set of questions.
   1) What is the profit maximizing price and quantity for this monopolist given the above information? Show how you found your answer and what your reasoning was. Calculate the monopolist's profit.
   2) Calculate the monopolist's consumer surplus (CS), producer surplus (PS), and deadweight loss (DWL). In a well-labeled graph illustrate this monopolist: be sure to include the areas that represent CS, PS, and DWL in your graph.
   3) Suppose demand increases by 90 units at every price. Find the equation for the monopolist's new demand curve. Then, calculate the new profit maximizing price and quantity for this monopolist given the new demand curve. Calculate the new level of monopoly profits.
   4) Calculate the value of consumer surplus (CS'), producer surplus (PS'), and deadweight loss (DWL') for this monopolist given the information in (3). In a well-labeled graph illustrate this monopolist: be sure to include the areas that represent CS', PS', and DWL' in your graph.

   Answer:

1) To find the profit maximizing quantity for the monopolist we need the firm's MR curve. Remember that for a linear downward sloping demand curve, the MR has the same y-intercept and twice the slope of this demand curve. Thus, MR = 200 – 4Q. Set MR = MC to find the profit maximizing quantity for the monopolist: 200 – 4Q = 20 + 2Q. Or, Q = 30 units. Use this quantity and the demand curve to find the monopolist's profit maximizing price: P = 200 – 2Q or P = $140 per unit. Profit is equal to TR – TC: so Profit = ($140 per unit) (30 units) – [(20) (30) + (30) (30) + 100] = $2600.

2) CS = (1/2) ($200 per unit - $140 per unit) (30 units) = $900
PS = (1/2) ($80 per unit - $20 per unit) (30 units) + ($140 per unit - $80 per unit) (30 units) = $2700
DWL = (1/2) ($140 per unit - $80 per unit) (45 units – 30 units) = $450

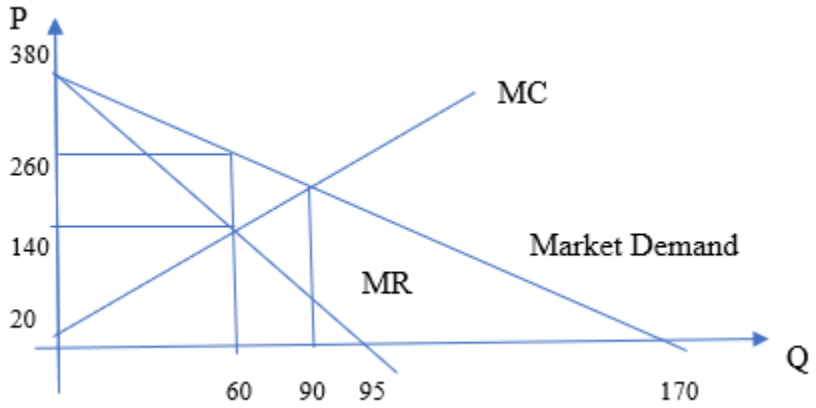


3) The slope of the demand curve is unchanged but at each price the quantity is now 90 units greater than the original quantity at that price. So, for instance, when P = $100 per unit, the quantity demanded initially was 50 units and now it is 140 units. Use these new (Q, P) coordinates to find the new demand curve: P = b + m Q. The slope of the new demand curve is the same as the slope of the initial demand curve. So, P = b – 2Q. Then, plugging in (Q, P) = (140, $100) into this equation we get 100 = b – 2(140) or b = 380. Thus, the new market demand curve is P = 380 – 2Q.

To find the profit maximizing quantity for the monopolist we need the firm's MR' curve. Remember that for a linear downward sloping demand curve, the MR has the same y-intercept and twice the slope of this demand curve. Thus, MR' = 380 – 4Q. Set MR' = MC to find the profit maximizing quantity for the monopolist: 380 – 4Q = 20 + 2Q, Or, Q' = 60 units. Use this quantity and the new demand curve to find the monopolist's profit maximizing price: P' = 380 – 2Q or P' = $260. Profit is equal to TR – TC: so Profit = ($260 per unit)(60 units) – [20(60) + (60)(60) + 100] or Profit = $15,600 - $4900 = $10,700.

4) CS' = (1/2)($380 per unit - $260 per unit)(60 units) = $3600
PS' = (1/2)($140 per unit - $20 per unit)(60 units) + ($260 per unit - $140 per unit)(60 units) = $10,800

DWL' = (1/2)($260 per unit - $140 per unit)(90 units – 60 units) = $1800



2. Consider a monopoly where the market demand curve is given by the equation:

Market Demand Curve: Q = 40 – 2P

To simplify the math of this problem let's assume this firm has fixed cost of $10 and that the firm's MC can be written as:

MC for the Firm: MC = $2 per unit of output

1) Suppose this profit-maximizing monopolist acts as a perfect price discriminating (1st degree) monopolist. Determine the following values.
   a. What is the level of output the firm will produce of the firm acts as a perfect price discriminating monopolist? Show your work.
   b. What is the level of consumer surplus (CS), the level of producer surplus (PS), and the deadweight loss (DWL) if this firm acts as a perfect price discriminating monopolist?
   c. What is the level of profits the firm will earn when it acts as a perfect price discriminating monopolist? Provide a graph that illustrates your answers from (a), (b), and (c).

Answer:

a. The monopoly here can simply extract all of the consumer surplus by charging different prices until the consumers' willingness to pay (the demand) is equal to its marginal cost, namely until p = MC.

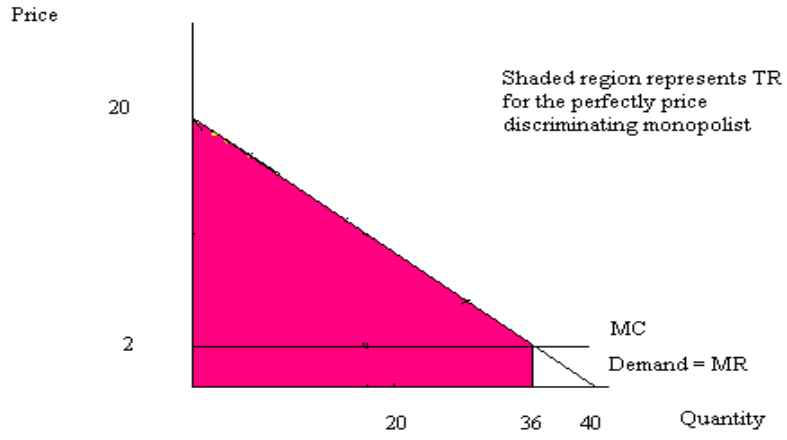
$$P = MC = 2$$

$$Q = 40 - 2P = 40 - 2(2) = 36$$

b. TR = (1/2)($20 per unit of output - $2 per unit of output)(36 units of output) + ($2 per unit of output)(36 units of output) = $396.
TC = FC + VC. Hence, TC = $10 + ($2 per unit of output) (36 units of output) = $82.

DWL = $0 since the perfect price discriminating monopolist produces the socially optimal amount of the good where P = MC for the last unit produced.

c. The perfect price discriminating monopolist's profit = TS = $314

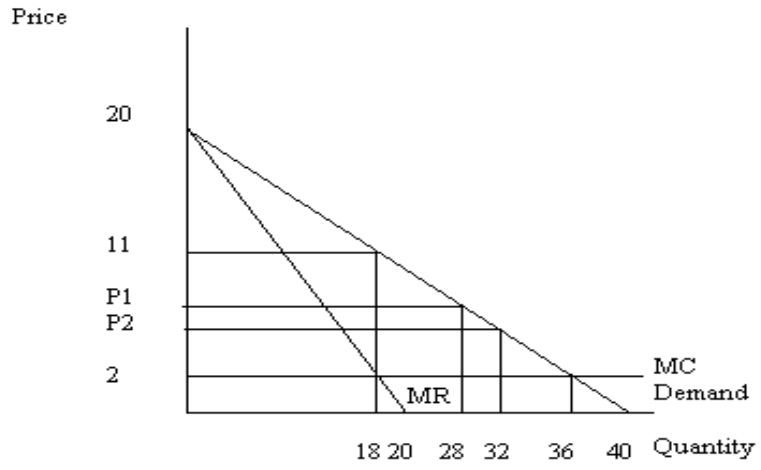


2) Now, suppose this monopolist decides to practice second degree price discrimination. The monopolist plans to sell 18 units of output at a price of $11per unit. The monopolist then plans to offer an additional 10 more units at a second pricing level; and an additional 4 more units at a third, and lower, pricing level. Given this information and holding everything else constant, determine your answers to the following questions.

a. What is the second pricing level? Show how you found your answer to this question.
b. What is the third pricing level? Show how you found your answer to this question.
c. Is it better for the monopolist to practice first degree price discrimination as described in the first part of this question or is it better for the monopolist to practice second degree price discrimination as described by this part of the question? Explain your answer. Illustrate your answers to (a), (b) and (c) with a well-labeled graph. In your graph indicate the areas that correspond to total revenue (TR) and variable costs (VC).

Answer:

a. P1 is that price on the demand curve when quantity is equal to 18 + 10 = 28: thus, P1 = 20 – (1/2)(28) = $6 per unit of the good.
b. P2 is that price on the demand curve when quantity is equal to 28 + 4 = 32: thus, P2 = 20 – (1/2)(32) = $4 per unit of the good.
c. TR = ($11 per unit of output)(18 units of output) + (P1)(10 units of output) + (P2)(4 units of output). TR = $198 + ($6 per unit of output)(10 units of output) + ($4 per unit of output)(4 units of output) or TR = $274.
   TC = VC + FC or TC = ($2 per unit of output) (32 units of output) + 10 = $74.
   Profit = TR – TC = $200
   This monopolist makes greater profits ($314 versus $200) when it acts as a perfect price discriminator rather than a second degree price discriminator. For the monopolist it is better to practice first degree price discrimination.



3) Suppose now suppose this monopolist decides to practice third degree price discrimination. That is, it can discriminate between two groups of consumers and charge each group a different price. (The original market demand curve is unrelated to this question)

The demand functions of the two groups are given by:

Demand Curve for Group 1: $P1 = 24 - Q1$

Demand Curve for Group 2: $P2 = 10 - 0.5\ Q2$

a. What is the level of output each group will choose to consume and the price each group will pay for the good? Show how you found your answer.
b. What is the value of consumer surplus (CS) and producer surplus (PS) when this monopolist practices third degree price discrimination? Show how you found your answer.
c. What is the level of profits the monopolist will earn when it practices third degree price discrimination? Show how you found your answer. Then illustrate your answer by drawing two graphs: one representing Group 1 and the other representing Group 2. Make sure you label both graphs clearly and completely.

Answer:

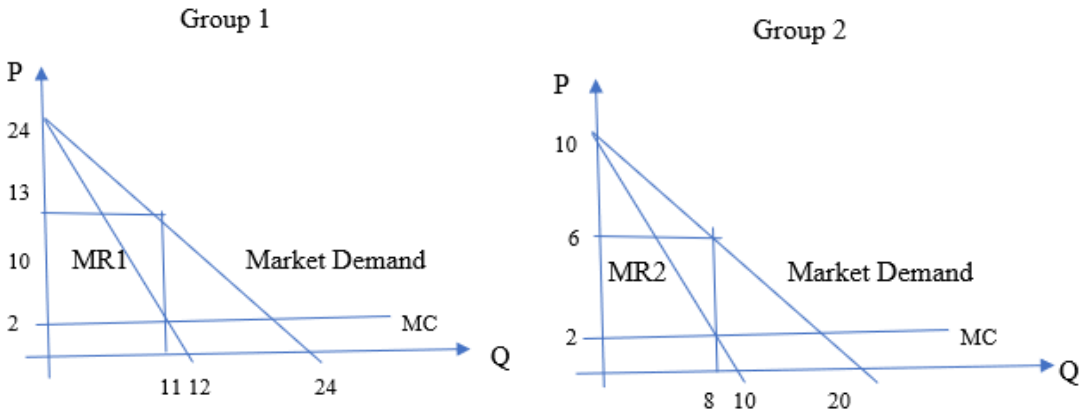
a. We need to find Marginal Revenue (MR) for each group first.
MR1 = 24 - 2Q1
MR2 = 10 - Q2
Optimal condition requires MR = MC

So we set MR1 = MC, 24 - 2Q1 = 2, Q1= 11 units of the good, P1= $13 per unit of the good

MR2 = MC, 10 – Q2 = 2, Q2 = 8 units of the good, P2 = $6 per unit of the good

b. PS = (13 - 2)*11 + (6 - 2)*8 = $121 + $32 = $153
CS = (24 - 13)*11/2 + (10 - 6)*8/2 = $60.50 +$16 = $76.50

c. Profits = TR - TC = (11*13 + 8*6) - (2*(11 + 8) + 10) = $143



Part 2. Game Theory

3. Consider the following games:

1) Two people are trying to figure out how to split $8 that they found lying around. In order to make it fair (but interesting!), they use a random number generator to create some simple payouts for a 2x2 game. The game can be represented by the following payoff matrix, with the left number in each cell referring to Player One, and the right number referring to Player Two. Each person can choose one of two options that the machine spits out, which gives the following results:

		Player Two	
		Option A	Option B
Player One	Option A	3,5	2,6
	Option B	7,1	1,7

Are there any dominant strategies for Player One? Are there any dominant strategies for Player Two? Based on this and assuming players are rational, what do you think the outcome of the game will be?

2) In the classic game theory problem "the Stag Hunt", two hunters must decide on their approach. By working together, they can bring down a stag, which means they'll have a feast. However, either hunter can decide instead to abandon the plan and try to trap rabbits. Catching a rabbit is good, but not as good as a stag. Worse still, if a hunter tries to catch a stag alone, he fails and receives nothing.

The game can be represented by the following payoff matrix, with the left number in each cell referring to hunter one, and the right number referring to hunter two.

		Hunter Two	
		Hunt Stag	Hunt Rabbit
Hunter One	Hunt Stag	4,4	0,2
	Hunt Rabbit	2,0	2,2

Are there any strictly dominant strategies for either hunter? Based on this, what do you think the outcome of the game will be?

Answer

1) Player One has no dominant strategies: when Player Two plays A, Player One should play B, but when Player Two plays B, Player One should play A.

   Player Two has a dominant strategy: it is always better to play B than it is to play A.

   Since we know Player Two will play B, then we know Player One would prefer to play A. Hence, we should expect that the outcome is (A, B).

2) There are no strictly dominant strategies for either hunter. For each hunter, it is better to hunt stag when the other hunter hunts stag, but better to hunt rabbit if the other hunter hunts rabbit. As a result, we cannot determine the outcome of the game by simply considering dominant strategies.

Part 3. Externality and Public Good

4. A vast reserve of tight oil is discovered in previously-unnoticed shale underneath the University of Madison! An oil company rapidly sets up to extract as much as they can, with a local market supply curve (the marginal private cost curve) given by the following equation:

Market supply: $P = 2Q$

Where Q is the quantity of barrels of crude oil and P is the price per barrel. A small refining industry develops around the University, with a demand (marginal private benefit) curve given by:

Market demand: $P = 150 - Q$

A group of environmental economists have concerns, however, that the horizontal drilling and hydraulic fracturing methods used to extract oil could have adverse effects on Lake Mendota.

They estimate an approximate negative externality of $15 per barrel per barrel of oil that is sold.

1) Find the competitive equilibrium (i.e., the equilibrium quantity and the equilibrium price) in the market, assuming externalities are not accounted for by any of the market participants.

2) Given the above information, what are the equations for the marginal social cost and marginal social benefit curves?

3) Graph the marginal private cost/benefit and marginal social cost/benefit curves. Find the socially optimal equilibrium. Compare it to the competitive equilibrium.

4) The State of Wisconsin steps in to intervene by ordering an excise tax placed on local oil producers. What level of tax is needed to result in the new competitive equilibrium producing the same result as the socially optimum equilibrium?

5) Under this tax level and the new competitive equilibrium, find the price producers will receive, the price consumers will pay, and the tax revenue.

6) What is the deadweight loss when the government decides not to intervene?

Answer:

1) Setting MPB = MPC:

   $2Q = 150 - Q \Rightarrow Q = 50$ barrels of oil $\Rightarrow P = \$100$ per barrel of oil

2) MSB = MPB = 150 - Q

   However, we need to consider the externality on the cost:

   MSC = MPC + 15

   MSC = 2Q + 15

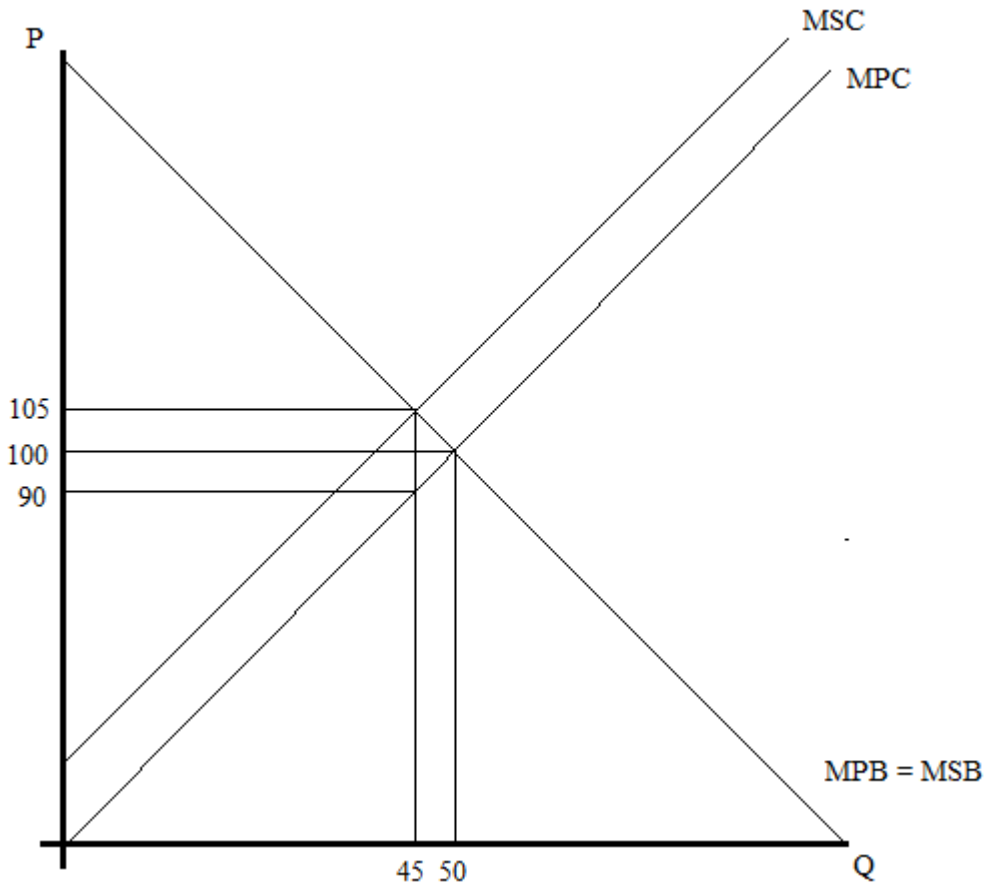
3) The socially optimum equilibrium sets MSC = MSB:

   $2Q + 15 = 150 - Q$

   $3Q = 135$

   $Q = 45, P = 105$

The social equilibrium has a lower quantity and higher price than the competitive equilibrium.



4) The tax necessary should internalize the externality. Since the externality is $15, we know immediately that an excise tax of $15 will set MPC + tax = MSC = MPC + externality.

5) The equilibrium under the tax is the same as the socially optimum equilibrium (since we set the tax specifically to achieve this!). Q = 45, P = 105

   Producers receive $90, consumers pay $105, and the government raises $15 * 45 = $675

6) (1/2) * (Size of externality) * (Difference in quantity) = (1/2) * (15) * (5) = 75/2 = $37.5

5. As winter rolls around in the village of Economica, three residents begin considering that they will need to organize snow-plowing services if they ever want to get to work to write exams. Each resident has different levels of acclimation to the cold and tolerance for inconvenience, so they value the use of snow-plowing differently. We can write their willingness to pay

represented by the following demand curves, where P is the price of the service and Q is the quantity of hours spent plowing per month.

Resident A: $P = 120 - 2Q$

Resident B: $P = 180 - 2Q$

Resident C: $P = 300 - 6Q$

It costs the village \$80 per hour of snow-plowing per month, and hence the MC of each additional unit is constant at \$80.

1) Suppose this market is competitive. Find the quantity demanded by each resident and the price per unit paid. Are there any free-riders in this market?

2) Now, recognizing that this good is a public good in that it is nonexcludable and nonrival in consumption, find the aggregate demand for snow-plowing services. Draw the graph of this aggregate demand curve and label any kink points.

3) What is the socially optimum quantity of snow-plowing? How much should each resident contribute towards this on a per-unit basis?

Answer

1) When the market is competitive, in theory each resident will want to consume the quantity where their demand curve intersects the marginal cost curve at \$80.

   Resident A: $80 = 120 - 2Q \Rightarrow Q = 20$,

   Resident B: $80 = 180 - 2Q \Rightarrow Q = 50$,

   Resident C: $80 = 300 - 6Q \Rightarrow Q = 110/3$

   However, we note that since Resident B will pay for 50 units (more than either Resident A or C would demand) and that snow-plowing benefits everyone, Residents A and C have no reason to purchase anything because they can free-ride.

   Hence the outcome is that Resident B pays \$80/unit for 50 units, while Residents A and C pay nothing.

2) The marginal social benefit curve can be found by summing the demand curves vertically: summing the prices at each level of quantity. We can solve this algebraically using the three demand curves provided, considering the functions piecewise:

   For $0 \leq Q \leq 50$, all three consume:

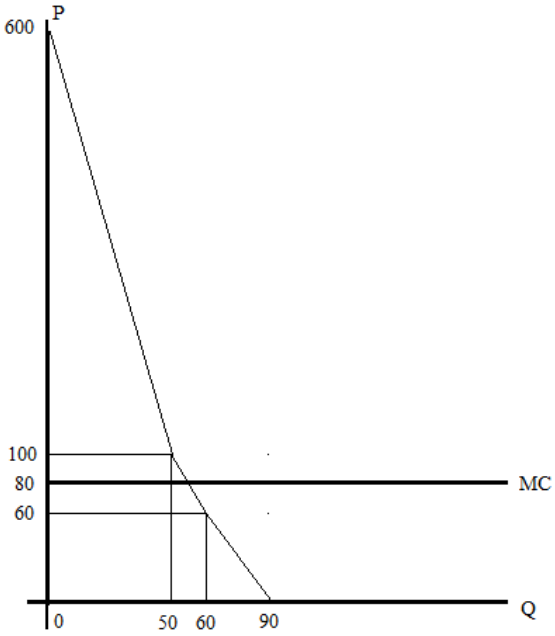
   $P = 600 - 10Q$

   For $50 \leq Q \leq 60$, A and B consume:

   $P = 300 - 4Q$

For $60 \leq Q$, B consumes:

$P = 180 - 2Q$



3) Now, we can find where $P = 80$ intersects this curve. From the graph in section (b), we can tell that is it in segment 2 where $50 \leq Q \leq 60$:

$80 = 300 - 4Q \Rightarrow Q = 220/4 = 55$

$P_A = 120 - 2(55) = 10$

$P_B = 180 - 2(55) = 70$

$P_C = 0$ (in the second segment, Resident C is a free-rider as they demand fewer than 50 units)

Hence for each hour of snow-plowing, Resident A will pay \$10, Resident B will pay \$70, and Resident C will free-ride and pay nothing.