

This week, you will learn:

- Essential Mathematics Review (Chapter 1)
  - o Line and Equation of a Line
  - o Solving Two Equations (will be covered along with market equilibrium)
  - o Percentages (will be covered along with elasticities)
  - o Area of Triangle, Rectangle, and Trapezoid
- Basic Economics (Chapter 1 & 2)
  - o Opportunity Cost
  - o Absolute Advantage and Comparative Advantage
  - o Production Possibilities Frontier (PPF)

**ESSENTIAL MATHEMATICS REVIEW**

This handout goes over “almost” all of the mathematics required to succeed in ECON 101. It will be helpful to understand what goes through this handout in a step-by-step manner. You should be able to work with these problems as you will be using the concepts and techniques all of the time in this course.

Note further that calculators of any types are strictly forbidden in exams. So make sure that you are comfortable with calculations by hand, with precision and reasonable pace.

Line and Equation of a Line

1. Find the equation of a line going through (1, -3) with a slope of 3. Plot this line.
2. Find the equation of a line going through (0, 4) and (-2, 6). Plot this line.
3. Consider a line given by the equation  $y = 3x$ .
  - a) If it is shifted up by 2 units, what is the new equation of this line? Plot this shifted line alongside the original line.
  - b) Repeat part a) if instead the line is shifted to the left by 2 units.
4. Repeat question 3a) and 3b) when the original equation of a line is  $y = -3x$ .
5. Repeat question 3a) and 3b) when the original equation of a line is  $y = 0.5x + 5$ .
6. Suppose  $y$  is the distance travelled in miles, and  $x$  is the time travelled in hours. If the relationship between distance and time is given by equation  $y = 100x$ , what is the unit of the slope?

Percentages

7. Alice has received her salary raise from \$10 to \$12.5, what is the percentage change in her salary? What about Bryan who has received his salary cut from \$12.5 to \$10?

Area of Triangle, Rectangle, and Trapezoid

8. What is the area of a triangle with the base of 3 units and height of 6 units?
9. What is the area of a rectangle with the width of 4 units and height of 8 units?
10. What is the area of a trapezoid with the parallel legs of length 10 and 8 units and height of 6 units?

*“There is no Royal Road to geometry.” – Euclid’s reply to King Ptolemy*

## BASIC ECONOMICS

### Positive vs. Normative Statements

1. Which of the following questions requires a positive answer?
  - a. What fraction of the population is willing to save more if the government decides to cut income taxes by 10 percent this year?
  - b. What should the government set as the maximum budget for the new legislation for its war on drugs?
  - c. Why should the state of Wisconsin lower the minimum drinking age by 2 years?
  - d. Where should we go after this BLC session?

### Opportunity Cost

2. Annual college tuition at UW-Madison, including textbooks, is \$25,000. It costs \$10,000 per year to live in Madison. What are the opportunity costs for Alex and Bobby if:
  - a. Alex from Green Bay, WI – he would have earned \$30,000 per year from family business in Green Bay?
  - b. Bobby from Madison, WI – he would have earned \$30,000 per year from bussing tables in Madison?

### Absolute Advantage vs. Comparative Advantage

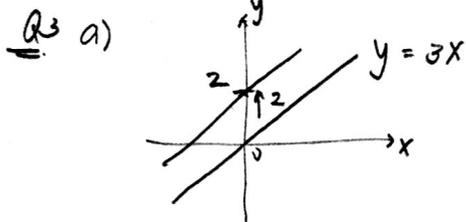
3. Suppose in 5 hours, Eugene can cook 10 meals or clean 5 cars, while Jonas can cook 6 meals or clean 9 cars.
  - a. Who has the absolute advantage in cooking meals? What about cleaning cars?
  - b. Suppose instead that in 10 hours, Jonas can cook 12 meals or clean 18 cars. Would this change any information of the problem?
  - c. Find the opportunity costs of cooking meals and cleaning cars for each person.
  - d. Who has the comparative advantage in cooking meals? What about cleaning cars?
  - e. Put meals (M) on vertical axes, plot the production possibility frontiers (PPFs) for both Eugene and Jonas. Write down the equations for both.
  - f. If both are only cooking meals now and one car is needed to be cleaned, who should be cleaning the first car?
  - g. (Optional) In light of your finding in 3f), plot the global PPF, that is, combine both Eugene's and Jonas' PPFs.
4. It takes 5 minutes for Ryan to pick a coconut and 10 minutes to catch a fish. For Jenny, it takes 6 minutes to pick a coconut and 15 minutes to catch a fish.
  - a. In one hour, how many coconuts can Ryan pick if he does not catch any fish? How many fish can Ryan catch if he does not pick coconuts? What about Jenny?
  - b. Find the opportunity costs of picking a coconut and catching fish for each person.
  - c. Who has the comparative advantage in picking coconuts? What about catching fish?
  - d. Put coconuts (C) on vertical axes, plot the production possibility frontiers (PPFs) for both Eugene and Jonas. Write down the equations for both. Interpret the result with Marginal Rates of Transformation (MRT)
5. Abby and Gale make xylophones ( $x$ ) and yarn ( $y$ ) according to the PPFs given by  $y = 18 - 3x$  and  $y = 12 - 6x$ , respectively. List the opportunity costs each of them face.

# MATH REVIEW

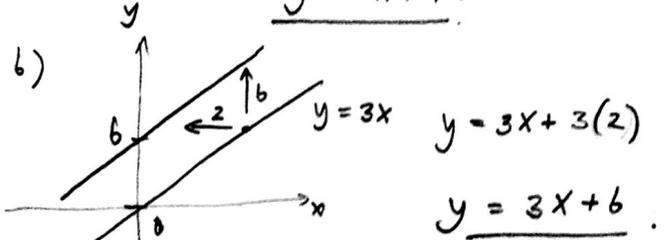
Q1  $m = 3, (x_1, y_1) = (1, -3) \Rightarrow y - y_1 = m(x - x_1), y - (-3) = 3(x - 1)$

so:  $y = 3x - 6$

Q2  $(x_1, y_1) = (0, 4) \left\{ \begin{array}{l} m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{6 - 4}{-2 - 0} = \frac{2}{-2} = -1 \end{array} \right.$  use  $y = mx + c$ ,  
 $(x_2, y_2) = (-2, 6)$  so  $y = -x + c$ ,  $c$  to be determined.  
 Pick  $(x, y) = (0, 4) \Rightarrow 4 = -0 + c \Rightarrow c = 4$ . Hence:  $y = -x + 4$

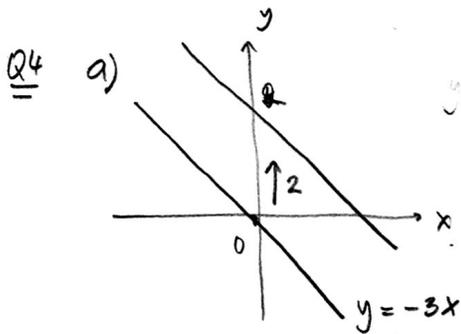


$y = 3x + 2$

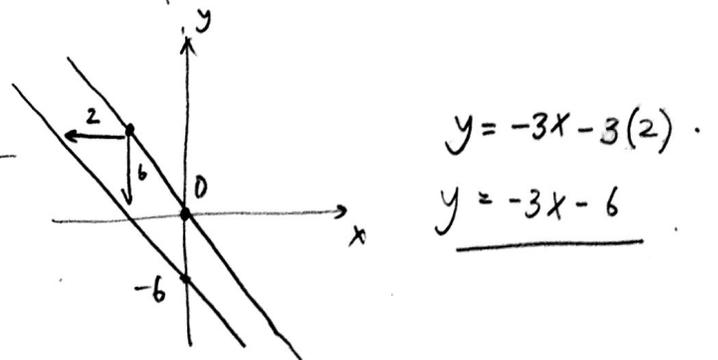


$y = 3x + 3(2)$

$y = 3x + 6$

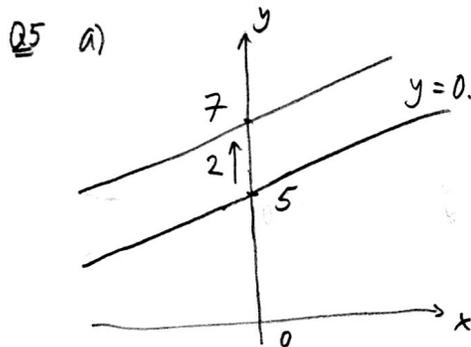


$y = -3x + 2$

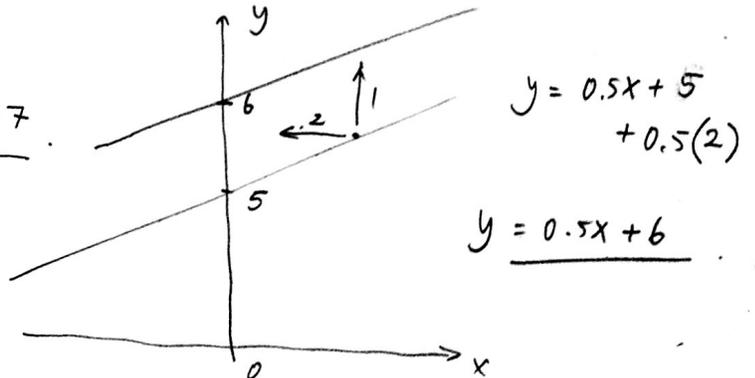


$y = -3x - 3(2)$

$y = -3x - 6$



$y = 0.5x + 7$



$y = 0.5x + 5 + 0.5(2)$

$y = 0.5x + 6$

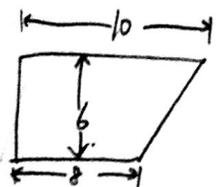
Q6  $y$  miles }  $y = 100x$   
 $x$  hours } miles = 100 · hours  $\Rightarrow$  units must be miles/hour.

Q7 Alice  $\frac{12.5 - 10.0}{10.0} = +0.25 = +25\%$ , Bryan  $\frac{10.0 - 12.5}{12.5} = -0.2 = -20\%$

Q8  $\frac{1}{2} \times 3 \times 6 = 9$

Q9  $4 \times 8 = 32$

Q10  $\frac{1}{2} \times (10 + 8) \times 6 = 54$



# BASIC ECONOMICS

Q1 a) requires positive answers; b), c), d) require normative answers.

Q2 a) Alex's OC = 25000 + 10000 + 30000 = 65000

b) Bobby's OC = 25000 + 30000 = 55000

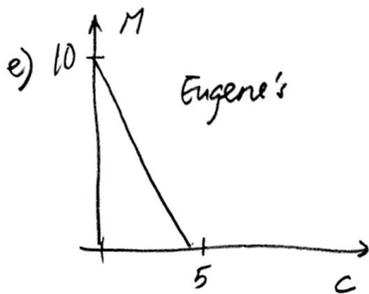
Q3

	Meals	Cars	opportunity costs
Eugene	10 M	5 C	$\Rightarrow 10/5 = 2 \text{ M/C}$ or $5/10 = 0.5 \text{ C/M}$
Jonas	6 M	9 C	$\Rightarrow 6/9 = 2/3 \text{ M/C}$ or $9/6 = 1.5 \text{ C/M}$

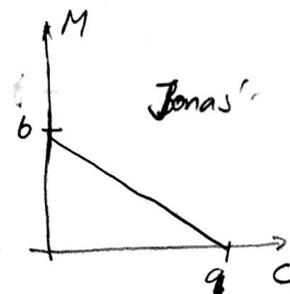
a) Eugene has AA in meals, Jonas has AA in cars.

b) No.

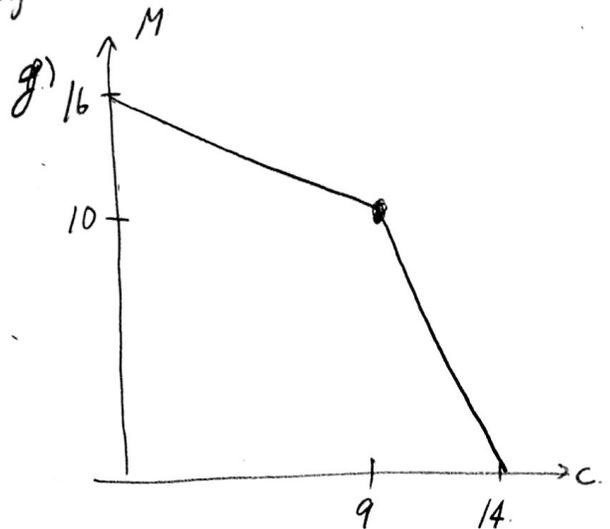
c), d) Eugene sacrifices 0.5 C for 1 M } Jonas has CA in Cars.  
 Jonas sacrifices 1.5 C for 1 M } Eugene has CA in Meals.



$M = 10 - 2C$



$M = 6 - \frac{2}{3}C$



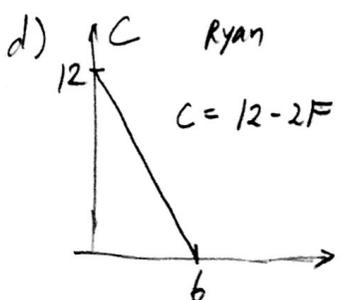
f) Jonas

Q4 a) In one hour, Ryan  $\left\{ \begin{array}{l} 12 \text{ Coconuts} \\ 6 \text{ fish} \end{array} \right.$ , Jenny  $\left\{ \begin{array}{l} 10 \text{ coconuts} \\ 4 \text{ fish} \end{array} \right.$

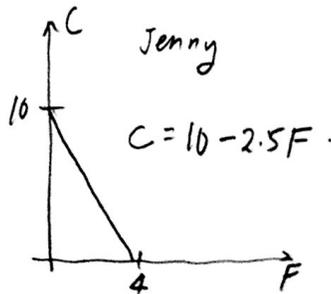
b) Ryan sacrifices 12 coconuts  $\rightarrow$  6 fish =  $\frac{12}{6} = 2 \text{ C/F}$   $\Leftrightarrow \frac{6}{12} = 0.5 \text{ F/C}$

Jenny sacrifices 10 coconuts  $\rightarrow$  4 fish =  $\frac{10}{4} = 2.5 \text{ C/F}$   $\Leftrightarrow \frac{4}{10} = 0.4 \text{ F/C}$

c) Ryan has CA in fish, Jenny has CA in coconuts.



$C = 12 - 2F$



$C = 10 - 2.5F$

Q5

Opportunity costs are:

Abby 3 Yarns/Xylophone.

Gale 6 Yarns/Xylophone.

**This handout contains exercises of**

- Demand and Supply: The Basics, Shifts vs. Movement, Determinants
- The Market Demand and Market Supply Curves
- Demand and Supply: Equilibrium

**Things you should know**

- What are the law of demand and the law of supply?
- What are the determinants of demand and supply of each good?
- What is the difference of change in quantity demanded/supplied and change in demand/supply?
- What happen when there is a shift in demand or supply?
- From individual demand or supply curves, how to find the aggregated (market/joint) demand or supply curves?
- What is equilibrium? How to find the equilibrium in demand-supply system?

**Exercises**

Question 1 (Basics of Demand and Supply)

Consider the following situations in the market for Apple iPhone 6S. Holding everything else constant and assume that iPhone is a normal good, analyze what would happen to the demand and/or supply for Apple iPhone 6S?

- a. Special price sale for iPhone 6S is announced just for today and today only.
- b. Special price sale for Samsung Galaxy is announced.
- c. The State of Wisconsin announces 10% raise to all state employees.
- d. "Shame on Apple" labor dispute protest affects the perception of Apple products.
- e. Rumors of \$200 Black Friday sales of iPhone 6S leaks out to public.
- f. Foxconn factory (supplier of iPhones) improves production method.
- g. Price of MacBook increases as all students are buying laptops for schools.

Question 2 (Shifts of Demand and Supply in multiple markets)

- a. Let us reconsider the example from 1g). We consider the markets for the following goods: MacBook, iPhones and iPhones accessories. Draw three demand-supply diagrams for each of the three markets and analyze the effects towards equilibria when students are buying more MacBooks.
- b. (Challenging, don't try this at home!) This year's drought has dramatically plagued water supply for brewery. Wisconsinites must have beer with brats. Also, recent Health and Safety inspections shut down the majority of sausages factories due to poor hygiene. Draw three demand-supply diagrams for each of the three markets - beer, brats, and wine - then analyze the effects towards equilibria.

Question 3 (The Market Demand with Tabulated Numerical)

From Anna's and Maria's demands and market demand for iced coffee, complete the table and plot the market demand.

Price of Iced Coffee (\$/cup)	Anna's Quantity	Maria's Quantity	Market Quantity
\$ 0	10	8	
\$ 2	5	4	
\$ 4	2		2
\$ 6	0	0	

Question 4 (The Market Demand with Equations, and Supply)

There are only two persons in the Austrian Alps - Jeremy and Mitch. Each of them has the following individual demand curve for Swiss cheese:

$$\text{Jeremy } p = 10 - 0.5q \qquad \text{Mitch } p = 20 - 2q$$

The market supply is given by:  $Q = 0.5P$ .

1. Draw each of the individual demand curves.
  2. At market price  $P = 20$ , what is quantity demanded in the market? What about when the market price is  $P = 10$ ,  $P = 5$  and  $P = 0$ ?
  3. Find the market demand curve graphically and denote the kink points. Write down the equations for each segment.
  4. Find the equilibrium price and quantity.
- (Extra) What if there is a third consumer on the demand side?

Question 5 (Demand-Supply)

Let the demand equation be given by  $Q = 100 - 0.5P$ . The supply equation is  $P = 2Q$ .

1. Plot the demand and supply curves. Denote where there are shortage and surplus.
2. Find the equilibrium price and quantity.
3. If demand increases by 40 units, what is the new equilibrium?
4. If supply decreases by 10 units, what is the new equilibrium?
5. What can we say about the equilibrium if supply increases and demand increases?
6. What can we say about the equilibrium if supply decreases and demand decreases?

# HANDOUT 2

Q1) a) Movement along the demand curve of iPhone.

b) Demand shifts left.

c) Demand shifts right.

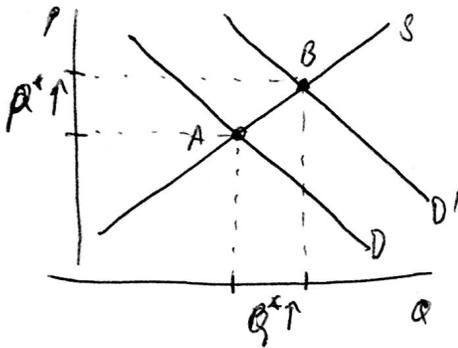
d) Demand shifts left.

e) Demand shifts left. (It's going to be cheaper next month.)

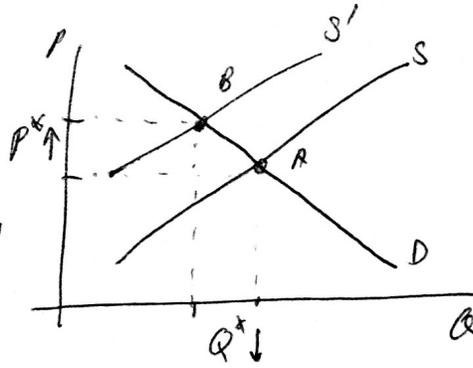
f) Supply shifts right.

g) Supply shifts left.

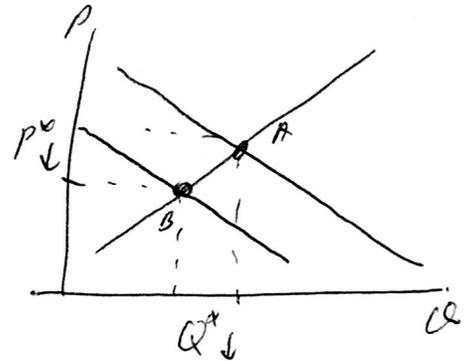
Q2) a) MacBook.



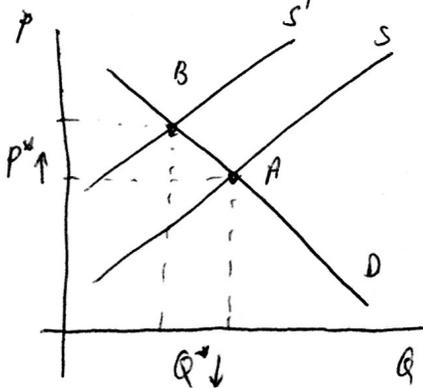
iPhone



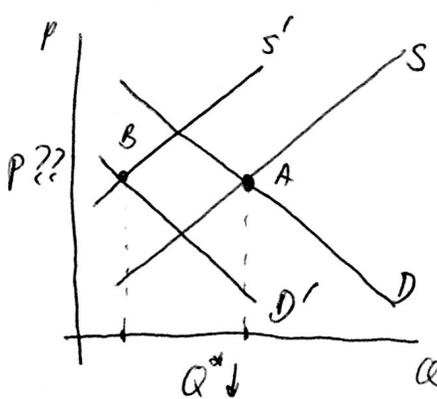
iPhone accessories.



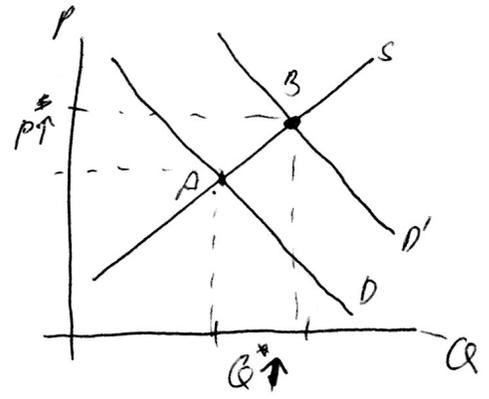
Q2) b) Beer



Brats

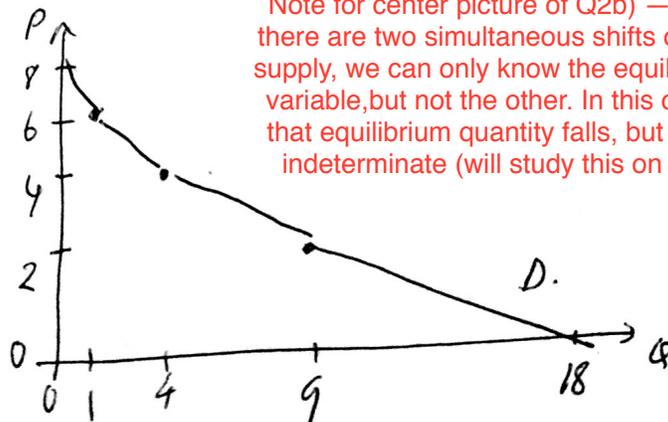


Wine



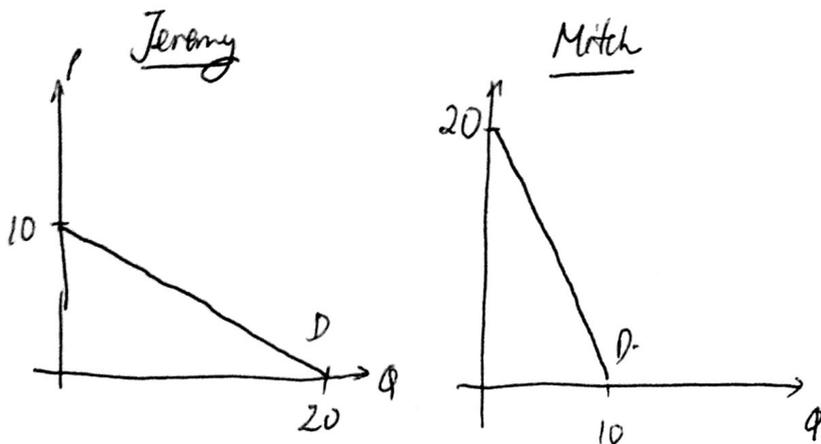
Q3)

P	Q <sup>A</sup>	Q <sup>M</sup>	Q <sub>Agg</sub>
\$ 0	10	8	18
\$ 2	5	4	9
\$ 4	3	1	4
\$ 6	1	0	1
\$ 8	0	0	0



Note for center picture of Q2b) — In this case, since there are two simultaneous shifts of both demand and supply, we can only know the equilibrium effect on one variable, but not the other. In this case, we only know that equilibrium quantity falls, but equilibrium price is indeterminate (will study this on Thursday lecture)

Q4 a)



b)

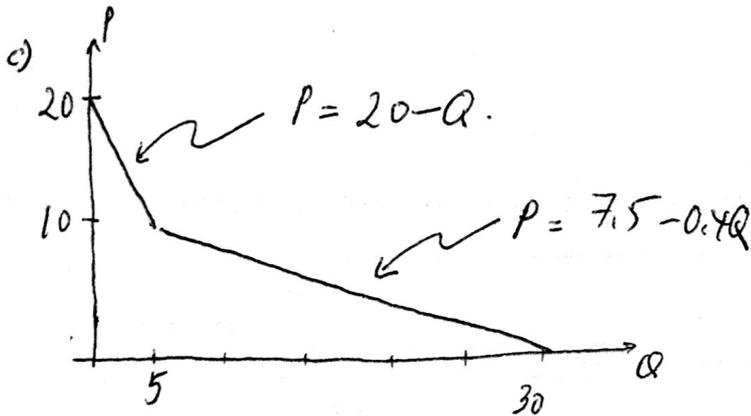
$$P=20 \Rightarrow Q^J + Q^M = 0 + 0 = 0$$

$$P=10 \Rightarrow Q^J + Q^M = 0 + 5 = 5$$

$$P=5 \Rightarrow Q^J + Q^M = 10 + 7.5 = 17.5$$

$$P=0 \Rightarrow Q^J + Q^M = 20 + 10 = 30$$

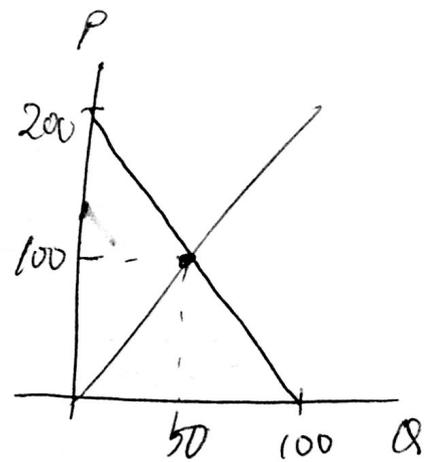
From  $P = 20 - 2Q \Rightarrow Q = 10 - \frac{1}{2}P$   
 $P = 10 - 0.5Q \Rightarrow Q = 20 - 2P$   
 $\underline{Q = 30 - 2.5P}$



$$Q = \begin{cases} 10 - 0.5P & P \geq 10 \\ 30 - 2.5P & P < 10 \end{cases}$$

d)  $Q^* = 5, P^* = 10$ .

Q5 (D)  $P = 200 - 2Q$       a)  $Q^* = 50, P^* = 100$   
 (S)  $P = 2Q$                       b) }



c)  $Q = 140 - 0.5P$  and  $Q = 0.5P \Rightarrow Q^* = 70$   
 $P^* = 140$

d)  $P = 2Q + 20$  and  $P = 200 - 2Q \Rightarrow Q^* = 45$   
 $P^* = 110$

**This handout contains exercises of**

- Demand and Supply: Numerical Equilibrium
- Demand and Supply: Consumer and Producer Surpluses
- Demand and Supply: Market Intervention (Price and Quantity) and Deadweight Loss
- Demand and Supply: International Trade

**Things you should know**

- What is equilibrium? How to find the equilibrium in demand-supply system? What are consumer and producer surpluses?
- What are price ceiling and price floor? What is deadweight loss? What are the effects towards economic surpluses?
- What happens when the small open economy opens to trade? How to find the price and quantity that the product is sold? What is tariff?

**Exercises**

Question 1 (Qualitative Shifts of Demand and Supply)

1. What can we say about the equilibrium if supply increases?
2. What can we say about the equilibrium if demand increases?
3. What can we say about the equilibrium if supply increases and demand increases?
4. What can we say about the equilibrium if supply increases and demand decreases?
5. What can we say about the equilibrium if supply decreases and demand increases?
6. What can we say about the equilibrium if supply decreases and demand decreases?

Question 2 (Demand-Supply: Economic Surpluses, Shifts, Market Intervention, and International Trade)

Let the demand equation be given by  $Q = 100 - 0.5P$ . The supply equation is  $P = 2Q$ .

This section introduces the basic equilibrium.

1. Plot the demand and supply curves. Denote at which prices are there shortage and surplus.
2. Find the equilibrium price and quantity.
3. Find the consumer's and producer's surplus.

This section gives you examples of shifting demand or supply curves.

4. If demand increases by 40 units, what is the new equilibrium?
5. If instead supply decreases by 10 units, what is the new equilibrium?

Revert to the original demand and supply curves given. This section analyzes the effects of government intervention.

6. If the government enacts a price floor of \$80, find the quantity sold, excess supply, consumer and producer surpluses, and deadweight loss.
7. If the price floor enacted is \$140, find the quantity sold, excess supply, consumer and producer surpluses, and deadweight loss.
8. If instead the price ceiling is enacted at \$50, find the quantity sold, excess demand, consumer and producer surpluses, and deadweight loss.
9. Draw the demand and supply graphs, along with the surpluses and deadweight loss, when the quantity restriction is in place at 40 units.

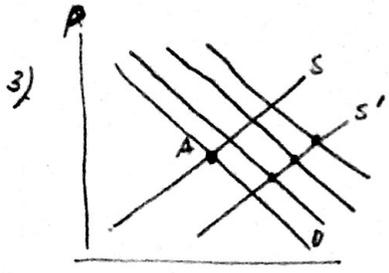
Demand and Supply - Applications, Analysis, and International Trade

This section gives you an example when a small open economy opens to trade. That is, it is possible to buy or sell this goods from and to other countries. Suppose this country has the demand and supply of the product as listed above.

10. Suppose the world price for this product is \$50, what would be the quantity produced by domestic producers? What is the quantity consumed in this country? How many units are imported or exported? Find consumer and producer surpluses.
11. Seeing the world price of \$50, the government wishes to help domestic producers by implementing a \$30 tariff per each unit imported. Answer the same questions as in part 10.
12. Answer the same questions as in part 10 if the world price is \$140.

QUESTION I

- 1)  $P^* \downarrow, Q^* \uparrow$
- 2)  $P^* \uparrow, Q^* \uparrow$

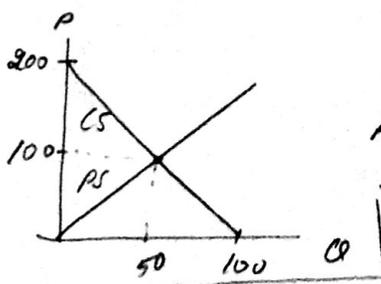


$P^*$  ambiguous,  $Q^* \uparrow$

- 4)  $P^* \downarrow, Q^*$  ambiguous
- 5)  $P^* \uparrow, Q^*$  ambiguous
- 6)  $P^*$  ambiguous,  $Q^* \downarrow$

QUESTION II

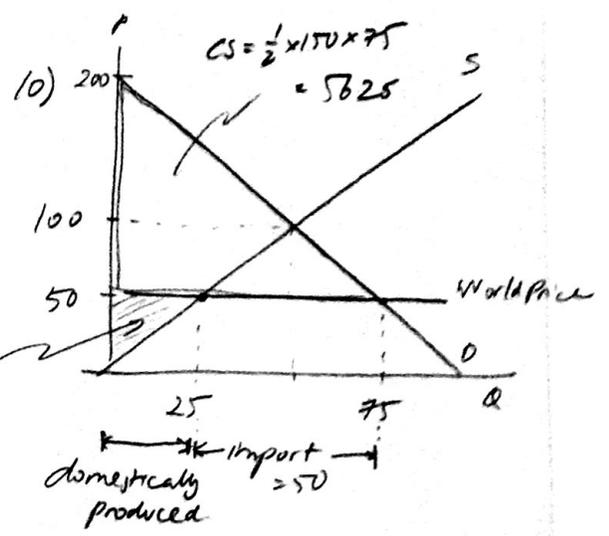
1)-3)  $P = 200 - 2Q \dots (D)$  }  $P^* = 100$   
 $P = 2Q \dots (S)$  }  $Q^* = 50$



$CS = 2500$   
 $PS = 2500$

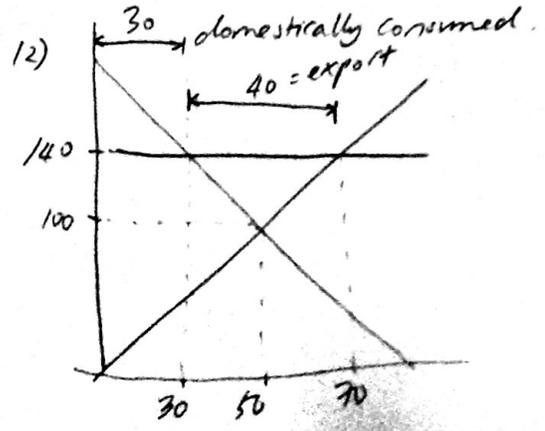
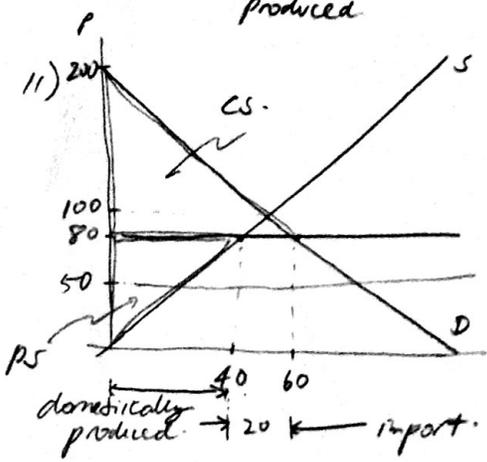
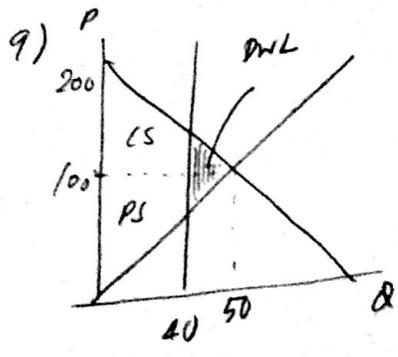
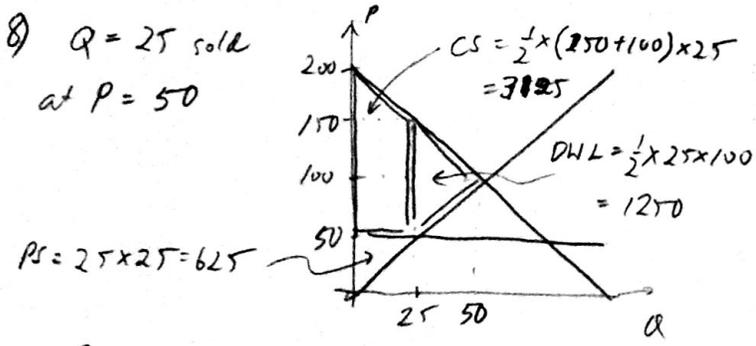
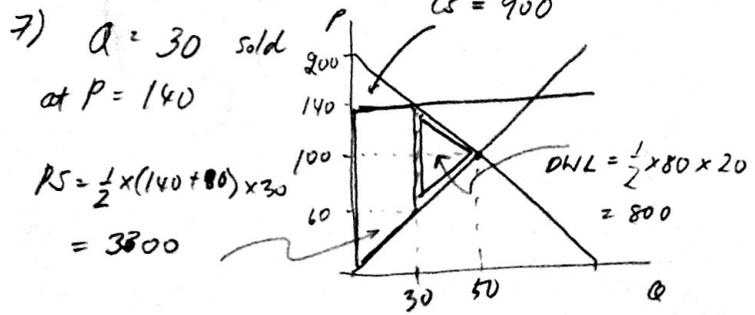
4)  $P = 200 + 80 - 2Q = 280 - 2Q (D)$  }  $Q^* = 70$   
 $P = 2Q (S)$  }  $P^* = 140$

$Q^* = 70$   
 $P^* = 140$



5)  $P = 2Q + 20 \dots (S)$  }  $Q^* = 45$   
 $P = 200 - 2Q \dots (D)$  }  $P^* = 90$

6) Nothing happens



**This handout contains exercises of**

- Demand and Supply: Elasticities
  - o (Own) Price Elasticity of Demand
    - Point Calculation / Midpoint Percentage Calculation
    - Revenue Maximization
  - o Cross-Price Elasticity of Demand
  - o Income Elasticity of Demand
  - o Price Elasticity of Supply

**Things you should know**

- See Kanit's Midterm 1 Review Sheet (which also includes the formulation)

**Exercises**

Question 0

Write down and explain the formulas and intuitions of all elasticities we have studied.

Question 1 (Price Elasticity of Demand: Calculating Elasticities)

1. What can be concluded if the price elasticity of demand is -1.5? What can we say about this demand of this good at this moment?
2. Suppose price of a good increases from \$3 to \$5 causing the quantity demanded to decrease from 10 units to 6 units. What is the price elasticity of demand using midpoint percentage?
3. Suppose the demand curve for a good is given by  $P = 10 - 0.5Q$ . Find the price elasticity of demand:
  - a. when the price is \$3.
  - b. when the quantity is 7 units.
  - c. when the price is \$5. (You should know something about this number.)
4. If the price elasticity of demand is -1 when the current price is \$2 and current quantity is 10 units. What is the slope of the demand curve?

Question 2

Suppose the demand for Tuberculosis drug is given by  $Q = 100$ . Draw this demand curve.

1. If the price of this drug increases from \$13.5 to \$750, what is the effect to the quantity demanded? What is the price elasticity of demand?
2. Suppose supply decreases, what would happen to the equilibrium price and quantity?

Question 3 (Income Elasticity of Demand)

1. Suppose income increases by 10% causes the quantity demanded to decrease by 10%, what is the income elasticity of demand? What can be said about this good at current situation?
2. Suppose income increases from \$14,000 to \$16,000 causes the quantity demanded of a good to change from 590 units to 610 units. What is the income elasticity of demand calculated using midpoint percentage? What can we say about the characteristic of this good?

Question 4 (Cross-price Elasticity of Demand)

1. If the price of ski boots increases, then the [ quantity demanded / demand ] of ski boots would [ increases / decreases ]. This causes the [ quantity demanded / demand ] of skis to [ increases / decreases ]. That is, there is a [ shift / movement along ] the demand curve for skis to the [ left / right ]. Thus, the cross price elasticity of demand for skis with respect to ski boots price is [ negative / positive ]. In other words, skis and ski boots are [ complements / substitutes ].

Demand and Supply - Elasticities

2. A 10 percent decrease in the price of corn causes the demand for the zucchini to decrease by 10 percent. What is the cross price elasticity of demand for zucchini with respect to the price of corn? What can we say about corn and zucchini?

Question 5 (Revenue Maximization)

1. In a linear demand curve, when the demand is elastic, a decrease in price causes a [ large / small ] increase in quantity demanded. Therefore, total revenue, which is price times quantity, [ decreases / increase ].
2. Suppose the demand curve is given by  $P = 20 - 2Q$ .
  - a. If the current quantity sold is 2 units, an increase in price will [ increase / decrease ] the total revenue.
  - b. If the current price is \$4, an decrease in price will [ increase / decrease ] the total revenue.
  - c. At what price and quantity does the producer maximize the total revenue?

# HANDOUT 4

QUESTION 1 (1) Price  $\uparrow$  1%  $\Rightarrow$  Quantity demanded  $\downarrow$  1.5%, elastic.

$$(2) E_D = \frac{\frac{6-10}{6+10}}{\frac{5-3}{5+3}} = \frac{\frac{-4}{16}}{\frac{2}{8}} = -1$$

$$(3) P = 10 - 0.5Q \Rightarrow E_D = \frac{1}{-0.5} \times \frac{P}{Q} = -2 \frac{P}{Q}$$

$$\text{so: (a) } P=3 \Rightarrow E_D = -2 \cdot \frac{3}{14} = -\frac{6}{14} = -\frac{3}{7}$$

$$(b) Q=7 \Rightarrow E_D = -2 \cdot \frac{6.5}{7} = -\frac{13}{7}$$

$$(c) E_D = -1$$

$$(4) E_D = -1 = \frac{1}{\text{slope}} \cdot \frac{2}{10} \Rightarrow \text{slope} = -0.5$$

QUESTION 2 (1) No change,  $E_D = 0$ .

(2) equilibrium price  $\uparrow$ , equilibrium quantity remains the same.

QUESTION 3 (1)  $E_I = \frac{10\%}{10\%} = 1$ , Normal good.

$$(2) E_I = \frac{\frac{610-590}{610+590}}{\frac{16000-14000}{16000+14000}} = \frac{\frac{20}{1200}}{\frac{2000}{30000}} = 0.25, \text{ normal good}$$

QUESTION 4 (1) quantity demanded, decreases, demand, decrease, shift, left, negative, complements

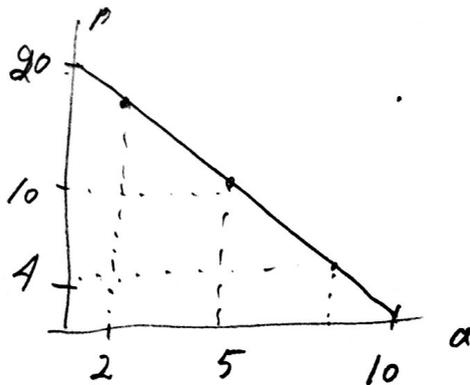
$$(2) E_D = \frac{-10\%}{-10\%} = 1 \Rightarrow \text{substitute}$$

QUESTION 5 (1) large, increase.

(2) (a) decrease

(b) decrease

(c)  $P=10, Q=5$



## Business Learning Center - Econ 101 (Hansen)

Review Sheet (also known as “The Giant Flash Card”) for Topics Covered in Midterm 1<sup>1</sup>

### DO NOT BRING THIS REVIEW SHEET TO THE EXAM!

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The following topics have been covered in lectures and discussion sections, so you are expected to know these and be able to solve WITH ACCURACY and SPEED. There will be 33 questions in 75 minutes, so you should average out 2 minutes 15 seconds per question. Even if some questions might take you less than 30 seconds, others might take as long as 5 minutes, spare your time accordingly. *Rule of thumb: if the additional (marginal) benefit (3 points) is greater than additional (marginal) cost (additional time wasted), do it! Otherwise, don't! (In fact, this is the main idea of every economic concepts!) You are maximizing the probability of getting the questions right, subject to the time constraint – if the additional time cost needed to get them right is higher the additional benefit, then you should do other questions!*

Topics studied so far are inter-related, you should expect something to cross-over with each other, e.g. curve shifting and shifts in demand and supply, demand shifting due to complement-substitute goods and cross-price elasticity of demand

#### • Mathematical preliminaries

- Finding equations of lines – both cases of (a) given a point and a slope or (b) given two points. How to shift a line horizontally or vertically?
- Solving linear equations, system of linear equations, find intercepts, find intersection
- Fraction, multiplication-division by hand (No calculators or Pentium processors in exam!)
  - \* *All these will be applied in the subsequent topics, so you should know and be able solve quickly*

#### • Definition of economics and preliminaries

- What is economics? What are positive and normative statements? What are types of data and how are they different? What is scarcity and choice?
- Opportunity costs: what is it? How is it defined? How to find? (Make sure you get the units correct to what you are being asked, e.g. opportunity cost of writing an email to you is in terms of how many of a computer program I can write, so 2 computer programs per email, etc.)
- Absolute and comparative advantage: what are they? How to find? Any relation to opportunity cost? What are abstract and concept of absolute and comparative advantage?
- Production possibility frontiers: what is it? How is it defined? How to find individual and joint PPF? What is the relationship to opportunity costs and PPF slopes? (Clearly joint PPF is not a simple way of horizontal or vertical summation! But how?) What are kink points? Why there are kink points and how to find them? What is the underlying assumption that individual PPF is a straight line? Why is the combined PPF concave?
- What is the meaning of a concave/convex PPF? What is the law of increasing/decreasing opportunity cost?
- What is economic growth? What attributes to economic growth? How do they affect the PPF (shift or rotate) and all the analysis made before and after?

#### • Demand and supply – the basics

- What is the law of demand? What is the meaning of downward sloping demand? Is it always that the demand is downward sloping? What is Giffen good?

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<sup>1</sup>Prepared by Kanit Kuevibulvanich. (<http://www.kanitik.com>) This version: September 22, 2015. Disclaimer: Although summarized from textbook, homework and lectures, this note does not constitute as the official guidelines for the course, comments welcomed.

- What is the law of supply? What is the meaning of upward sloping demand?
  - What is individual demand and individual supply? How to obtain market demand and market supply from individual information? (Is it horizontal summation or vertical summation?)
  - What is demand and supply function? What is demand and supply curve? How to plot the demand and supply curve? (I can't emphasize anymore but you must put P on y-axis and Q on x-axis, even if you're in a panic!)
  - How to get an equation for demand-supply function/curve? How to solve for equilibrium price and quantity? What are shortage and surplus? (Clearly surplus here means excess supply.) How to calculate consumer and producer surpluses? (Clearly surplus here is extra happiness on each party.) What is the meaning of consumer and producer surpluses? What is producer revenue/consumer expenditure?
  - How does the market adjust itself? What is the signal of such adjustment? What is the difference between moving along the curve and shifting the curve? Is it increase/decrease in demand/supply or increase/decrease in quantity demanded/supplied?
  - What is the meaning of a horizontal (left-right) shift in demand-supply – by quantity or by price? (Think carefully!) How to get the equation of each curve after shift? What happen after the shifts - definite answers or ambiguous answers? What is the new equilibrium after shifts?
  - What factors attributes to shifting each curve? How do they get shifted? (Consumer side: normal vs. inferior, complements vs. substitutes; producer side: factor of productions, etc.)
- **Demand and supply – the government intervention locally**
    - What happen in price floors or price ceilings? What price that crosses through the demand-supply curves?
    - When there are a price floors/price ceilings are they always effective/binding? How to find short-ages/surpluses, i.e. excess demand/supply? How to calculate consumer/producer surpluses? Who pays/receives how much and how many transacted/produced? How to calculate the deadweight loss? What is the black market and is there always black market resulting from each policy? What are socially wasteful results from each policy? How to draw the graphs for each policy on each side of the market?
- **Demand and Supply – The International Trade and Intervention**
    - With international trade, what is the effect to the domestic demand/supply? What is the world price? What happen if world price is lower/higher than autarky equilibrium? What is the new supply or new demand curve? What is the new equilibrium? How to find the amount consumed? How to find the amount produced domestically?
    - With import tariff, what is the new demand/supply curve? How to solve for the new equilibrium? How to find the amount consumed? How to find the amount produced domestically? How to find government revenue? What is the deadweight loss? What is prohibitive import tariff?
- **Elasticities and Total Revenue**
    - What is midpoint percentage change?
    - In general, what is elasticity? It is simply the ratio of percentage change of the cause ( $x$ ) to percentage change of the effect ( $y$ ), i.e.  $\varepsilon_x^y = \frac{\% \Delta y}{\% \Delta x}$ . So whatever you have in the world as cause and effect, you can measure in terms of elasticity. Hence, think about the price of a good causes the change in quantity demanded for that good (own-price elasticity of demand), to the quantity demanded for the other good (cross-price elasticity of demand), or to the quantity supplied for that good (price elasticity of supply). How about income causes change to quantity demanded (income elasticity of demand)?

- The three formulation of elasticities: slope form, point elasticity, arc (midpoint) elasticity. Take the own-price elasticity of demand, clearly price of good  $x$  ( $p$ ) causes the change in quantity demanded of good  $x$  ( $q$ ), so we have the following formulation:

$$\text{(Slope form)} \quad \varepsilon_p^d = \frac{\% \Delta q}{\% \Delta p} = \frac{\frac{\Delta q}{q}}{\frac{\Delta p}{p}} = \frac{\Delta q}{\Delta p} \cdot \frac{p}{q} = \frac{1}{\text{slope of demand curve}} \cdot \frac{p}{q}$$

$$\text{(Midpoint percentage elasticity)} \quad \varepsilon_p^d = \frac{\% \Delta q}{\% \Delta p} = \frac{\frac{\Delta q}{q}}{\frac{\Delta p}{p}} = \frac{\frac{q_2 - q_1}{\left(\frac{q_1 + q_2}{2}\right)}}{\frac{p_2 - p_1}{\left(\frac{p_1 + p_2}{2}\right)}} = \frac{\frac{q_2 - q_1}{q_1 + q_2}}{\frac{p_2 - p_1}{p_1 + p_2}}$$

- If you have demand curve/demand function, supply curve/supply function, you should be able to find and calculate the elasticities. Similarly, you should also be able to back out the demand curve/demand function, supply curve/supply function!
- Hence, you can derive the formula for all elasticities we have studied.
- Which elasticity you can take the absolute value (i.e. neglect the negative sign)? Why and why not? What is the meaning of each elasticity? Why is it normal good, inferior good, substitute and complement? Can you interpret the elasticities?
- What is elasticity on the demand curve? Is it always the same throughout the demand curve? How is it changing? What is the point where revenue is maximized? The midpoint of demand curve is not the same as midpoint elasticity, but the elasticity of the midpoint of demand curve.

*Good Luck for Your Midterm 1 Exam!*

**This handout contains exercises of**

- Budget Line (Budget Constraint, Budget Set)
- Consumer Theory

**Things you should know**

- How to draw a budget line? What shifts and rotates a budget line and how?
- What are total and marginal utility? What is the law of diminishing marginal utility?
- What is indifference curve? What is the meaning of its slope?
- How to find the optimal consumption bundle (consumer equilibrium) in both tabulated and equation question formats?

**Exercises**

Question 1 (Budget Line Basics)

1. Write down the equation for the budget line of two goods, when one has an income of \$200, the price of good X is \$5 and the price of good Y is \$10. What is the slope of this budget line?
2. What happens to the budget line if the price of good X decreases from \$5 to \$2.5?
3. What happens to the budget line if the price of good Y increases from \$10 to \$20?
4. What happens to the budget line if the income decreases to \$100?
5. What happens to the budget line if one has an income of \$100, the price of good X is \$2.5 and the price of good Y is \$5?

Question 2 (Consumer Theory – Tabulated Question Format)

Suppose good X and good Y are indivisible, that is, must be consumed in exact units.

Quantity (Units)	Good X			Good Y		
	Total Utility	Marginal Utility		Total Utility	Marginal Utility	
0	0	-		0	-	
1	50			40		
2	80			60		
3	100			70		
4	110			75		

1. Fill in the marginal utilities in the table above.

Suppose the price of good X is \$5, the price of good Y is \$10

2. If the income is \$40, what is the optimal consumption bundle of good X and Y?
3. If the income is \$25, what is the optimal consumption bundle of good X and Y?
4. If the income is \$30, what is the optimal consumption bundle of good X and Y?

Question 3 (Consumer Theory – Conceptual Question)

If price of good X is \$10, and price of good Y is \$20

1. What is the marginal rate of substitution of the optimal consumption bundle?
2. If currently the marginal rate of substitution ( $MU_X/MU_Y$ ) is 4, then one is consuming [ too much / too few ] of good X and [ too much / too few ] of good Y.
3. If currently the marginal rate of substitution ( $MU_X/MU_Y$ ) is 0.5, then one is consuming [ too much / too few ] of good X and [ too much / too few ] of good Y.

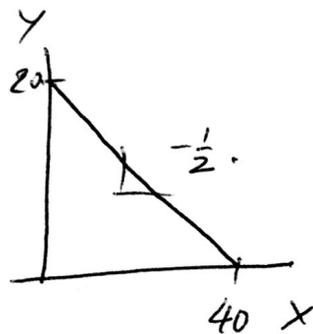
Consumer Theory - Budget Lines, Indifference Curves, and Optimal Consumption Rule

Question 4 (Consumer Theory - Equation Question Format)

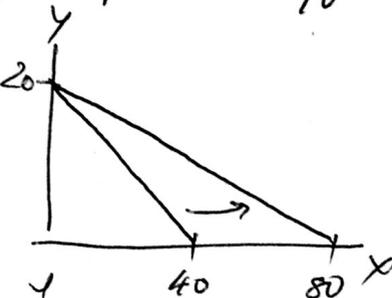
1. There are two goods to be consumed, X and Y, at price  $P_X$  and  $P_Y$ , respectively. Write down the condition which yields the maximum happiness. Explain the happiness formula.
2. The marginal rate of substitution is given by  $MRS = MU_X/MU_Y = 3Y/X$ . If prices of good X and good Y are \$10 and \$5, respectively, and you have the income of \$120, what is your optimal consumption bundle? Also draw the solution in the budget line and indifference curve.
3. If prices of good X and good Y are \$20 and \$10, respectively, and you have the income of \$240, what is your optimal consumption bundle? (Hint: If it takes you more than 5 seconds for this part, you must have been zoning out in class!)

# HANDOUT 5 SOLUTION

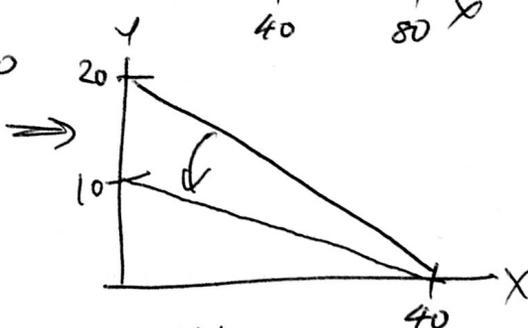
(Q1) 1)  $5X + 10Y = 200$ , slope =  $-\frac{5}{10} = -\frac{1}{2}$ .



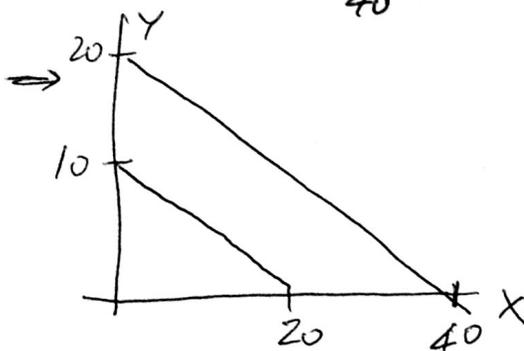
2)  $2.5X + 10Y = 200 \Rightarrow$



3)  $5X + 20Y = 200$



4)  $5X + 10Y = 100$



5)  $2.5X + 5Y = 100 \Rightarrow 5X + 10Y = 200$ .  
identical to

(Q2)	Quantity	$TU_x$	$MU_x$	$MU_x/P_x$	$TU_y$	$MU_y$	$MU_y/P_y$
1)	0	0	—	—	0	—	—
	1	50	50	10	40	40	4
	2	80	30	6	60	20	2
	3	100	20	4	70	10	1
	4	110	10	2	75	5	0.5

2)  $\frac{MU_x}{P_x} = \frac{MU_y}{P_y}$  at  $X=3, Y=1$  and  $X=4, Y=2$ .

3)  $\frac{MU_x}{P_x} > \frac{MU_y}{P_y}$  Expenditure = 25

4)  $\frac{MU_x}{P_x} < \frac{MU_y}{P_y}$  Expenditure is 40.

○ = 0 If income is \$40, can afford  $X=4, Y=2$

□ = □ If income is \$25, can afford  $X=3, Y=1$  only.

If income is \$30, can afford  $X=4, Y=1$  only.

Last \$5 can still be spent on 4<sup>th</sup> unit of good X!!

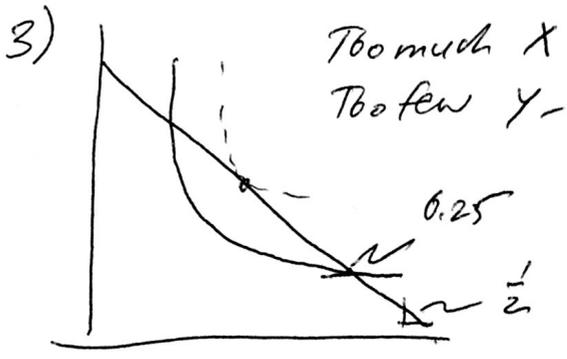
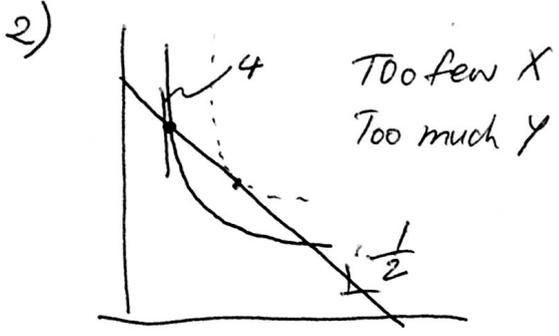
(Q3)

HANDOUT 5

SOLUTION: 19c2

since  $P_x = 10, P_y = 20 \Rightarrow$  slope of budget line  $= -\frac{P_x}{P_y} = -\frac{10}{20} = -\frac{1}{2}$ .

1) MRS at optimal bundle must be  $\frac{1}{2}$ .

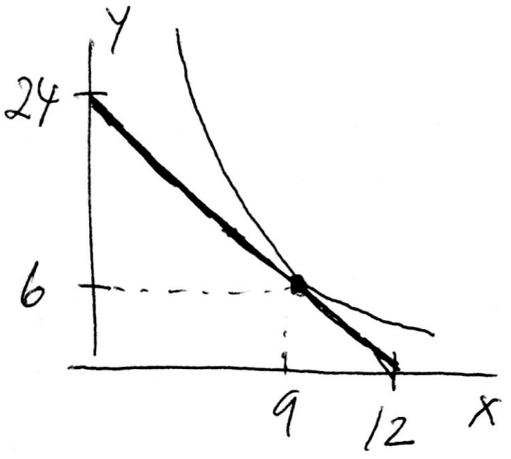


(Q4)

1)  $\frac{MU_x}{MU_y} = \frac{P_x}{P_y} \Leftrightarrow \frac{MU_x}{P_x} = \frac{MU_y}{P_y}$

2)  $\frac{3Y}{X} = \frac{10}{5} \Leftrightarrow 15Y = 10X$

Budget line  $10X + 5Y = 120 \Rightarrow 15Y + 5Y = 120, Y = 6$   
 $X = 9.$



3) Budget line is

$$20X + 10Y = 240$$

which is the same as in 2).

**This handout contains exercises of**

- Consumer Theory

**Things you should know**

- How to find the optimal consumption bundle in the tabulated question?
- How to derive a demand curve?
- How to find the relationship of goods consumed and income?

**Exercises**

Question 1 (Explaining the Example in Class: Consumer Theory - Tabulated Question Format)

Suppose good X and good Y are indivisible, that is, must be consumed in exact units.

Quantity (Units)	Philharmonic Concert (P = 10)			Theater (P = 12)		
	Total Utility	Marginal Utility	MU/P	Total Utility	Marginal Utility	MU/P
0	0	-		0	-	
1	10	10	1	20	20	1.67
2	17	7	0.7	35	15	1.25
3	22	5	0.5	45	10	0.83
4	26	4	0.4	50	5	0.42
5	28	2	0.2	50	0	0
6	29	1	0.1			
7	27	-2	-0.2			

If the income is \$100, what is the optimal consumption bundle of each good?

Question 2 (Consumption Choice with Multiple Goods)

Find Jim's optimal consumption bundle for the following 4 goods when he has \$32 to spend.

Goods	Price	Marginal Utility from 1 <sup>st</sup> Unit	Marginal Utility from 2 <sup>nd</sup> Unit	Marginal Utility from 3 <sup>rd</sup> Unit	Marginal Utility from 4 <sup>th</sup> Unit
Burrito	\$8	160	40	20	8
Tacos	\$2	10	10	5	4
Salad	\$4	40	20	10	10
Soda	\$1	4	3	3	3

Question 3 (Deriving a Demand Curve)

Your income is \$100. When the price of good X and good Y are \$10 and \$5, respectively, you purchase 5 units of good X and 10 units of good Y. When the price of good X decreases to \$5, you purchase 15 units of good X and 5 units of good Y.

1. Graphically exhibit the two scenarios explained above in the context of consumer theory.
2. From the diagram drawn in part 1, plot the demand curve in the graph beneath.
3. Suppose the demand curve is linear, write down the equation for the demand curve.
4. Can you conclude anything whether good X and good Y are complements or substitutes?

Question 4 (Income and Consumption - The Engel Curve)

This question outlines what you will see when we derive the Engel curve for goods. Assuming that the price of goods X and Y remain constant at \$10 and \$5, respectively.

- When income is \$100, you consume 6 units of good X and 8 units of good Y.
  - When income is \$150, you consume 10 units of good X and 10 units of good Y.
  - When income is \$200, you consume 9 units of good X and 22 units of good Y.
1. Graphically exhibit the three scenarios given above in the context of consumer theory.
  2. As income increases from \$100 to \$150, what can we say about the characteristic of good X?
  3. As income increases from \$150 to \$200, what can we say about the characteristic of good Y?
  4. From the diagram drawn in part 1, plot the curve exhibiting the relationship between income and quantity of good X consumed, putting the quantity of good X on horizontal axis. This is known as the Engel curve.

## HANDOUT 6

(Q1)  $\frac{MU_P}{P_P} \approx \frac{MU_T}{P_T}$  when 4 Philharmonic Concerts are consumed and 4 Theaters

$$\text{Expenditure} = 4 \times 10 + 4 \times 12 = \$88.$$

$$\text{Remaining Budget} = 100 - 88 = \$12.$$

From \$12 remaining, spending on Philharmonic gives  $\frac{MU_P}{P_P} = 0.2$

spending on Theater give  $\frac{MU_T}{P_T} = 0.$

$\Rightarrow$  Spending on Philharmonic gives extra utility (most bang for the bucks)

therefore, consume  $4+1=5$  Philharmonic Concerts and 4 Theaters.

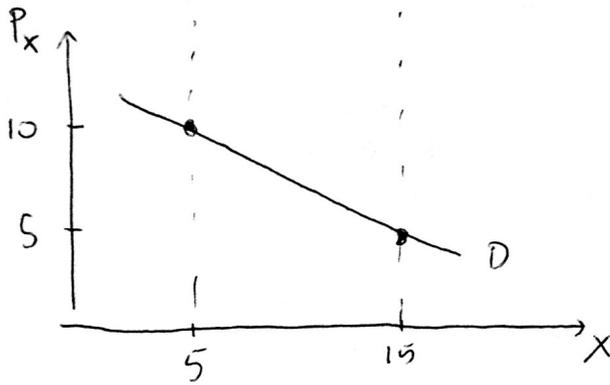
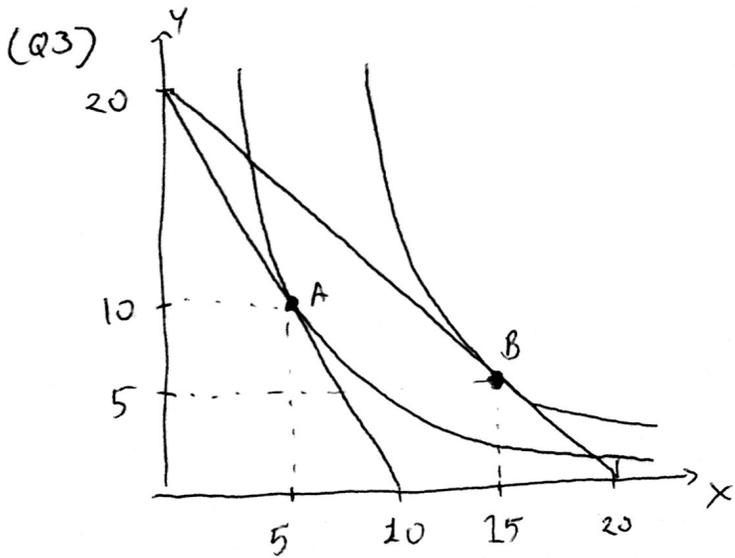
(Q2) Find  $MU/P$  for each good at each level of consumption.

Goods	P	1 <sup>st</sup> Unit MU/P	2 <sup>nd</sup> Unit MU/P	3 <sup>rd</sup> Unit MU/P	4 <sup>th</sup> Unit MU/P
Burrito	\$8	20	5	2.5	1
Tacos	\$2	5	5	2.5	2
Salad	\$4	10	5	2.5	2.5
Soda	\$1	4	3	3	3

At optimal  $\frac{MU}{P}$  of each good should be equal. There are many possible combination, let's pick from left to right.

If Jim buys 2 of Burritos, Tacos and Salads he is spending.

$8 \times 2 + 2 \times 2 + 4 \times 2 = \$28 \Rightarrow$  Has \$4 remaining, should he get any more of Burrito, Tacos or Salad? NO! It doesn't give him the bang for the bucks as Soda, which gives  $\frac{MU}{P} = 4$ , even 4 sodas still gives him  $\frac{MU}{P} = 3$ .  
He will spend \$4 remaining on 4 sodas.



Demand curve:

$$b = \frac{10 - 5}{5 - 15} = \frac{5}{-10} = -\frac{1}{2}$$

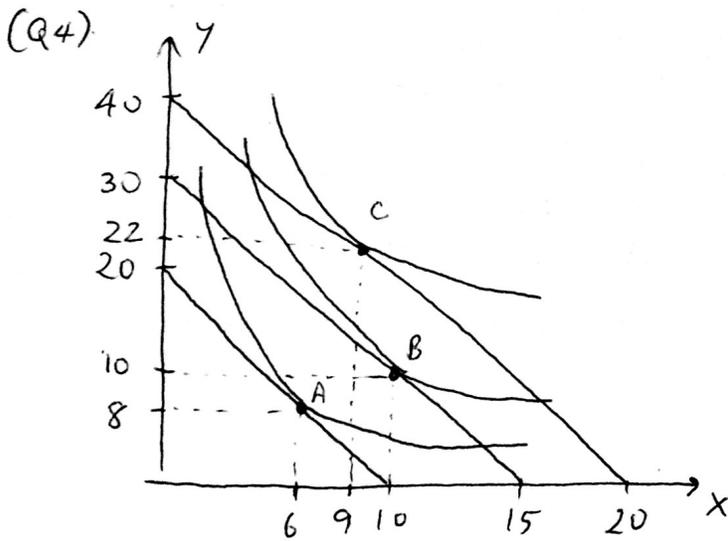
$$P = a - \frac{1}{2}Q$$

$$10 = a - \frac{1}{2} \times 5 \Rightarrow a = 12,5$$

Demand curve is  $P = 12,5 - 0,5Q$ . □

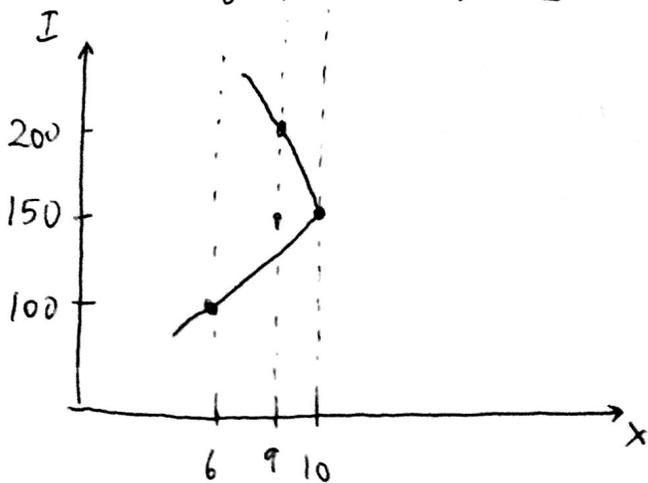
Since  $P_x \downarrow$  causes the quantity of good  $Y$  consumed to decrease

→  $X$  and  $Y$  are substitutes.



$A \rightarrow B$  good  $X$  is normal

$B \rightarrow C$  good  $X$  is inferior



**This handout contains exercises of**

- Consumer Theory (Engel Curve, Substitution and Income Effect)

**Things you should know**

- How to draw the graphs and find the substitution and income effect when price changes?
- How to analyze the income characteristic of each good?

**Exercises**

Question 1 (Practice Quiz)

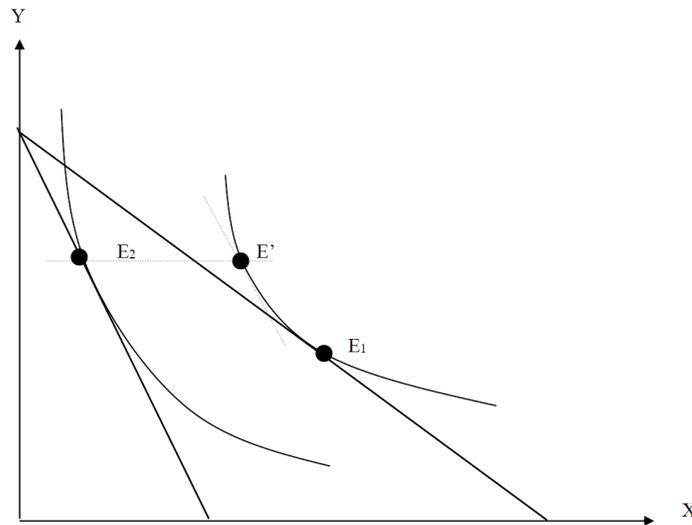
You need two large, clear graphs (one for each question) for this quiz, and short explanations. Please present quantity of good X along the horizontal axis in each graph, mark all intercepts and mark income, substitution and price effect on your graphs.

1. *True or false:* If good X is a normal good, after a decrease in price for good X from  $P_{X1}$  to  $P_{X2}$ , we expect to see an income effect that reinforces the substitution effect for a larger price effect. Assume that consumer has income,  $I$ , and the price for good Y is  $P_Y$ .
2. *True or false:* If good X is a Giffen good, after a decrease in price for good X from  $P_{X1}$  to  $P_{X2}$ , we expect to see an income effect that reinforces the substitution effect for a larger price effect. Assume that consumer has income,  $I$ , and the price for good Y is  $P_Y$ .

Question 2 (Engel Curve)

Assume that there are only two goods, X and Y. Argue intuitively (without calculus or math) that it is not possible for both goods to be simultaneously inferior goods. (Hint: "More is preferred to less.")

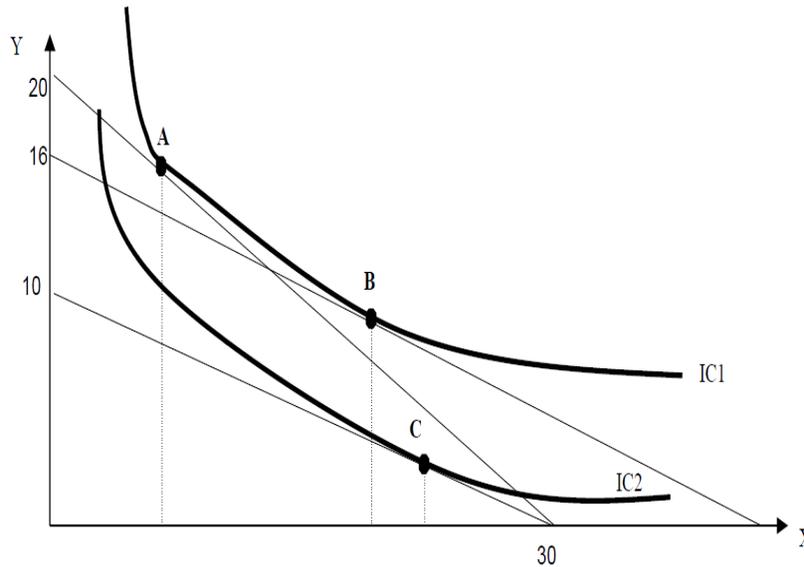
Question 3 (Substitution and Income Effect)



The diagram above exhibits the scenario when price of good X increases. We can conclude that the substitution effect causes the consumption of good X to [ increase / decrease ], and the consumption of good Y to [ increase / decrease ].

Furthermore, we can conclude that good X is [ a normal / an inferior / neither normal nor inferior ] good, and good Y is [ a normal / an inferior / neither normal nor inferior ] good.

Question 4 (Income and Consumption - Graphical Question)



The diagram above exhibits an increase in the price of good Y.  
 The price effect is exhibited by the movement from point \_\_\_\_\_ to point \_\_\_\_\_.  
 The substitution effect is exhibited by the movement from point \_\_\_\_\_ to point \_\_\_\_\_.  
 The income effect is exhibited by the movement from point \_\_\_\_\_ to point \_\_\_\_\_.  
 When price of good Y increases, the substitution effect causes the [ increase / decrease ] in the consumption of good Y, and the consumption of good X [ increases / decreases ].  
 The income effect causes the [ increase / decrease ] in the consumption of good Y, and the consumption of good X to [ increase / decrease ]. Therefore, good Y is [ a normal / an inferior ] good and good X is [ a normal / an inferior ] good.

Question 5 (Determining the Hypothetical Budget Line)

The following concludes the information regarding the prices and consumption bundles from the price, substitution and income effects.

Point	$P_X$	$P_Y$	Income	$X^*$	$Y^*$
E <sub>1</sub> (Original Prices)	\$5	\$5	\$100		10
E' (Hypothetical Budget Line)				7	12
E <sub>2</sub> (New Prices)	\$10	\$5	\$100	5	

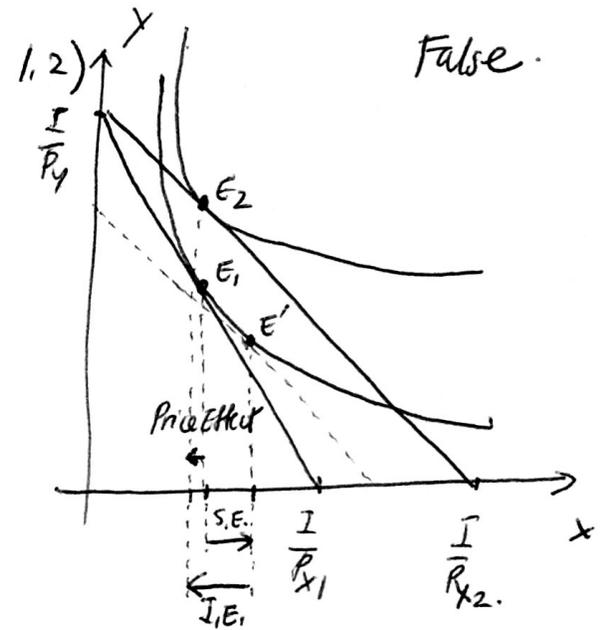
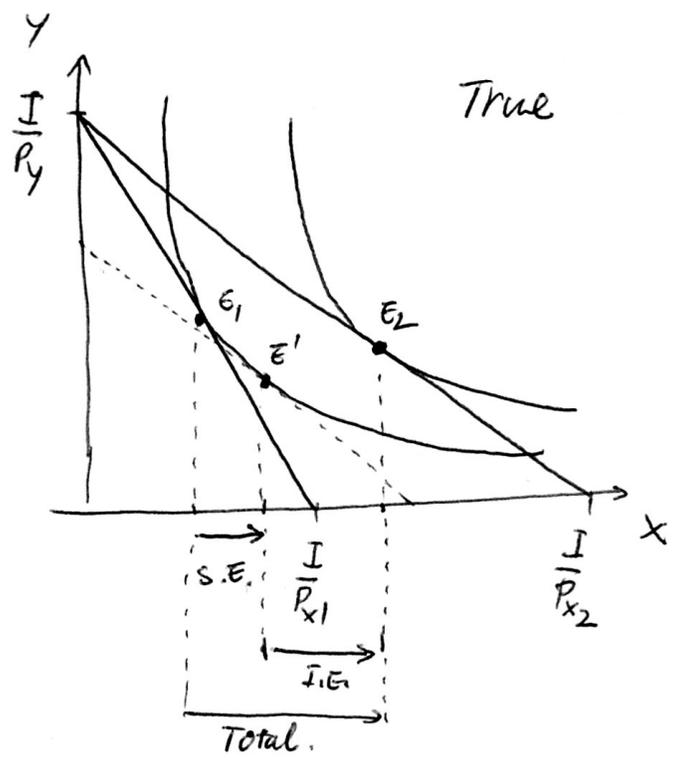
- Fill in the blanks in the table above. Using the information, draw a diagram exhibiting the decomposition of substitution and income effect when price of good X changes.
- Write down the equation for the hypothetical budget line.
- The substitution effect causes the consumption of good X to [ increase / decrease ] by \_\_\_\_\_ units and the consumption of good Y to [ increase / decrease ] by \_\_\_\_\_ units.  
 The income effect causes the consumption of good X to [ increase / decrease ] by \_\_\_\_\_

Consumer Theory - Income and Substitution Effects

units and the consumption of good Y to [ increase / decrease ] by \_\_\_\_\_ units. Thus, good X is [ a normal / an inferior ] good, and good Y is [ a normal / an inferior ] good.

HANDOUT 7

(Q1) 1.1)



(Q2)

More is preferred to less, assume X and Y are both inferior goods.

If I have more income and X is inferior good, I consume less X.  
 If I also consume less Y as well, assuming Y is an inferior good. Then I consume less of both X and Y. Then more is not preferred to less.  
 Contradiction, X and Y cannot be inferior good at the same time.

(Q3)

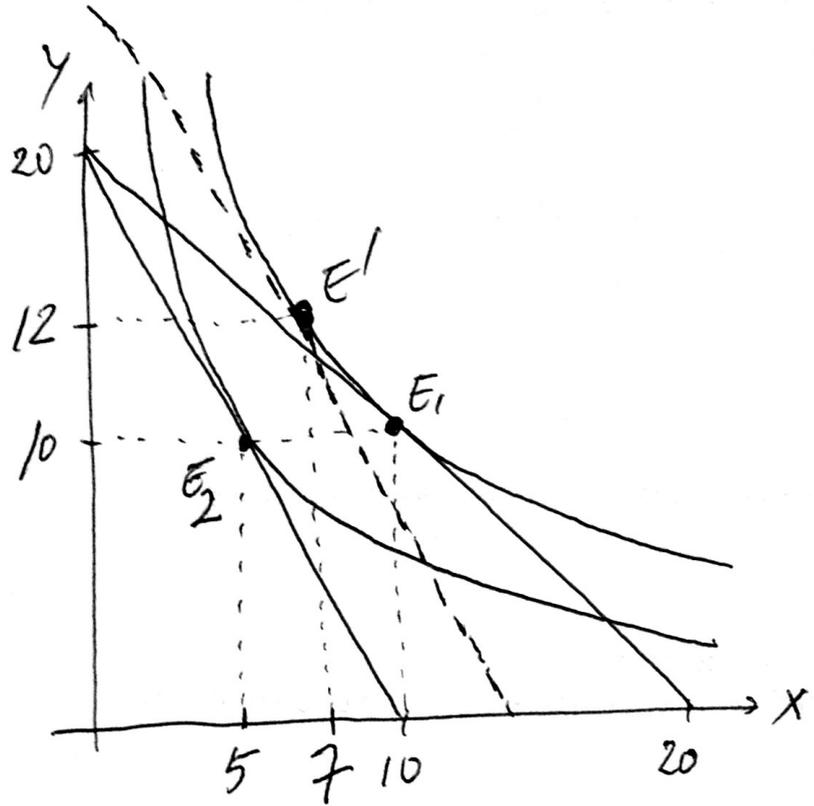
decrease, increase  
 a normal, neither normal nor inferior.

(Q4)

A → C  
 A → B  
 B → C  
 decrease  
 increases  
 decrease  
 increase a normal  
 a normal.

(a5)

	$P_x$	$P_y$	$I$	$X^*$	$Y^*$
1) $E_1$	\$5	\$5	\$100	10	10
$E_1'$	\$10	\$5	\$130	7	12
$E_2$	\$10	\$5	\$100	5	10



2) Hypothetical Budget Line  
 $10X + 5Y = 130$

- 3) decrease ..... 3 units
- increase ..... 2 units.
- decrease ..... 2 units
- decrease ..... 2 units
- normal normal.

**This handout contains exercises of**

- Producer Theory

**Things you should know**

- How to find total products, marginal products and average products from production function? What is the shape of each curve?
- What is increasing returns, diminishing returns, and negative returns to labor?

**Exercises**

Question 1 (Productivity)

The following table describes how many T-shirts can each firm produce given the amount of workers hired. Describe the characteristic of each firm in regards to its returns to labor.

Workers Hired	Firm A	Firm B	Firm C
1	100	200	600
2	400	400	800
3	800	600	900
4	1000	800	960
5	900	1000	1000

Question 3 (Production Function)

Suppose the production function and the marginal product are given by

Production function:  $TP = 100L^2 - L^3$       Marginal product:  $MP = 200L - 3L^2$

What are the level of workers (L) and quantity produced (TP) such that the average product (AP) and marginal product (MP) intersect? Draw the AP and MP curves.

Question 4 (Numerical Example of Productions and Costs)

The following table describes the productions and costs of Poison Catering and Food Co. at each level of worker L hired. The company has to operate its kitchen regardless of its operation, costing \$100. The wage is \$100 for each worker hired. The quantity produced by L workers hired is given in total product (TP). Fixed cost, variable cost, and total cost are FC, VC, and TC, respectively.

L	TP	MP	AP	FC	VC	TC	AFC	AVC	ATC	MC
0	0	-	-				-	-		
1	40	40	40							
2	100	60						2	3	1.67
3		80	60				0.56	1.67	2.22	1.25
4	240	60	60				0.42	1.67	2.08	1.67
5	280		56				0.36	1.79	2.14	2.5
6		20					0.33			

1. List the definition of marginal product (MP), average product (AP), average fixed cost (AFC), average variable cost (AVC), average total cost (ATC), and marginal cost (MC)
2. Fill in the blanks in the table above.
3. At what level or range of level of workers hired does the marginal product curve intersects the average product curve?
4. At what level or range of level of quantity produced does the marginal cost curve intersects the average variable cost curve?

Producer Theory - Production and Cost Functions

5. At what level or range of level of quantity produced does the marginal cost curve intersect the average total cost curve?

# HANDOUT 8

(Q1) Firm A: increasing returns to labor, then diminishing returns to labor eventually negative returns to labor

Firm B: constant returns to labor

Firm C: diminishing returns to labor

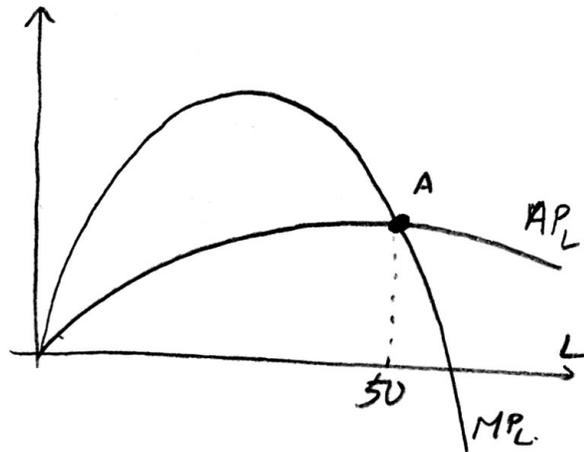
(Q2)  $AP = \frac{TP}{L} = \frac{100L^2 - L^3}{L} = 100L - L^2$

$MP = 200L - 3L^2$

$AP = MP$  at point A

$\Rightarrow 100L - L^2 = 200L - 3L^2 \Leftrightarrow 2L^2 = 100L$

$L = 50$



(Q3)

L	TP	MP	AP	FC	VC	TC	AFC	AVC	ATC	MC
0	0	-	-	100	0	100	-	-	-	-
1	40	40	40	100	100	200	2.5	2.5	5	2.5
2	100	60	50	100	200	300	1	2	3	1.67
3	180	80	60	100	300	400	0.56	1.67	2.22	1.25
4	240	60	60	100	400	500	0.42	1.67	2.08	1.67
5	280	40	56	100	500	600	0.36	1.79	2.14	2.5
6	300	20	50	100	600	700	0.33	2	2.33	5

1)  $MP = \frac{\Delta TP}{\Delta L}$ ,  $AP = \frac{TP}{L}$ ,  $AFC = \frac{FC}{Q}$ ,  $AVC = \frac{VC}{Q}$ ,  $MC = \frac{\Delta TC}{\Delta Q}$   
 $ATC = \frac{TC}{Q} = AFC + AVC = \frac{\Delta VC}{\Delta Q}$

3) At  $L = 4$

4) At range between  $Q = 180$  and  $Q = 240$

5) At range between  $Q = 240$  and  $Q = 280$

Perfect Competition - Profit Maximization

**This handout contains exercises of**

- Profit Maximization in Perfectly Competitive Market

**Things you should know**

- What are the characteristics of firms in perfectly competitive market?
- How to find the firm's behavior and quantity to produce that maximizes its profit?

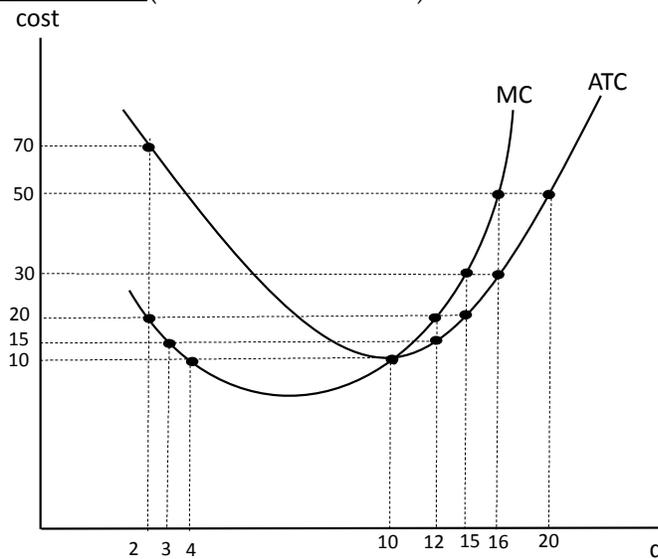
**Exercises**

Question 1 (Perfectly Competitive Market)

Which of the following is most likely considered a typical firm in a perfectly competitive industry?

- a) Apple Corporation
- b) A wheat farmer in Wisconsin
- c) University of Wisconsin
- d) Ian's Pizza

Question 2 (Profit Maximization)



Suppose the fixed cost is \$60. In this perfectly competitive industry, if the market price of this product is currently \$20, each profit-maximizing firm will produce \_\_\_\_\_ units and earn an economic profit of \_\_\_\_\_.

- a) 12 / \$60
- b) 2 / -\$100
- c) 0 / -\$60
- d) 15 / \$150

Question 3 (Profit Maximization)

Consider the following information table regarding costs of production.

Quantity	Fixed Cost (\$)	Variable Cost (\$)
0	12	0
1		24
2		32
3		48
4		68
5		108
6		168

1. If the market price is \$40, this firm should produce \_\_\_\_\_ units to maximize its profits, which is \_\_\_\_\_.
2. If the market price is \$20, this firm should produce \_\_\_\_\_ units to maximize its profits, which is \_\_\_\_\_.
3. If the market price is \$16, this firm should produce \_\_\_\_\_ units to maximize its profits, which is \_\_\_\_\_.
4. If the market price is \$8, this firm should produce \_\_\_\_\_ units to maximize its profits, which is \_\_\_\_\_.

Perfect Competition - Profit Maximization

Question 4 (Profit Maximization - Equation Format)

Consider the following production cost information of a firm.

Total cost:  $TC = q^2 + 2q + 40$

Marginal cost:  $MC = 2q + 2$

Average cost:  $AC = q + 2 + 40/q$

1. What is the amount of fixed cost experienced by this firm?  
a) 2      b) 10      c) 40      d) Not enough information to determine the fixed cost.
  
2. If the market price is \$42 and this firm is currently producing 30 units of good, this firm should \_\_\_\_\_. This firm is earning or could be earning the maximum profits of \_\_\_\_\_.  
a) decrease the quantity produced to maximize its profit / \$480  
b) increase the quantity produced to maximize its profit / \$1260  
c) maintain the quantity produced as it has already maximized its profit / \$260  
d) decrease the quantity produced to maximize its profit / \$360

## HANDOUT 9

Q1) B.

Q2) A.

Q3)

Q	FC	VC	TC	MC	AVC	ATC
0	12	0	12	—	—	—
1	12	24	36	24	24	36
2	12	32	44	8	16	22
3	12	48	60	16	16	20
4	12	68	80	20	17	20
5	12	108	120	40	21.6	24
6	12	168	180	60	28	30

1)  $P = \$40$ , produce 5 units, profit = \$80.

2)  $P = \$20$ , produce 4 units, profit = \$0

3)  $P = \$16$ , produce 3 units, profit = -\$12.

4)  $P = \$8$ , produce 0 units, profit = -\$12.

Q4) 1) C.

2) D.

$$P = MC \Rightarrow 42 = 2q + 2 \Rightarrow q^* = 20.$$

$$\begin{aligned} \text{Profit} &= 20 \times 42 - [20^2 + 2 \times 20 + 40] = 840 - 480 \\ &= 360 \end{aligned}$$

**This handout contains exercises of**

- Profit Maximization in Perfectly Competitive Market

**Things you should know**

- What are the characteristics of firms in perfectly competitive market?
- How to find the firm’s behavior and quantity to produce that maximizes its profit?

**Exercises**

**Question 1** (Review of Production and Cost Functions, and Profit Maximization)

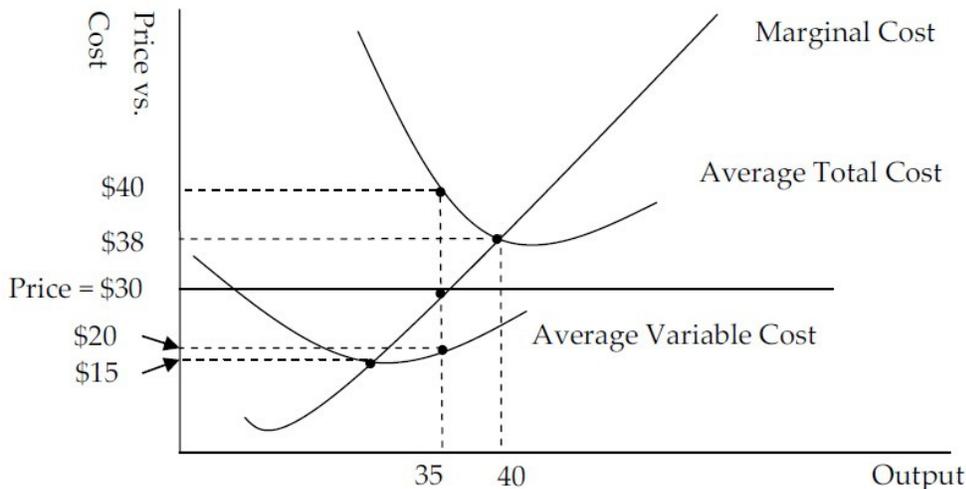
Suppose each worker costs \$100 to hire. An example firm has the following production and cost schedule.

L	Q	MPL	TC	MC
...	...	...	...	...
10	200	20	1200	2.5
60	(a)	16	(b)	6.25
(d)	1800	(e)	(c)	10

1. Fill in the blanks (a), (b), (c), (d), and (e). Then find the amount of fixed cost for this firm.
2. If the market price is \$10, this firm should [ produce \_\_\_\_\_ units / shut down ] to maximize the profit of \$ \_\_\_\_\_. If the market price is \$2.5, this firm should [ produce \_\_\_\_\_ units / shut down ], the profit is \$ \_\_\_\_\_.

**Question 2** (Profit Maximization in the Short-run)

The graph below shows the production cost curves of a firm in a perfectly competitive industry.



1. What is the amount of fixed cost for this firm?
2. If the current market price is \$30, what is the quantity this firm should produce? Will the firm make (economic) profit or suffer loss? How much? Should the firm shut down?
3. What is the break-even price for this firm? What is the shut down price for this firm?
4. Suppose this firm is fined by \$1000 due to pollution violation while the market price remains the same at \$30, this results in the average variable cost to [ increase / remain unchanged ], the average total cost to [ increase / remain unchanged ], and the marginal cost to [ increase / remain unchanged ]. Therefore, this firm should [ produce 35 units / shut down ].
5. (Bonus) Revert to the original scenario, figure out what is the total variable cost when the output is 40 units.

Question 3 (Equation Questions for Shutdown and Breakeven Points in the Short-run)

Consider the following production cost information of a firm

Total cost:  $TC = q^2 + 5q + 25$

Marginal cost:  $MC = 2q + 5$

Average total cost:  $ATC = q + 5 + 25/q$

What is the breakeven price? What is the price below which the firm should shut down its operation? (Hint: You still need to find total variable cost)

Question 4 (Equation Questions for Short-run vs. Long-run)

Continuing from Question 3, assume that all firms – incumbent and prospective entrant – have the same cost structure

Total cost:  $TC = q^2 + 5q + 25$

Marginal cost:  $MC = 2q + 5$

Average total cost:  $ATC = q + 5 + 25/q$

Furthermore, the market demand is given by  $P = 105 - Q$

1. If the current market price is \$45, what is the quantity each firm should produce to maximize its profit?
2. What is the size of the industry with current market price of \$45? That is, how many firms are there in the short-run?
3. Given the current market price of \$45 in the short-run, the profit of each firm is positive. What do you expect to happen in the long-run?
4. What is the breakeven price of each firm?
5. If there are new firms entering the industry in the long-run, what is the quantity produced by all firms in the market?
6. How many firms are there in the industry in the long-run and how many units each firm is producing?
7. Given the number of firms in the long-run found in above sub-question, what is the industry supply curve?

(Q1)	L	Q	MPL	TC	MC
	10	200	20	1200	2.5
	60	(a)	16	(b)	6.25
	(d)	1800	(e)	(c)	10

1) (a)  
 $MPL = \frac{\Delta Q}{\Delta L} = 16, \Delta L = 50$   
 $\Rightarrow \Delta Q = 50 \times 16 = 800$   
 so  $Q = 200 + 800 = \underline{1000}$

(b)  $MC = \frac{\Delta TC}{\Delta Q} = 6.25, \Delta Q = 800 \Rightarrow \Delta TC = 6.25 \times 800 = 5000$   
 so  $TC = 1200 + 5000 = \underline{6200}$ .

(c)  $MC = \frac{\Delta TC}{\Delta Q} = 10, \Delta Q = 800 \Rightarrow \Delta TC = 10 \times 800 = 8000$   
 so  $TC = 6200 + 8000 = \underline{14200}$

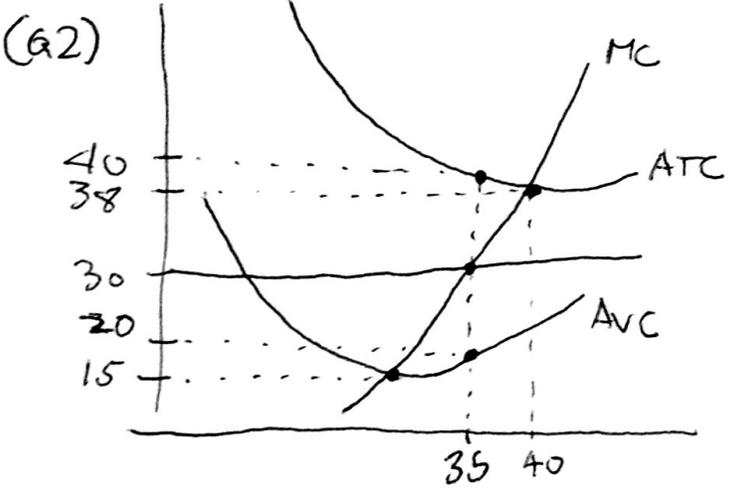
(d)  $\Delta TC = \Delta TVC = 8000$ , each labor costs \$100  $\Rightarrow \Delta L = 80, L = 60 + 80 = \underline{140}$

(e)  $MPL = \frac{\Delta Q}{\Delta L} = \frac{800}{80} = \underline{10}$   
 Fixed cost =  $1200 - 10 \times 100 = \underline{200}$ .

2) •  $P = MC$  at \$10 and  $Q = 1800$ ,  
 $TR = 10 \times 1800 = 18000$   
 $TC = 14200$   
 Profit = 3800 by produce 1800 units ✓

•  $P = MC$  at \$2.5 at  $Q = 200$ ,  
 $TR = 2.5 \times 200 = 500$   
 $TC = 1200$   
 Profit = -700 by producing 200 units.

If shut down, lose only fixed cost = -200  $\Rightarrow$  better shut down. ✓



- 1)  $AVC = 20$  and  $ATC = 40$  at  $Q = 35$   
 so  $AFC = 20, FC = 20 \times 35 = \underline{700}$
- 2) Produce 35 units, loss if produce  
 $\downarrow$   
 $Profit = 30 \times 35 - 40 \times 35 = \underline{-350}$   
 If shutdown, lose 700. Better operate.
- 3) Break-even  $P = 38$ , shutdown  $P = 15$ .

- 4) AVC remains unchanged  
ATC increases  
MC remains unchanged  
Firm should produce 35 units.

since

• loss when operate

$$= 30 \times 35 - 40 \times 35 - 1000$$

$$= \underline{-1350}$$

• loss if shutdown = 1700

- 5) since  $TFC = 700$ ,  $ATC = 38$  when  $Q = 40$ , so  $TC = 1520$   
thus  $TVC = TC - TFC = 1520 - 700 = \underline{820}$ .

(Q3) From  $TC = q^2 + 5q + 25 \Rightarrow ATC = q + 5 + \frac{25}{q}$

Break-even  $P$  when  $P = ATC = MC$ , so:  $q + 5 + \frac{25}{q} = 2q + 5$

$$P = MC = 2 \times 5 + 5 = 15 \quad \leftarrow \quad \underline{q = 5}$$

Break-even price = 15

Shut down  $P$  when  $P = AVC = MC$ , so:  $q + 5 = 2q + 5$

$$TVC = q^2 + 5q$$

$$AVC = q + 5$$

$$P = MC = 2 \times 0 + 5 = 5$$

$$\leftarrow \quad q = 0.$$

Shut down price = 5

(Q5) 1)  $P = MC \Rightarrow 45 = 2q + 5 \Rightarrow \underline{q = 20}$ .

2) When  $P = 45$ ,  $\underline{Q_{\text{industry}} = 105 - 45 = 60}$  (From demand).

So industry size =  $\frac{60}{20} = 3$  firms,

3) Firms will enter in the industry in long run to take profits.

4) Breakeven  $P$  when  $P = MC = ATC$ , so  $2q + 5 = q + 5 + \frac{25}{q}$

$q = 5 \Rightarrow \underline{P_{\text{Breakeven}} = 2 \times 5 + 5 = 15}$

5) Firms will enter until  $P_{\text{Breakeven}}$  is reached,  $\underline{Q_{\text{industry}}^{\text{LR}} = 105 - 15 = 90}$ .

6) When  $P = 15$ , each firm will produce  $q = 5$ , There will be

$\frac{90}{5} = \underline{18}$  firms in the long-run.

7) There are 18 firms, when  $P = 15 \Rightarrow Q = 90$

$P = 45 \Rightarrow Q = 20 \times 18 = 360$

Supply curve is  $\underline{Q = -45 + 9P}$ .

Perfect Competition – Long-run Behavior, Exit, Long-run Average Cost, Market Supply Curve

**This handout contains exercises of**

- Long-Run Average Cost Curve
- Profit Maximization of Perfectly Competitive Firms in the Long-Run

**Things you should know**

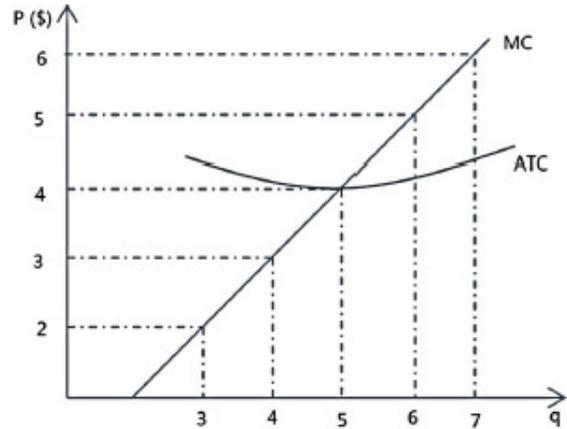
- What are the characteristics and adjustments of firms in the long-run?
- What are the characteristics of firms in perfectly competitive market in the long-run?
- How to find the firm’s behavior and quantity to produce that maximizes its profit?

**Exercises**

Question 1 (Profit Maximization in the Long-Run)

In a perfectly competitive industry, all firms face the cost structure and market demand as depicted below.

Market Demand	
Price (\$)	Quantity
6	140
5	180
4	200
3	240
2	270



1. If the current market price is \$5, then each firm will produce \_\_\_\_\_ units, and there are \_\_\_\_\_ firms in the industry.
2. What is the long-run equilibrium number of firms in this industry? What is the quantity produced by each firm in this long-run equilibrium?

Question 2 (Short-Run vs. Long-Run: Conceptual Question)

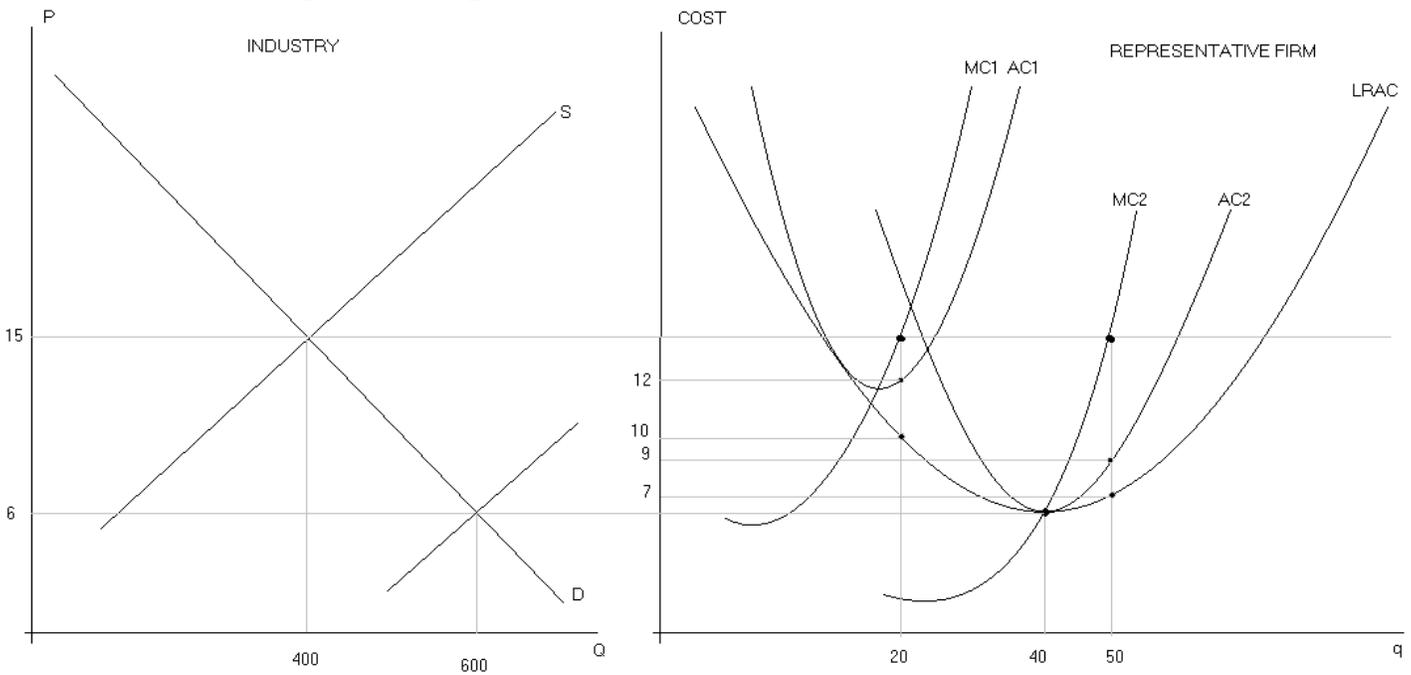
Each worker (L) costs \$10 to hire, each unit of capital (K) costs \$10 to rent. The following table denotes the combinations of capital and worker mixes for a representative firm to produce certain quantities of good:

Q	L	K	TC	AC
100	20	20	400	
200	60	20	800	
200	30	30	600	

1. What should a firm do in the short-run if it wishes to increase the production from 100 units to 200 units? Why?
2. What should a firm do in the long-run if it wishes to increase the production from 100 units to 200 units? Why?
3. Relate the difference between short-run and long-run average cost curves in light of answers in part 1 and 2.
4. Can you tell if the firm is experiencing increasing, decreasing or constant returns to scale?

Perfect Competition – Long-run Behavior, Exit, Long-run Average Cost, Market Supply Curve

Question 3 (Long-Run Average Cost Curves and Profit Maximization)



Each firm has the ability to choose Scale 1 or Scale 2, denoted by MC1, AC1 and MC2, AC2, respectively. Consider the industry demand-supply curve and the cost structure of a representative firm and answer the following questions:

1. Suppose the current market price is \$15, then each firm would produce \_\_\_\_\_ units, and there are \_\_\_\_\_ firms in the industry. Each firm earns an economic profit of \_\_\_\_\_.
2. What would happen in the long-run?
3. How many firms are there in the long-run?

## HANDOUT 11

(Q1) 1) At  $P = \$5$ , each firm produces 6 units, there are  $\frac{180}{6} = 30$  firms.

2) LR eq<sup>m</sup>:  $q_{LR} = 5$ ,  $P = 4$ ,  $n = \frac{200}{5} = 40$  firms.

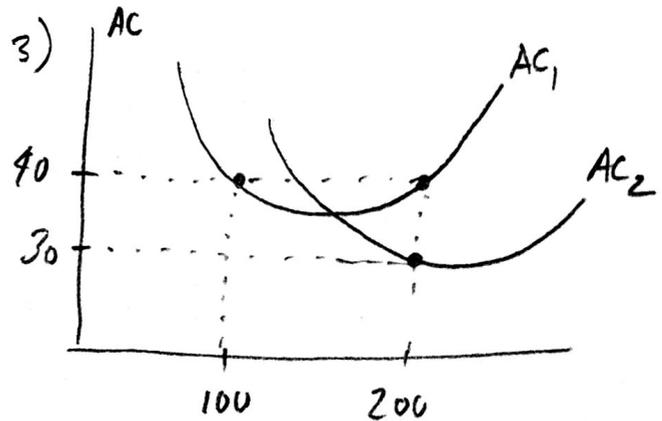
(Q2)

	Q	L	K	$\pi$	AC
A	100	20	20	400	40
B	200	60	20	800	40
C	200	30	30	600	30

4) From A  $\rightarrow$  C, increasing returns to scale

1) increase L from 20 to 60 workers

2) scale up the firm by 50%



(Q3) 1)  $P = \$15$ , each firm produces 50 units (using scale 2)  
There are  $\frac{400}{50} = 8$  firms, each earning profits of \$300.

2) There will be new firms entering, driving down the market price and profits.

3)  $n = \frac{600}{40} = 15$  firms.

**This handout contains exercises of**

- Factor and Input Markets

**Things you should know**

- How does a firm choose the amount of worker/capital it hires/rent?

**Exercises**Question 1 (Numerical examples)

In this industry, all firms operate using the same production function. All firms hire workers in the perfectly competitive labor market and sell goods in the perfectly competitive goods market.

Suppose a representative firm has the production function exhibited in the following table:

Quantity of Labor (L)	Total Product (Q)
0	0
1	40
2	70
3	90
4	105
5	115
6	120

1. Suppose the current wage is \$100 per worker and the price of goods is \$10 per unit. How many workers should each firm hire?
2. Suppose there are less people willing to work, causing the wage to increase to \$200, and as a result, each firm is now hiring 4 workers, what must have happened to the price of goods for such equilibrium?
3. Instead, suppose better technology doubles the output produced by any firms, it is expected that the demand for labor would [ increase / decrease ], causing the wage in the labor market to [ increase / decrease ].

Question 2 (Two factors of production)

You are the owner of a manufacturing company using capital and labor to produce goods. Currently you are hiring 200 workers and renting 100 machines. Through competitive factor markets, the wage (price of labor) is \$20 per worker and the rent (price of capital) is \$10. The 200<sup>th</sup> worker brings 40 units of output to the production, while the 100<sup>th</sup> machine brings 30 units of output to the production. This good sells for \$20 per unit in the perfectly competitive market.

1. State the optimal rules for the choice between hiring labor and renting capital. (Hint: Recall the bang-for-the-bucks)
2. Is the current levels of labor and capital the most profitable? If not, should you hire or fire workers? Should you rent more or less capital?

Question 3 (Factors complementarity and substitutability)

A car manufacturer uses assembly robots, which are complementary with robot technicians and substitutable with hand-made workers. An increase adoption of assembly robots used will:

- [ increase / decrease ] demands for robot technicians.
- [ increase / decrease ] demands for hand-made workers.

In the aspects of marginal products, this increased adoption of assembly robots used will:

- [ increase / decrease ] marginal products of assembly robots.
- [ increase / decrease ] marginal products of robot technicians.

# HANDOUT 12

(Q1)	L	Q	MPL	MRPL (when P=10) = P × MPL
	0	0	-	-
	1	40	40	400
	2	70	30	300
	3	90	20	200
	4	105	15	150
	5	115	10	100
	6	120	5	50

1)  $W = 100$  equals  $MRPL = 100$   
at  $L = 5$ .

2) If  $W = 200$  and  $L = 4$

$$\downarrow$$
$$MP_L = 15$$

$$\text{and } W = P \times MP_L$$

$$200 = P \times 15 \Rightarrow P = \frac{200}{15}$$

3) Demand for labor would increase.  
Wage would increase.

(Q2)

$$1) \frac{MP_L}{W} = \frac{MP_K}{r}$$

2) Now, at  $L = 200, K = 100$

$$MP_L = 40 \quad W = 20$$
$$MP_K = 30 \quad r = 10$$

$$\text{so } \frac{MP_L}{W} = \frac{40}{20} = 2 < 3 = \frac{30}{10} = \frac{MP_K}{r}$$

Hire less labor, rent more capital.

- (Q3)
- increase demands for robot technicians
  - decrease demands for hand-made workers
  - decrease MP of assembly robots.
  - increase MP of robot technicians.

## Business Learning Center - Econ 101 (Hansen)

Review Sheet (also known as “The Giant Flash Card”) for Topics Covered in Midterm 2<sup>1</sup>

### DO NOT BRING THIS REVIEW SHEET TO THE EXAM!

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The following topics have been covered in lectures and discussion sections, so you are expected to know these and be able to solve WITH ACCURACY and SPEED. There will be 33 questions in 75 minutes, so you should average out 2 minutes 15 seconds per question. Even if some questions might take you less than 30 seconds, others might take as long as 5 minutes, spare your time accordingly. *Rule of thumb: if the additional (marginal) benefit (3 points) is greater than additional (marginal) cost (additional time wasted), do it! Otherwise, don't! (In fact, this is the main idea of every economic concepts!) You are maximizing the probability of getting the questions right, subject to the time constraint – if the additional time cost needed to get them right is higher the additional benefit, then you should do other questions!*

Topics studied so far are inter-related, you should expect something to cross-over with each other, e.g. production functions and factor markets

### Consumer Theory

- If you draw graphs in these type of problems, always be precise and label everything.
- What is budget line? What are the components of budget line? What is the meaning of the budget line, the meaning of endpoints of budget line? When price changes, what happen to the budget line? When income changes, what happen to the budget line? What is income tax considered as on the budget line?
- What is utility? What is marginal utility? What is indifference curve? What is the meaning of the slope of indifference curve? What is marginal rate of substitution and the meaning? Why is it convex to the origin (bending towards the origin)? Can two indifference curves cross each other?
- Consumer utility maximization problem (UMP) – the optimality (solution of consumer) consists of budget line and indifference curve. What is the optimal condition for consumer choosing the consumption bundle?  $\left(\frac{MU_x}{P_x} = \frac{MU_y}{P_y} \text{ or } MRS = \frac{MU_x}{MU_y} = \frac{P_x}{P_y}\right)$  What does it mean? (Last dollar spent on good  $x$  gives the same marginal utility utility from good  $x$  as the last dollar spend on good  $y$  gives the same marginal utility from good  $y$ . Clearly, if the last dollar you have gives you higher additional utility from good  $x$  than good  $y$ , you should spend it on good  $x$ .)
- Table format question – How to find/calculate the optimal consumption bundle? How to find the solution when you have utility table? What if you have money left after equating marginal utilities per dollar?
- Equation format question – How to find/calculate the optimal consumption bundle? How to find the solution when you have  $MRS$  and budget line?
- What happen to the optimal consumption bundle if price changes or income changes? Can you derive the demand curve of a good? Can you analyze the substitutability/complementarity of goods when price changes? Can you illustrate/show/exhibit/answer questions for both good  $X$  and good  $Y$ ?
- How to decompose the effects of price change? What are substitution effect and income effect? How to draw the hypothetical budget line? What is the meaning of hypothetical budget line? Can we say that a good is normal or inferior? How do substitution and income effects look like when a good is normal or inferior? What about the special cases of indifference curves? Can you illustrate the effects for Giffen goods?

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<sup>1</sup>Prepared by Kanit Kuevibulvanich. (<http://www.kanitk.com>) This version: November 1, 2015. Disclaimer: Although summarized from textbook, homework and lectures, this note does not constitute as the official guidelines for the course, comments welcomed.

## Production and Cost

- What is production function? (How much you put – what do you put in to production – gives how many units of output?) What is the marginal product? What is average product? Marginal over what? Average over what? How to find the marginal? (Important, it's per one additional worker!) Why does the production function take some particular shape? Where should MP and AP goes through each other?
- Make sure you don't get tangled with the spaghetti of cost curves! Total cost (TC), total fixed cost (TFC), total variable cost (TVC), average total cost (ATC), average fixed cost (AFC), average variable cost (AVC), marginal cost (MC) - how to find each one? Marginal over what? Average over what? How to find the marginal (Important, it's per one additional unit of output!) Where should the curves of MC goes through the ATC and AVC? What is the gap between AFC and ATC, the gap between AVC and ATC? How do they look like?
- If you don't have functional form, you have the table of costs, how to fill in? Can you come up with mathematical relationship between total/average/marginal costs and fixed/variable/total costs? Can you find where the minimums of AVC and ATC are? How about the production function table? Variable cost depends on quantity, fixed cost does not.
- Can you relate to the amount produced and cost of production? (Can you relate production function to/from cost function?)
- What are short run and long run? How are they defined? Do you have fixed cost in the long run?
- Make sure you distinguish inefficiencies between short run (law of diminishing marginal return) and long run (return to scale). What are they? How are they defined?
- How do you choose the most efficient production technology given the price of production inputs?

## Perfect Competition in Short-Run and Long-Run

- What is perfectly competitive market? What are the characteristics of this market type? What are the characteristics of firms in this market type? Why do you have perfectly elastic demand (thus,  $p = MR$ ) for product of a firm? What does it have to do with market demand and market supply? Should firm still produce even if it makes zero economic profit or negative profit in short-run and in long-run?
- Short run - The spaghetti of MC, AVC and ATC shows up here. Where is the optimal production (profit maximization) of a firm in short run? How much should it produce? What is the revenue, cost and profit? How do you find the profit-maximizing quantity produced/profits/costs from graphs and equation types of questions?
- Short run - How many firms in the short run equilibrium? What happen when there are outside shifts of demand and supply curves? What is the break-even price? What is the shut-down price? Where is the supply curve in the short run? What is the criterion that a firm uses to determine whether it wants to shutdown or exit and why?
- Short run - How does an increase in fixed/variable costs change the firm's decision?
- Long run - The spaghetti of MC and AC shows up here. Where is the optimal production (profit maximization) of a firm in long run? How much should it produce? What is the revenue, cost and profit? How many firms in the long run equilibrium? Can you find in both graphs and equation types of questions?
- Long run - How do you explain the long-run average cost curve? What are the returns to scale and the relationship to LRAC? What is the long-run equilibrium in the LRAC curve?
- What happen when there is entry/exit to the market? What is the difference between shutdown and exit? What is the exit price?

## Factor Markets

- What are factor markets? How are the inputs related to firms? What are complementarity and substitutability of production factors?
- How do firms optimally (in a profit-maximizing manner) hire/rent labor/capital? What is the demand for labor? What is the demand for capital? What is marginal revenue product of labor/capital? What are the rules that firm follow to optimally hire/rent labor/capital? What if there is only one factor of production? What about more than one factors of production?

*Good Luck for Your Midterm 2 Exam!*

**This handout contains exercises of**

- Monopoly

**Things you should know**

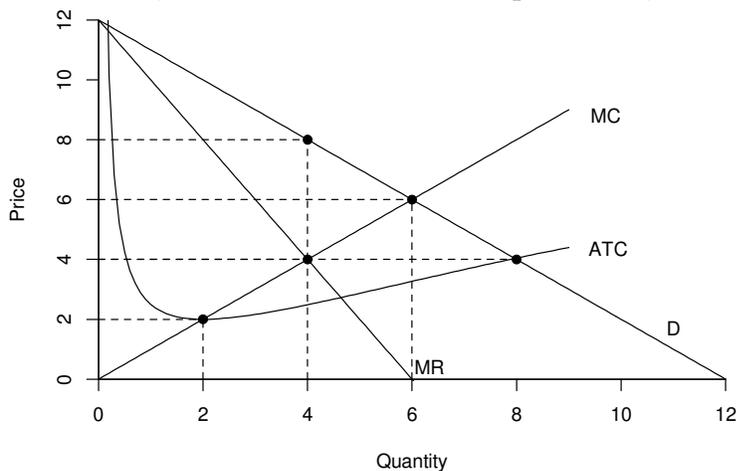
- What are the characteristics of monopoly market?
- How does a monopolist maximize its profit? Can it shutdown or exit?
- Why is there no supply curve for monopoly market?

**Exercises**

Question 1 (Market Structure)

1. If a firm producing goods in a perfectly competitive industry raises its price by 1% above the market price, its quantity sold will \_\_\_\_\_.
2. The demand curve for goods produced by a firm in perfectly competitive industry is \_\_\_\_\_, while the demand curve for a firm in monopoly market is \_\_\_\_\_.
3. Which of the following descriptions would be close to the definition of firms/market in imperfect competition?
  - i) Apple iPhone
  - ii) Shell gasoline pump in large Interstate stops with 10 other brand pumps
  - iii) Madison Gas and Electric, provider of electricity in Madison
  - iv) Corn in the United States
4. Which of the following statements is true when the market structure is monopoly?
  - a. There are many buyers and sellers in this market.
  - b. There are barriers to entry in this market.
  - c. The products sold in this market by different firms are indistinguishable.
  - d. Each firm in the market always earns positive economic profit.
5. Explain economically why each of us does not own personal nuclear power generator.

Question 2 (Numerical Questions – Graph Format)



1. In the graph above, suppose the average total cost is \$3 when quantity is 4 units. This monopolist should produce the profit-maximizing quantity of \_\_\_\_\_ units and set the price at \_\_\_\_\_. This monopolist earns a profit of \_\_\_\_\_ in the short-run and in the long-run it should \_\_\_\_\_.
2. A profit-maximizing monopolist produces a positive quantity  $Q^* > 0$ . At  $Q^*$  the monopolist also finds that  $ATC > P > AVC > MR = MC$ . Given this information, this monopolist should \_\_\_\_\_.

Monopoly – Market Structure, and Applications

\_\_\_\_\_ in the short-run and earns \_\_\_\_\_. Assuming that there is no change to the demand or cost structure of this good, this monopolist should \_\_\_\_\_.

- Suppose a monopolist currently produces a positive quantity to maximize its profit and it is earning positive profit. Suppose it faces a fine of \$50,000 for environmental violation so it earns negative economic profit, then in the short-run, it should [ keep operating at the same quantity / operate at lower quantity / shut down ]

Question 3 (Numerical Questions – Table Format)

The table below shows the quantity demanded at each price for a good, and the total cost to produce at each quantity for a monopolist.

Q	P	TC
0	90	100
10	80	800
20	70	1200
30	60	1500
40	50	1700
50	40	2000

- What is the profit-maximizing quantity? What price should this monopolist set for this good? What is the profit this monopolist earns?
- Suppose this monopolist must now bribe the government to maintain the status as the sole producer. The government offers two ways to do so:
  - Option 1:* Pay a license fee of \$10 per unit produced
  - Option 2:* Pay a flat license fee of \$300
  - In each of the options offered by the government, evaluate the profit-maximizing behavior of this monopolist.
  - Which option would you, as a monopolist, choose?
  - What is the government revenue if you choose Option 1?

Question 4 (Numerical Questions – Equation Format)

Suppose the market demand of a good produced by monopolist is given by:  $P = 40 - Q$ . For this monopolist, the total cost is:  $TC = Q^2 + 100$ , the marginal cost is:  $MC = 2Q$ .

- What is the profit-maximizing quantity? What price should this monopolist set for this good? What is the profit this monopolist earns?
- Suppose the fixed cost is now \$350. In the short-run, what is the profit-maximizing quantity? What price should this monopolist set for this good? What is the profit this monopolist earns? Should this monopolist operate in the long-run?

# HANDOUT 13

## QUESTION 1

1. decrease to zero.
2. perfectly elastic (horizontal at market price) / the market (industry) demand
3. i) and iii).
4. b.
5. Large fixed cost, large economies of scale, natural monopoly.

## QUESTION 2

1.  $Q^* = 4$  /  $P^* = \$8$  / Profit =  $(8 - 3) \times 4 = \$20$  / operate in long-run.
2. operate in the short-run / earns negative profits / exit in long-run.
3. Keep operating at the same quantity.

## QUESTION 3

Q	P	TR	MR	original problem		Option 1		Option 2	
				TC	MC	TC	MC	TC	MC
0	90	0	—	100	—	100	—	400	—
10	80	800	80	800	70	900	80	1100	70
20	70	1400	60	1200	40	1400	50	1500	40
30	60	1800	40	1500	30	1800	40	1800	30
40	50	2000	20	1700	20	2100	30	2000	20
50	40	2000	0	2000	30	2500	40	2300	30

1. At  $Q^* = 40$ ,  $P^* = 50$ , Profit =  $\$2000 - \$1700 = \$300$

2. i) Option 1 (MR=MC=40) At  $Q^* = 30$ ,  $P^* = 60$ , Profit =  $\$1800 - \$1800 = \$0$   
Option 2 (MR=MC=20) At  $Q^* = 40$ ,  $P^* = 50$ , Profit =  $\$2000 - \$2000 = \$0$ .

ii) Indifferent between both options.

iii) Revenue =  $\$10 \times 30$  units =  $\$300$ .

## QUESTION 4

1. From  $P = 40 - Q \Rightarrow MR = 40 - 2Q$

Maximize profit at  $MR = MC \Rightarrow 40 - 2Q = 2Q \Rightarrow Q^* = 10$

set price at  $P = 40 - 10 = \$30$

Profits =  $TR - TC = 30 \times 10 - [10^2 + 100] = \$100$

2. Profits =  $TR - TC = 30 \times 10 - [10^2 + 350] = -\$150$

(Same  $Q^*$  since no change in MC!)

Short-run || If operate  $\rightarrow$  loss = \$150  
|| If shutdown  $\rightarrow$  loss = fixed cost = \$350  $\Rightarrow$  operate!

Long-run  $\Rightarrow$  exit.

**This handout contains exercises of**

- Monopoly and Economic Efficiency
- Price Discrimination

**Things you should know**

- What is the impact on economic efficiency when market power exists?
- What are the required pre-conditions to price-discriminate?
- How does a monopolist set prices and quantities if it can discriminate consumers – as first- and third-degree price discriminations? What is the impact on economic efficiency?

**Exercises**

Question 1 (Monopoly and Market Efficiency)

Suppose the demand for a particular good is given by  $P = 120 - Q$ . This good is produced by a monopolist who has the cost function of  $TC = 0.5Q^2 + 30Q + 100$ , and the marginal cost is given by  $MC = Q + 30$ . This monopolist cannot discriminate prices each consumer pays.

1. What would be the profit-maximizing behavior of this monopolist? What is its profit?
2. What are the price and quantity if this good were to be produced in a perfectly competitive setting? Compare the changes in consumer surpluses, producer surpluses, and, if any, deadweight losses in each case. Draw the graphs to illustrate these facts.
3. If this monopolist did not study Econ101 before starting his business and he decides to maximize the revenue instead. (This is usually seen in real life by managers who maximize sales instead of profits.) What would be the price and quantity if he does so? Compare the profits to the case where this monopolist maximizes his profits.

Question 2 (Price Discrimination – Conceptual Question)

Identify which kind of price discrimination is practiced in each of the following scenarios.

- i) Student price for Wisconsin Men's Basketball tickets
- ii) Plastic molding company poisons material and labels "Not Suitable for Food Handling"
- iii) Priceline "Name Your Price" lets you choose the price you want for hotels and flights
- iv) Airlines and hotels charging different prices when buying at different time before travel

Question 3 (First-Degree Price Discrimination)

Suppose a hotel can perfectly identify how much each consumer is willing to pay and it knows that the demand curve is  $P = 100 - Q$ . The operating cost per room is constant at  $AC = MC = 20$ .

1. What is (are) the price(s) the hotel will charge to consumers? How many rooms would be sold? What is its profits?
2. What is the consumer surplus? What is the producer surplus? What is the deadweight loss?
3. Compare the results to the scenario where the hotel cannot price-discriminate and must charge a single price.

Question 4 (Third-Degree Price Discrimination)

Northeast Airlines has the same operating cost per passenger in First Class and Economy Class at  $MC = AC = 20$ . The demand by First Class passengers is  $P = 100 - 2Q$ , while the demand by Economy Class passengers is  $P = 50 - 0.5Q$ .

1. Suppose the airlines can price-discriminate, how many seats will the airlines sell? At what price(s)? What is its profits?
2. Suppose the airlines is unable to price-discriminate, how many seats will the airlines sell? At what price(s)? What is its profits?

Question 5 (Third-Degree Price Discrimination)

1. Kanit has to fly to Alaska tonight for important snowboard filming. Zander would maybe like to visit Alaska on vacation sometime next year. Both of them have not purchased airline tickets yet. Alaska Airlines is the only airliner that flies to Alaska and it has constant marginal cost that is greater than zero. Suppose Alaska Airlines can conduct third-degree price discrimination, it will charge \_\_\_\_\_ since \_\_\_\_\_ at the price charged.
- a. a higher price to Zander; he has higher price elasticity of demand
  - b. a lower price to Zander; he has higher price elasticity of demand
  - c. an equal price to both; they have equal price elasticity of demand
  - d. a lower price to Kanit; he has lower price elasticity of demand

**One Year Season Pass 2015/2016 – STUDENT PRICING**

Mount Bohemia Ski Resort – *the only premier ski resort in the Upper Peninsula Michigan*

Kanit Kuevibulvanich (University of Wisconsin-Madison)



TERMS and CONDITIONS:

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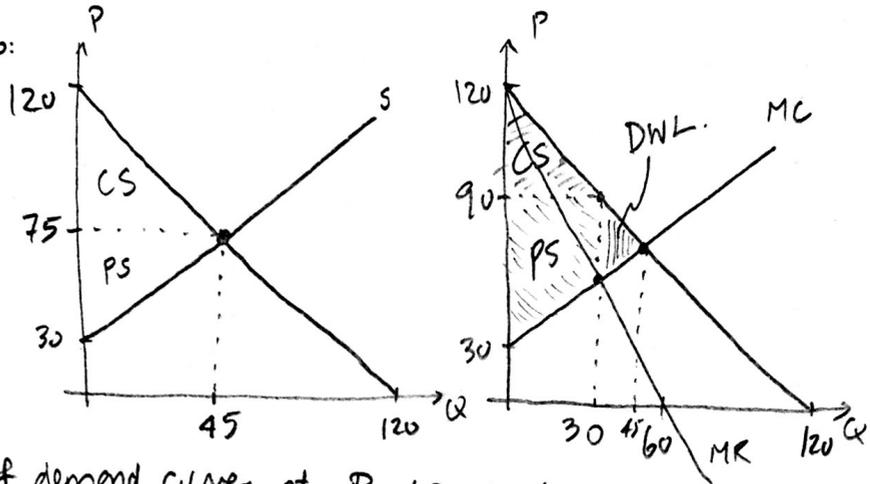
2. Which of the following must be included in the Terms and Conditions of the Season Pass Ticket depicted above to enforce third-degree price discrimination? (Pick all applicable)
- i) This season pass may only be used by the person named above.
  - ii) Student identification may be required to use this season pass.
  - iii) Skiing and snowboarding are inherently dangerous activities. User assumes all risks.
  - iv) Once purchased, this season pass is non-refundable.
  - v) This season pass is not transferrable to another person.

# HANDOUT 14

(Q1): 1)  $P = 120 - Q \Rightarrow MR = 120 - 2Q$ ,  $MR = MC \Leftrightarrow 120 - 2Q = Q + 30$ , so:  $Q_M^* = 30$ ,  $P_M^* = 90$   
 Profit =  $TR - TC = 90 \times 30 - [0.5 \times 30^2 + 30 \times 30 + 100] = 1250$ .

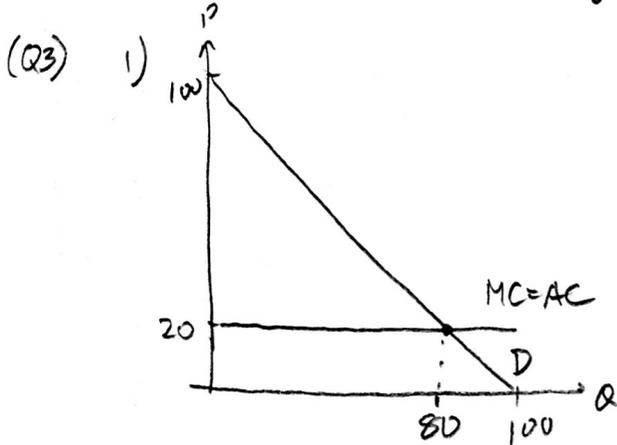
2)  $P = MC \Leftrightarrow 120 - Q = Q + 30$ , so:

$$Q_{PC}^* = 45, P_{PC}^* = 75$$



3) Maximize revenue at midpoint of demand curve at  $P = 60$ ,  $Q = 60$ .

(Q2) i) 3<sup>rd</sup> Degree ii) 3<sup>rd</sup> Degree iii) 1<sup>st</sup> Degree iv) 3<sup>rd</sup> Degree.

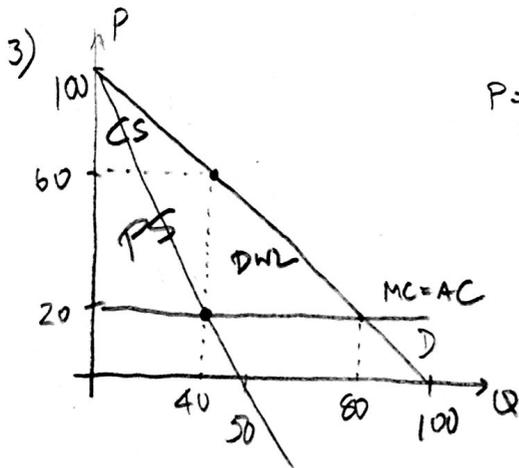


Prices: varies according to consumer at different willingness to pay, minimum \$20.

Quantity: 80 rooms.

$$\text{Profit} = \frac{1}{2} \times 80 \times (100 - 20) = \$3200$$

2)  $CS = \$0$ ,  $PS = \$3200$ ,  $DWL = \$0$ .



$$P = 100 - Q \Rightarrow MR = 100 - 2Q$$

$$MR = MC \Leftrightarrow 100 - 2Q = 20 \Rightarrow Q_M^* = 40, P_M^* = 60$$

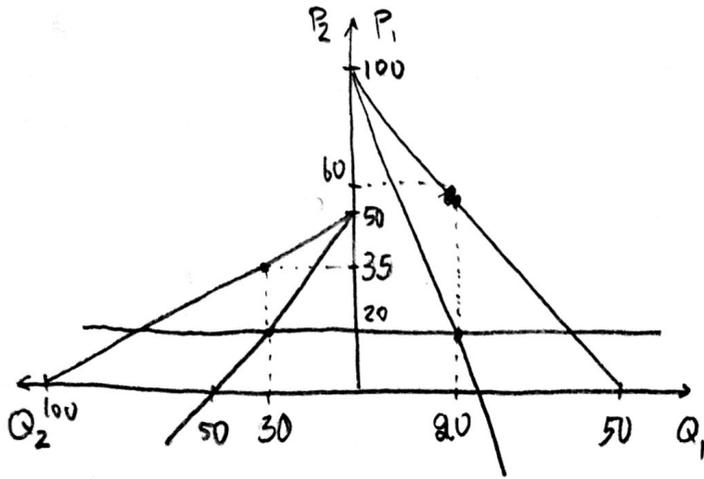
$$\text{Profit} = [60 - 20] \times 40 = \$1600$$

$$CS = \frac{1}{2} \times 40 \times [100 - 60] = \$800$$

$$PS = [60 - 20] \times 40 = \$1600$$

$$DWL = \frac{1}{2} \times [80 - 40] \times [60 - 20] = \$800$$

(Q4) 1) First Class:  $P = 100 - 2Q \Rightarrow MR = 100 - 4Q$ , Economy Class:  $P = 50 - 0.5Q \Rightarrow MR = 50 - Q$



First Class:  $MR = MC \Leftrightarrow 100 - 4Q = 20$

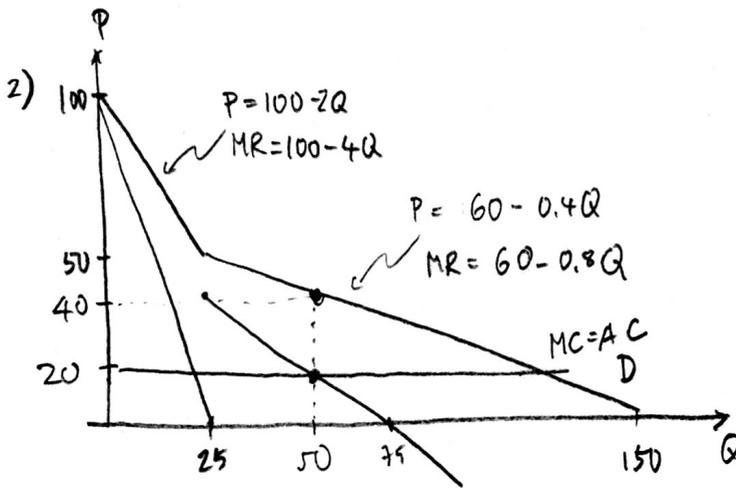
$Q^* = 20$   
 $P^* = 60$

Economy Class:  $MR = MC \Leftrightarrow 50 - Q = 20$

$Q^* = 30$   
 $P^* = 35$

Profit =  $[20 \times 60] + [30 \times 35] - [20 \times 50]$

$= 1200 + 1050 - 1000 = 1250.$



Single price:  $P_m^* = 40$

$Q_m^* = 50.$

Profit =  $2000 - [20 \times 50] = 1000$

(Q5) 1) b

2) i), ii), iv)

Oligopoly – Collusion and Price Leadership Models

**This handout contains exercises of**

- Collusion Model
- Price Leadership Model

**Things you should know**

- Why would collusion be unsuccessful?
- How to solve the price leadership model?

**Exercises**

Question 1 (Collusion)

Suppose there are two firms – A and B – entering into a collusion agreement to restrict the quantity sold. The demand curve of this good is given by  $P = 100 - Q$ , where  $Q$  is the total quantity in the market. Each unit of good costs  $AC = MC = 20$ . A single monopolist would maximize its profits of \$1600 at  $Q = 40$  units at price  $P = \$60$ .

1. It is initially agreed that each firm will produce 20 units. Suppose firm A is contemplating cheating by producing 10 more units, what would be its profits compared to firm B?

	Collusion				Firm A Cheats		
	Q	P	Profit		Q	P	Profit
Firm A	20 units	\$60	\$800	Firm A	30 units	\$50	
Firm B	20 units	\$60	\$800	Firm B	20 units	\$50	

2. What do you expect to happen next after Firm A cheats? When would this cheating end?

Question 2 (Price Leadership Model)

Suppose the market demand is  $P = 100 - Q$ , the supply curve of small firms is  $P = 20 + Q$ , the marginal cost of dominant firm is  $MC = AC = 30$ .

After each step, exhibit your curves or solutions graphically.

0. Find the price where market demand and supply curve of small firms intersect.
1. Find the equations of demand and marginal revenue for dominant firm.
2. What is the quantity the dominant firm produces? At what price would this dominant firm lead into this market?
3. What is the quantity the small firms produce? At what price would the small firms sell?
4. What is the total quantity sold in this market? Verify your answer.
5. (Bonus) What if the dominant firm has the marginal cost of  $MC = 10$ ?

Question 3 (Price Leadership Model)

There is one dominant firm and several smaller firms in the market for a particular good. The small firms supply curve is  $P = 10 + Q$ . The dominant faces a residual demand of  $P = 50 - 0.5Q$ .

1. Find the market demand curve.
2. If small firms produce 30 units, what is the price that the leader has set? What is the quantity that the leader has produced?
3. Assuming constant marginal cost by the leader firm, what is marginal cost?

Question 4 (Price Leadership Model)

There is one dominant firm and several smaller firms in the market for a particular good. The residual demand is  $P = 60 - 0.5Q$ , the market demand is  $P = 100 - Q$ . Suppose the small firms will not operate at price below \$20, and that price is currently \$40.

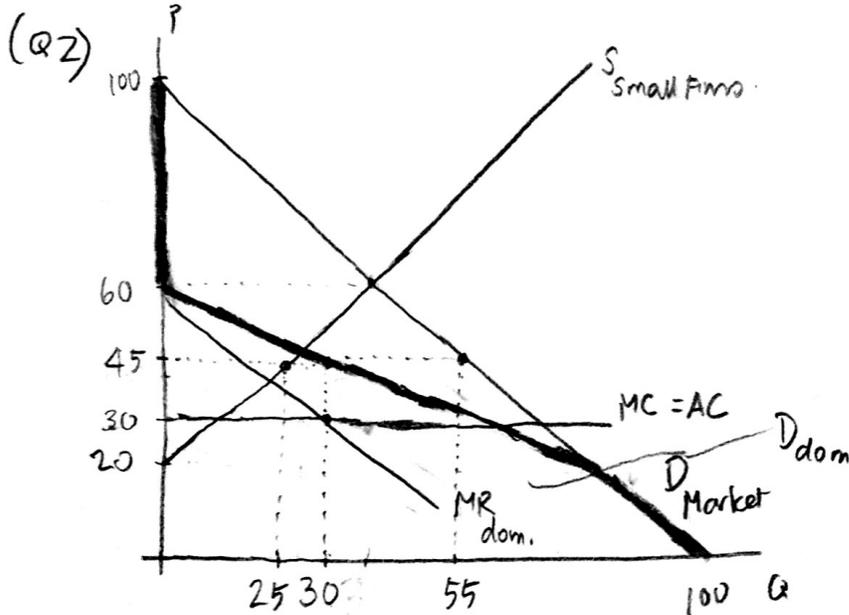
1. What is the marginal cost of the dominant firm if it has constant marginal cost?
2. What is the equation for the small firms supply?

# HANDOUT 15

(Q1) (1)

	Collision			Firm A cheats		
	Q	P	Profits	Q	P	Profits
Firm A	20	\$60	$(60-20) \times 20 = 800$	30	\$50	$(50-20) \times 30 = 900$
Firm B	20	\$60	$(60-20) \times 20 = 800$	20	\$50	$(50-20) \times 20 = 600$

(2) Firm A and B will both cheat until  $P = MC = AC = 20$ .



$$(0) \begin{cases} Q = 100 - P \\ Q = -20 + P \end{cases} \Rightarrow P = 60.$$

$$(1) D_{market} = D_{dominant} + S_{small firm}$$

$$D_{dominant} = D_{market} - S_{small firm} \\ = 100 - P - (-20 + P)$$

$$Q_{dom} = 120 - 2P \Rightarrow P = 60 - 0.5Q_{dom}$$

$$so: MR_{dom} = 60 - Q$$

$$(2) MR_{dom} = MC \Rightarrow 60 - Q = 30 \Rightarrow Q_{dom} = 30, so: P = 60 - 0.5(30) = 45$$

$$(3) Small firms take  $P = 45$  as given; so:  $45 = 20 + Q \Rightarrow Q_{SF} = 25$$$

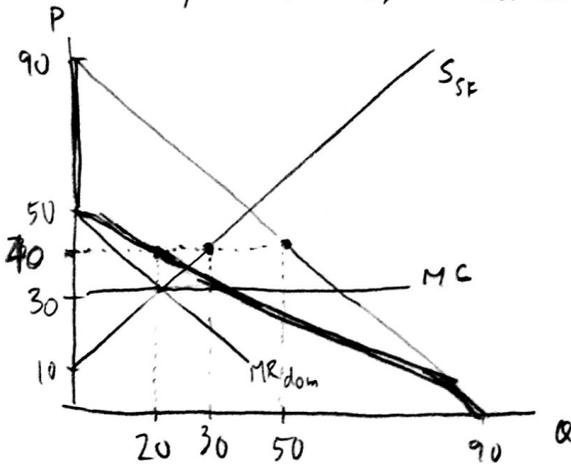
$$(4) Total quantity since  $P = 45 \Rightarrow Market demand: 45 = 100 - Q \Rightarrow Q_{Mkt} = 55$$$

$$Q_{dom} + Q_{SF} = 30 + 25 = 55.$$

(Q3) 1)  $Q_{mkt} = Q_{dom} + Q_{SF}$   
 $= 100 - 2P + P - 10$   
 $Q_{mkt} = 90 - P$

$Q_{SF}: P = 10 + Q \Leftrightarrow Q = P - 10$   
 $Q_{dom}: P = 50 - 0.5Q \Leftrightarrow Q = 100 - 2P.$

2) If  $Q_{SF} = 30$ , must come from given price of  $P = 10 + Q = 10 + 30 = 40$ .  
 At price  $P = 40$ , the leader has produced  $Q = 100 - 2(40) = 20$



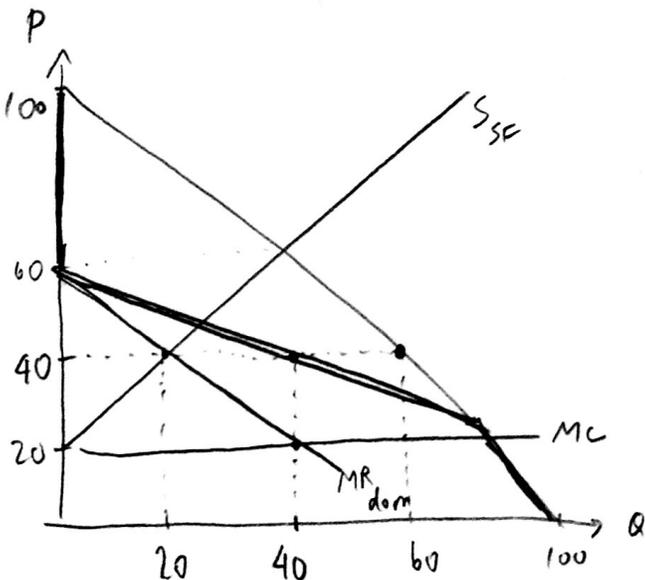
3) From  $Q_{dom}: P = 50 - 0.5Q$   
 $\rightarrow MR_{dom} = 50 - Q$   
 with  $Q_{dom} = 20 \rightarrow MR_{dom} = 50 - 20 = 30$   
 must be equal to  $MC_{dom} = 30$ .

(Q4) At current price  $P = 40 \Rightarrow$  Dominant firm:  $Q = 40$  ( $40 = 60 - 0.5Q$ )  
 market:  $Q = 60$  ( $40 = 100 - Q$ )

$\Rightarrow$  Small firms must be producing  $60 - 40 = 20$ .

1) From residual demand:  $P = 60 - 0.5Q \Rightarrow MR_{dom} = 60 - Q$ .

dominant firm must have  $MR = MC$ , so:  $MR = 60 - 40 = 20$   
 $MC = 20$ .



2) since small firms do not supply when price is below \$20  
 $\rightarrow P = 20, Q = 0$   
 And now  $P = 40, Q = 20$  } Find Equation

so. Supply of small firm is:

$P = 20 + Q_{SF}$

**This handout contains exercises of**

- Cournot Duopoly

**Things you should know**

- How to solve the Cournot duopoly model?

**Exercises**Question 1 (Cournot Model with Two Identical Firms)

Suppose there are two firms – A and B – competing as Cournot duopolists. The demand curve of this good is given by  $P = 100 - Q$ , where  $Q$  is the total quantity in the market. Both firms have the identical cost structure such that each unit of good costs  $AC = MC = 40$ . Graphically explain your answers in each step.

1. Suppose currently there is only one firm in the market, what is the quantity this monopolist would produce? What is the profit for this monopolist?
2. Find the quantity that would be sold if this market were to be a perfectly competitive market.
3. Find the equations of reaction functions of both firms.
4. What are the quantities sold by each firm when they compete as Cournot duopolists?
5. What are the profits of each firm when they compete as Cournot duopolists?
6. If the two firms were to collude, what would be the quantity sold in the market? What would be the profits of each firm? Compare your findings to when they compete as Cournot duopolists.

Question 2 (Cournot Model with Two Non-Identical Firms)

Suppose there are two firms – A and B – competing as Cournot duopolists. The demand curve of this good is given by  $P = 120 - Q$ , where  $Q$  is the total quantity in the market. Suppose firm A is more efficient and its cost structure is given by  $AC = MC = 20$ , while firm B is less efficient and  $AC = MC = 40$ .

1. Find the equations of reaction functions of both firms.
2. What are the quantities sold by each firm when they compete as Cournot duopolists?
3. What can you conclude from your findings?

Question 3 (Cournot Model with Missing Cost Information)

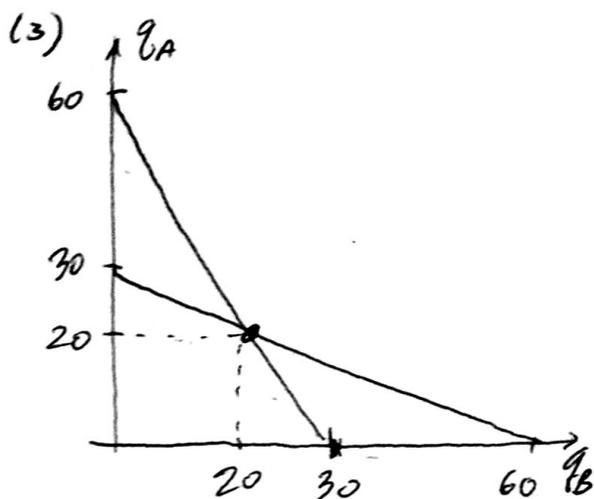
Suppose the reaction functions of two firms are given by  $q_A = 10 - 0.5q_B$  and  $q_B = 10 - 0.5q_A$ . The market demand is known as  $P = 50 - Q$ . Assuming that both firms have constant and identical marginal cost, what is the marginal cost for both firms?

(Q1) (1) Monopoly:  $P=100-Q \Rightarrow MR=100-2Q$

$$MR=MC \Rightarrow 100-2Q=40, \text{ so: } Q_M^* = 30, P_M^* = 70.$$

$$\text{Profit} = (70-40) \times 30 = 900.$$

(2) Perfect Competition:  $P=MC \Rightarrow 100-Q=40 \Rightarrow Q_{PC}^* = 60, P_{PC}^* = 40$



Firm A: • if B produce  $q_B = 0$

$\Rightarrow$  I produce  $q_A = 0$  (as monopolist)

• if B produce  $q_B = 60$

$\Rightarrow$  No room for me to produce  $q_A = 0$ .

$$\text{So: } q_A = 30 - \frac{1}{2}q_B.$$

$$\text{Firm B: similar, } q_B = 30 - \frac{1}{2}q_A.$$

$$(4) q_A = 30 - \frac{1}{2}q_B = 30 - \frac{1}{2}(30 - \frac{1}{2}q_A) = 30 - 15 + \frac{1}{4}q_A = 15 + \frac{1}{4}q_A$$

$$\text{Solve: } q_A = 15 + \frac{1}{4}q_A \Leftrightarrow \frac{3}{4}q_A = 15, \text{ so: } q_A = 20.$$

$$\text{Find } q_B \text{ from: } q_B = 30 - \frac{1}{2}q_A = 30 - \frac{1}{2}(20) = 20.$$

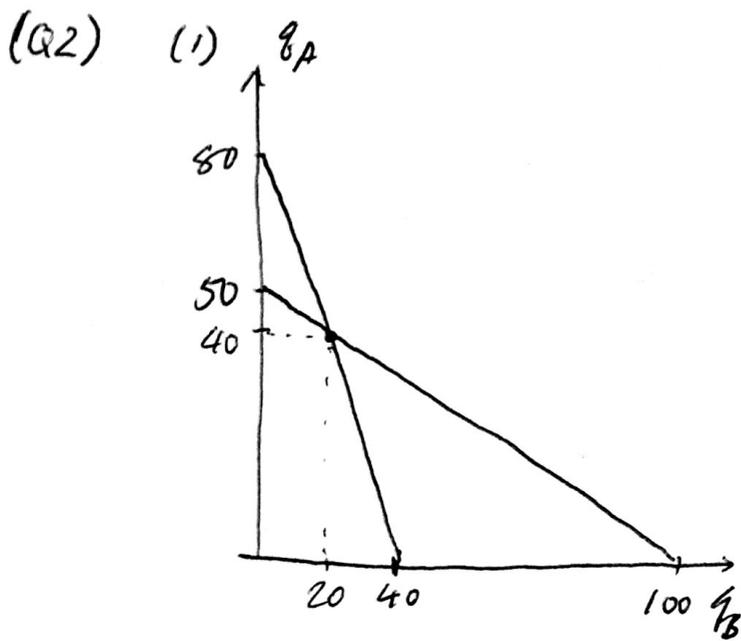
$$(5) \text{ Profits by each firm} = (60 - 40) \times 20 = 20 \times 20 = 400.$$

Quantity by each firm

Price in the market: since there are  $Q = q_A + q_B = 20 + 20 = 40$  units

sold in the market, the price is  $P = 100 - 40 = 60$ .

(6) Collusion: act like monopolist, jointly produce  $Q_M^* = 30$ , jointly earn profits of \$900. In duopoly, both firms produce a total quantity of  $Q = 40$ , each earning profit of \$400.



Firm A:

If  $q_B = 0 \Rightarrow A$  is monopolist

$$q_A = 50$$

If  $q_B = 100 \Rightarrow A$  has no room to produce  $\Rightarrow q_A = 0$

$$\text{So: } q_A = 50 - \frac{1}{2} q_B.$$

Firm B: similar reasoning:

$$q_B = 40 - \frac{1}{2} q_A$$

$$(2) \quad q_A = 50 - \frac{1}{2} q_B = 50 - \frac{1}{2} \left( 40 - \frac{1}{2} q_A \right) = 50 - 20 + \frac{1}{4} q_A = 30 + \frac{1}{4} q_A$$

$$\text{So: } q_A = 30 + \frac{1}{4} q_A \Leftrightarrow \frac{3}{4} q_A = 30, \text{ so: } q_A = 40.$$

$$\text{Find } q_B \text{ from } q_B = 40 - \frac{1}{2} q_A = 40 - \frac{1}{2} (40) = 20.$$

(3) Less efficient firm will produce less quantity.

(Q3) If  $q_B = 0 \Rightarrow q_A = 10$  and  $A$  is the monopolist

From demand:  $P = 50 - Q$  then  $MR = 50 - 2Q$

$q_A = 10$  maximizes profit for  $A$  when  $A$  is monopolist.

$$\text{So: } MR = MC \text{ at } MR = 50 - 2(10) = 30 = MC.$$

**This handout contains exercises of**

- Game Theory

**Things you should know**

- What are games and components of games?
- What are the dominant strategy, Nash strategy, collusion strategy and Maxmin strategy?
- How to find the equilibrium/solution of the game under each solution concept?

**Exercises**

Question 1 (Finding Games Solutions)

In each of the following games, find the game equilibrium (that is, you must list what strategy does each player choose, and what outcome each player gets) using each of the following solution concepts. Write down your explanation as you find the solutions.

- Dominant strategies
- Nash strategies
- Collusion strategies (if asked)
- Maxmin strategies (if asked)

1. Prisoners' Dilemma

Country A and Country B can decide to build “Nuclear” or “Non-nuclear” weapons. If both countries decide to build nuclear weapons, they are wastefully utilizing the resources. If both decide not to build nuclear weapons, they employ their resources somewhere efficient. If one country has the nuclear weapon but the other has not, the country that has the nuclear weapon is more powerful, while the country that has no nuclear weapon is prone to being attacked.

		<i>Country B</i>	
		Nuclear	Non-nuclear
<i>Country A</i>	Nuclear	0, 0	4, -4
	Non-nuclear	-4, 4	2, 2

Find the dominant strategy equilibrium, Nash equilibrium, collusion equilibrium and Maxmin strategy equilibrium, if any exists.

2. Chicken Game

Two drivers are driving from the opposite ends on the center of an unmarked road. As they come into visual, they can choose to swerve from each other or drive straight. Swerving the car takes effort but the crash is avoided with certainty, and accident can also be avoided if one driver swerves but the other drive straight. However, if both drive straight, they will crash.

		<i>Driver B</i>	
		Swerve	Drive Straight
<i>Driver A</i>	Swerve	-1, -1	-2, 0
	Drive Straight	0, -2	-10, -10

Find the dominant strategy equilibrium, Nash equilibrium and Maxmin strategy equilibrium, if any exists.

3. Battle of the Sexes

The couple is considering what to do on their date night but they don't know what they have agreed upon. The girl prefers to Netflix but the guy prefers to Chill. They have to choose the same activity to enjoy their time, even if one prefers the other activity. If they don't choose the same activity, they both lose.

Game Theory – Strategies and Equilibria

		<i>The Girl</i>	
		Netflix	Chill
<i>The Guy</i>	Netflix	1, 2	0, 0
	Chill	0, 0	2, 1

Find the dominant strategy equilibrium, Nash equilibrium, Collusion equilibrium and Maxmin strategy equilibrium, if any exists.

4. Rock-Paper-Scissors

A rock-paper-scissors game can be written in the game matrix as the following

		<i>Player B</i>		
		Rock	Paper	Scissors
<i>Player A</i>	Rock	0, 0	-1, 1	1, -1
	Paper	1, -1	0, 0	-1, 1
	Scissors	-1, 1	1, -1	0, 0

Find the dominant strategy equilibrium and Nash equilibrium, if any.

5. Find the dominant strategy equilibrium, Nash equilibrium, collusion equilibrium and Maxmin strategy equilibrium, if any exists.

		<i>Player B</i>				<i>Player B</i>	
		Left	Right			Left	Right
<i>Player A</i>	Up	2, 1	0, 0	<i>Player A</i>	Up	1, 0	1, 1
	Down	-1, -1	1, 2		Down	-5, 0	5, 1

Problem 2

Consider the following game table, then answer the questions

		<i>Player 2</i>	
		Left	Right
<i>Player 1</i>	Up	1, -1	-1, 1
	Down	X, Y	1, -1

1. Find Nash equilibrium if  $X = -1$  and  $Y = 1$ .
2. For what value of  $X$  is “Down” the dominant strategy for Player 1?
3. For what values of  $Y$  is “Left” the dominant strategy for Player 2?
4. For what values of  $X$  guarantees that “Up” is the Maxmin strategy for Player 1?
5. For what values of  $Y$  guarantees that “Right” is the Maxmin strategy for Player 2?
6. For what values of  $X$  guarantees that “Down” is the Maxmin strategy for Player 1?

HANDOUT 17

(Q1)

1)

		B	
		Nukes	No-nukes
A	Nukes	<u>0, 0</u>	<u>4, -4</u>
	No Nukes	<u>-4, 4</u>	2, 2

- Dominant strategy equilibrium
- Nash equilibrium
- Maxmin equilibrium
- Collusion equilibrium:

}	A	B
	Nukes,	Nukes
	0,	0.
	A	B
	No-nukes,	No-nukes
	2,	2

2)

		B	
		Swerve	Straight
A	Swerve	-1, -1	<u>-2, 0</u>
	Straight	<u>0, -2</u>	-10, -10

Dominant strategy eq<sup>m</sup> : does not exist

Nash equilibria:

	A	B		A	B
	Straight	Swerve	<u>and</u>	swerve	straight
	0	-2		-2	0

Maxmin eq<sup>m</sup>:

	A	B
	Swerve	Swerve
	-1	-1

(Note: There is another Nash equilibrium called mixed strategy, not covered in 101!)

3)

		Girl	
		Netflix	Chill
Guy	Netflix	<u>1</u> , <u>2</u>	0, 0
	Chill	0, 0	<u>1</u> , <u>2</u>

Dominant strategy eq<sup>m</sup>: does not exist

<u>Nash equilibria:</u> <u>Collusion eq<sup>m</sup></u>	Guy	Girl	<u>and</u>	Guy	Girl
	Netflix	Netflix		Chill	Chill
	1	2		2	1

(There is another Nash equilibrium called mixed strategy, not covered in 101!?)

Maxmin eq<sup>m</sup>: For both guy and girl, Netflix and Chill could both be their maxmin strategy-

4) There is no dominant strategy eq<sup>m</sup> (no dominant strategies by any players) and no Nash equilibrium

5)

		B	
		Left	Right
A	Up	<u>2</u> , <u>1</u>	0, 0
	down	-1, -1	<u>1</u> , <u>2</u>

Dominant strategy eq<sup>m</sup>: does not exist

<u>Nash eq<sup>m</sup></u> <u>Collusion eq<sup>m</sup></u>	A	B	<u>and</u>	A	B
	Up	left		Down	Right
	2	1		1	2

Maxmin eq<sup>m</sup>:

A	B
Up	Right
0	0

		B	
		Left	Right
A	Up	<u>1</u> , 0	1, <u>1</u>
	Down	-5, 0	<u>5</u> , <u>1</u>

Dominant strategy: only B has "Right" as dominant strategy.

<u>Nash eq<sup>m</sup></u> <u>Collusion eq<sup>m</sup></u>	A	B
	Down	Right
	5	1

Max min eq<sup>m</sup>:

A	B
Up	Right
1	1

(Q2)

		Player 2	
		Left	Right
Player 1	UP	1, -1	-1, 1
	Down	X, Y	1, -1

- 1) No Nash eqm when  $X = -1, Y = 1$
- 2) If  $X > 1$
- 3) Left can never be a dominant strategy for Player 2
- 4) If  $X < -1$
- 5) If  $Y < -1$
- 6) If  $X > 1$

**This handout contains exercises of**

- Monopolistically Competitive Market
- Externalities, Taxes and Subsidies

**Things you should know**

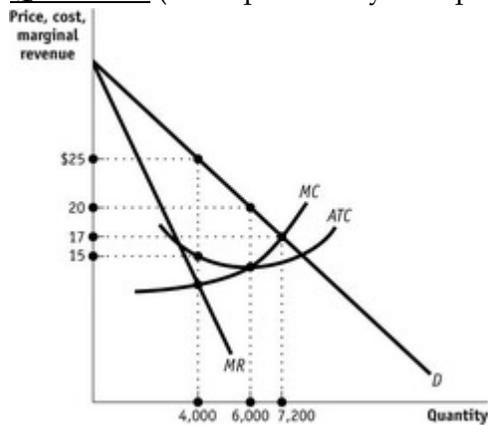
- What are the characteristics of monopolistically competitive markets? How do you find the short-run and long-run equilibrium?
- What is the marginal private benefits/costs? What is the marginal social benefits/costs?
- How to find the equilibrium outcomes under private decisions? How to find the socially optimal outcomes?
- How to achieve the socially optimal outcomes?
- When taxes are imposed, what are the burdens borne by each side – the consumers and the producers – of the market

**Exercises**

Question 1 (Monopolistically Competitive Market)

1. Which of the following statements is false in a monopolistically competitive market?
  - a. In the long run, each firm will earn zero economic profit.
  - b. The cost of variety arises from each firm not producing at the lowest average total cost in the long run.
  - c. Since each firm is earning zero economic profit in the long run, there is no deadweight loss.
  - d. Product differentiation is one of the features of this market.
  
2. In the long run, the demand for a particular firm in a monopolistically competitive industry \_\_\_\_\_ as the positive profits attracts entry. In other words, the demand for this particular firm is [ more / less ] elastic.
  
3. Suppose the restaurants industry is initially in the long-run equilibrium and there are many varieties of restaurants. The economy recovers from recession in the city of Madison, causing a rise in demands for eating out. Explain what would happen to the restaurants industry in both short run and long run.

Question 2 (Monopolistically Competitive Market)

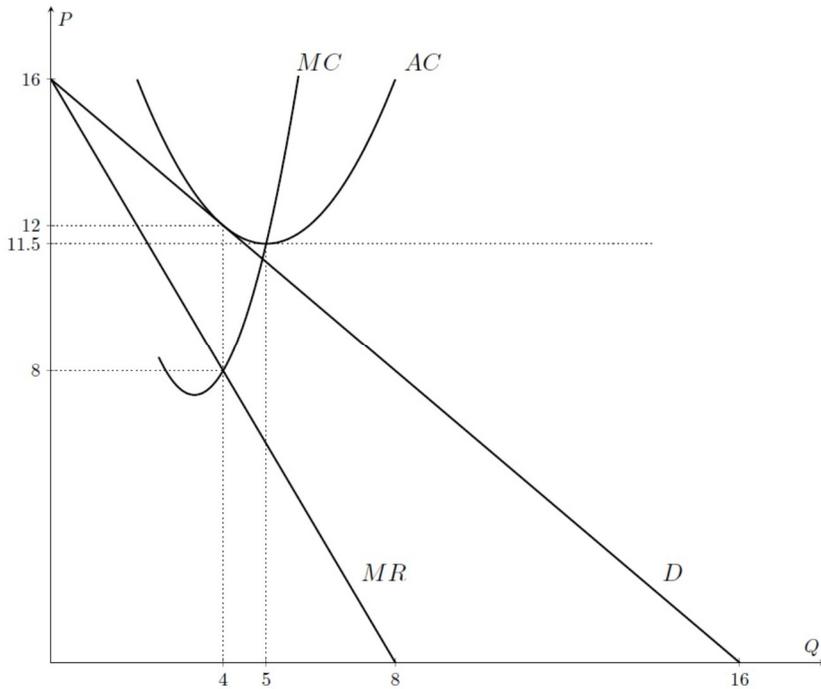


1. This firm in a monopolistically competitive industry is in the [ short-run / long-run ] equilibrium and earning a profit/loss of \_\_\_\_\_. The profit-maximizing level of output for this firm is \_\_\_\_\_, setting the price at \_\_\_\_\_.

If this picture does not represent long-run equilibrium, this industry is expected to witness [ entry / exit ] of firms in the long-run. This firm will receive a profit of \_\_\_\_\_ by producing [ more / less ] and selling at [ lower / higher ] price in the long run. This arises due to \_\_\_\_\_. Highlight the area that represents deadweight loss.

2. For a monopolistically competitive firm that is experiencing  $AC > P > MC = MR$ . This firm is in the [ short-run / long-run ] equilibrium, it is expected that firms [ enter / exit ].

Monopolistic Competition, and Externalities



Question 3 (Monopolistically Competitive Market)

This firm in a monopolistically competitive industry is in [ short-run / long-run ] equilibrium.

The profit-maximizing level of output is \_\_\_\_\_ and it sells the output at the price of \_\_\_\_\_.

The profits this firm earn is \_\_\_\_\_.

The consumer surplus is \_\_\_\_\_.

Explain how one would find the deadweight loss, highlight the said area.

Question 4 (Externalities)

The production of fluorescent lamp involves hazardous Mercury (Hg), which is dumped into the river after the production process. Firms have marginal (private) cost of producing fluorescent lamp given by  $MPC = 30 + Q$ . For each lamp produced, the mercury cleanup in the river costs \$30. The firms face the demand for fluorescent lamp given by  $P = 480 - 2Q$ , which is marginal private benefit. There are no externalities from consuming the lamps.

1. Is the externality negative or positive on production or consumption? Give the equations for marginal social cost and marginal social benefit.
2. Without consideration of societal consequence, what is the market equilibrium quantity that firms produce? At what price?
3. If firms think about the societal consequence, what is the socially optimal quantity that firms produce? At what price?
4. Observing the devastating result from firms neglecting the social cost, the government wishes to step in and imposes the regulation so that firms produce at the socially optimal quantity. Design a regulation to dis-incentivize producers from the market outcome.
5. From the regulation designed in 4., which is a taxation, who bears the burden of this taxation? Calculate the tax burden on each party. Which side of the market is relatively more elastic?

Question 5 (Externalities)

You are hosting a post-game party at Camp Randall. The marginal cost to you in hosting the party is given by  $MPC = 20 + Q$ . The marginal private benefit of partying is  $MPB = 100 - Q$ . The party makes everyone happy, so the positive externality caused by the party is given by 20.

1. Write down the marginal social cost and marginal social benefit.
2. Is the party under-supplied or over-supplied compared to socially optimal outcome?
3. Find both market outcome by market arrangements and socially optimal outcome, compare the answers.
4. How can the government incentivize you to achieve the socially optimal outcome?

(Q1) 1) c.

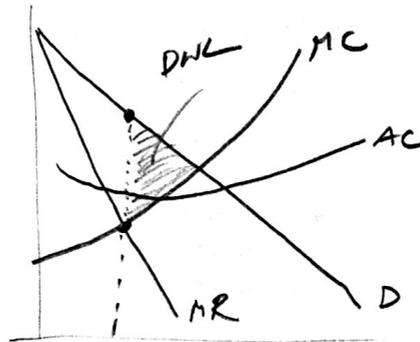
2) decreases / get flatter; more elastic

3) Demand for a restaurant increases  $\Rightarrow$  Profits becomes positive  $\Rightarrow$  Attracts new entry  $\Rightarrow$  Demand for this restaurant decreases  $\Rightarrow$  zero profits again

(Q2) 1) short-run; profits of  $(25-15) \times 4000 = \$40000$ ; output is 4000 units; price of \$25.

Entry; \$0; producing less; sell at lower price; the decrease in demand for products by this firm.

Deadweight loss area:

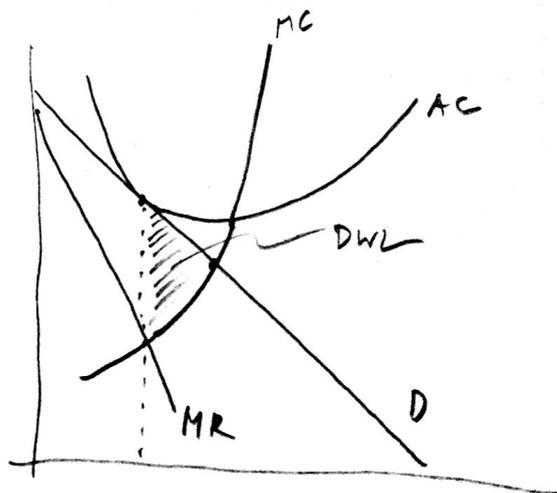


2) short-run equilibrium (making loss right now); exit.

(Q3) long-run; output = 4 units; price = \$12; profits = \$0;

$$\text{Consumer surplus} = \frac{1}{2} \times (\$16 - \$12) \times 4 = \$8$$

Deadweight loss



(Q4) 1) Negative externalities on production

$$MSB = 480 - 2Q$$

$$MSC = 30 + 60 + Q = 90 + Q.$$

2) Market outcomes:

$$MPC = MPB$$

$$30 + Q = 480 - 2Q \Rightarrow 3Q = 450, \quad Q^{\text{MKT}} = 150$$

$$P^{\text{MKT}} = 480 - 2(150) = 180.$$

3) Socially optimal:

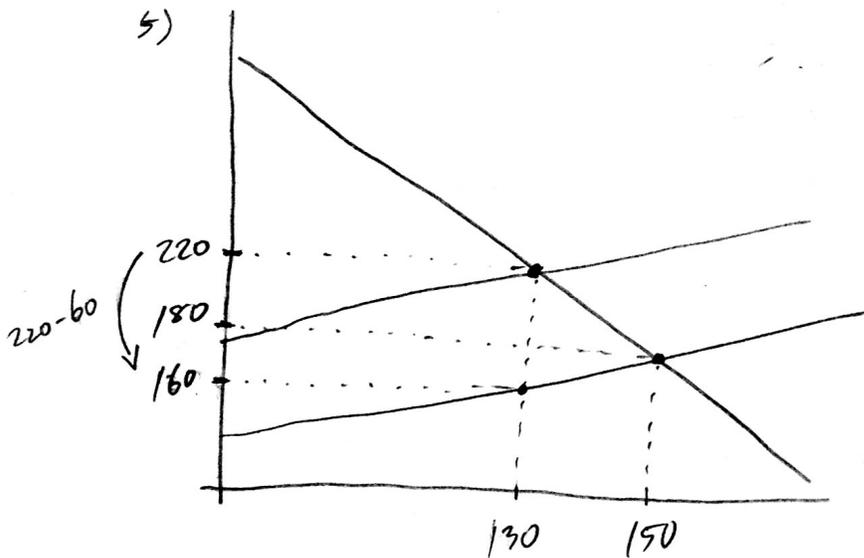
$$MSC = MSB$$

$$90 + Q = 480 - 2Q \Rightarrow 3Q = 390, \quad Q^{\text{SO}} = 130$$

$$P^{\text{SO}} = 480 - 2(130) = 220.$$

4) Government imposes taxes of \$60/unit.

5)



Consumer's Burden:

$$\begin{array}{|c|} \hline 220 \\ \hline \text{---} \\ \hline 180 \\ \hline \end{array} \quad \begin{array}{|c|} \hline 130 \\ \hline \end{array} = 40 \times 130 = 5200$$

Producer's Burden

$$\begin{array}{|c|} \hline 180 \\ \hline \text{---} \\ \hline 160 \\ \hline \end{array} \quad \begin{array}{|c|} \hline 130 \\ \hline \end{array} = 20 \times 130 = 2600.$$

$$\text{Government Revenue} = 60 \times 130 = 7800.$$

⊗ Consumer is relatively Less elastic (steeper demand)

→ Consumer bears more burden of the tax!

(Q5) 1)  $MSC = 20 + Q$   
 $MSB = 100 + 20 - Q$

2) Party is under-supplied.

3) Market outcome:  $MPC = MPB$

$$20 + Q = 100 - Q \Rightarrow Q^{\text{mkt.}} = 40, P^{\text{mkt.}} = 60.$$

Socially optimal:  $MSC = MSB$

$$20 + Q = 120 - Q \Rightarrow Q^{\text{so}} = 50, P^{\text{so}} = 70.$$

4) Government subsidizes each unit of party by \$ 20.

**This handout contains exercises of**

- Externalities, Taxes and Subsidies
- Public Goods

**Things you should know**

- What is the marginal private benefits/costs? What is the marginal social benefits/costs?
- How to find the equilibrium outcomes under private decisions? How to find the socially optimal outcomes?
- How to achieve the socially optimal outcomes?
- When taxes are imposed, what are the burdens borne by each side – the consumers and the producers – of the market
- What are the properties of public goods? What are excludability and rivalry?
- How does the existence of public good change the total demand? What are the differences between market outcome and socially efficient outcome for public goods? Who should contribute how much towards the public good?

**Exercises**

Question 1 (Externalities)

Demand for cigarettes in a casino is given by  $P = 400 - Q$ . The consumption of cigarettes in general causes the negative externalities of  $MDC = 2Q$ . Suppose the supply curve of cigarettes is  $P = Q$ .

1. Give the equations for marginal social cost and marginal social benefit.
2. Without consideration of societal consequence, what is the market equilibrium quantity of cigarettes consumed? At what price?
3. If consumers and producers think about the societal consequence, what is the socially optimal quantity of cigarettes consumed? At what price?
4. Observing the devastating result from firms neglecting the social cost, the government wishes to step in and imposes the regulation so that smokers consume the socially optimal quantity. Design a regulation to dis-incentivize smokers from the market outcome.
5. If the law says the non-smokers have the rights to clean air, what would the smokers do?
6. If the casino owner and the smoking law say the smokers have the rights to smoke in casinos, what would the non-smokers do?

Question 2 (Public Good)

In the town of Prince William Sound, there are only three people – Alice, Bob and Charlie. Their valuations for a public park are provided in the table above. Suppose a public park would cost \$6. The town holds a vote to determine whether or not to build the park. *If most vote yes, each person must contribute \$2 towards the park.* Otherwise, the park is not built and no money is spent. The valuation of each person to a public park is summarized in the table. Assume every citizen votes according to their own self-interest.

Citizen of Prince William Sound	Valuation to a Public Park	Vote (Yes/No)
Alice	\$4	
Bob	\$1.5	
Charlie	\$1	

1. Can you tell who will vote yes or no for a public park to be built?
2. What is the total valuation to a public park? Should the park be built?
3. Does voting result in the socially efficient outcome?
4. Repeat this question when Alice, Bob, and Charlie value a public park at \$3, \$2.5 and \$0, respectively.

Question 3 (Public Good)

Consider the problem of dorm room toilet used by two roommates: Alice and Bob. Alice has the valuation towards the cleanliness of toilet as  $P = 10 - Q$ , where  $Q$  is the cleanliness score and  $P$  is the per-unit price of cleanliness, i.e. time-value in cleaning. Bob has the valuation of  $P = 14 - Q$ . The marginal cost of cleaning the toilet is  $MC = 8$ .

1. If Alice decides to free-ride Bob in cleaning, what would be the market outcome?
2. Clearly the bathroom cleanliness is a public good, find the total demand for toilet cleanliness. What is the socially optimal cleanliness? At what price?
3. Compare the answers from 1., 2., and 3., is there the problem of under-provision of cleanliness?
4. To implement the socially optimal outcome, what should be the scheme of time-value contributed by Alice and Bob?
5. What would happen if the  $MC = 16$  and Alice decides to free-ride Bob in cleaning?

Question 4 (Tax Incidence)

Suppose there is no externalities from consumption or production of this good. The market demand is given by  $P = 120 - Q$ . The market supply is  $P = 2Q$ . The initial market equilibrium is  $P^* = 80$  and  $Q^* = 40$ . Suppose the government imposes a unit tax of \$30 to this good.

1. Write down the new supply curve after the tax is imposed. Sketch the demand, the supply curve before and after taxation.
2. Find the new equilibrium price and quantity. What is the price that producers receive? What is the price that consumers pay?
3. Calculate the deadweight loss, the incidence borne by consumers, and the incidence borne by producers. Who bears the higher incidence and why?

# HANDOUT 19

(Q1) 1)  $MSC = Q + 2Q = 3Q$ ,  $MSB = 400 - Q$

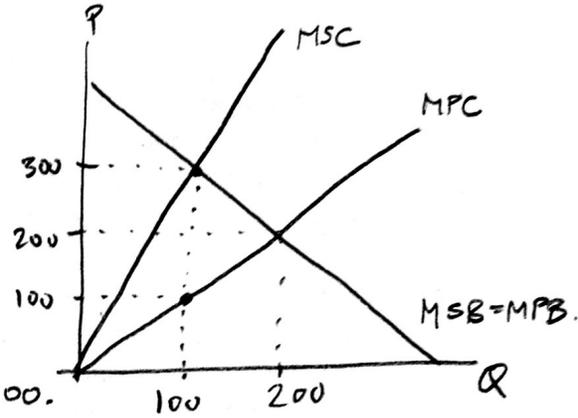
2)  $MPC = MPB \Rightarrow Q = 400 - Q \Rightarrow Q_{mkt} = 200$ ,  $P_{mkt} = 200$ .

3)  $MSC = MSB \Rightarrow 3Q = 400 - Q \Rightarrow Q_{so} = 100$ ,  $P_{so} = 300$ .

4) Tax of  $MDC = 2Q = 2 \times 100 = 200$ .

5) Smokers must bribe \$200 to non-smokers for the ability to smoke  $Q = 100$ .

6) Non-smokers must bribe \$200 to smokers to reduce the quantity of cigarettes smoked to  $Q = 100$ .



(Q2) 1) Person Valuation Vote

Alice	\$4	Yes (since \$4 > \$2)
Bob	\$1.5	No (since \$1.5 < \$2)
Charlie	\$1	No (since \$1 < \$2)

2) Total valuation = \$6.5, should have been built

3) Voting does not result in the park being built!

Person	Valuation	Vote
Alice	\$3	Yes
Bob	\$2.5	Yes
Charlie	\$0	No

Total valuation = \$5.5 → park should not be built.

But voting results in the park being built.

(Q3) 1) Bob will do the cleaning according to his valuation

$$P_{\text{Bob}} = MC \Rightarrow 14 - Q = 8 \Rightarrow \underline{Q = 6.}$$

2) Vertical Summation

$$P_{\text{market}} = P_{\text{Alice}} + P_{\text{Bob}}$$

$$= 10 - Q + 14 - Q$$

$$P_{\text{Public}} = 24 - 2Q, \text{ when } 0 \leq Q \leq 10$$

$$\text{and } P_{\text{Public}} = 14 - Q \text{ when } 10 \leq Q \leq 14$$

$$\text{Find } P_{\text{Public}} = MC$$

$$24 - 2Q = 8$$

$$\underline{Q_{\text{so}} = 8}, \quad \underline{P = 24 - 2(8) = 8}$$

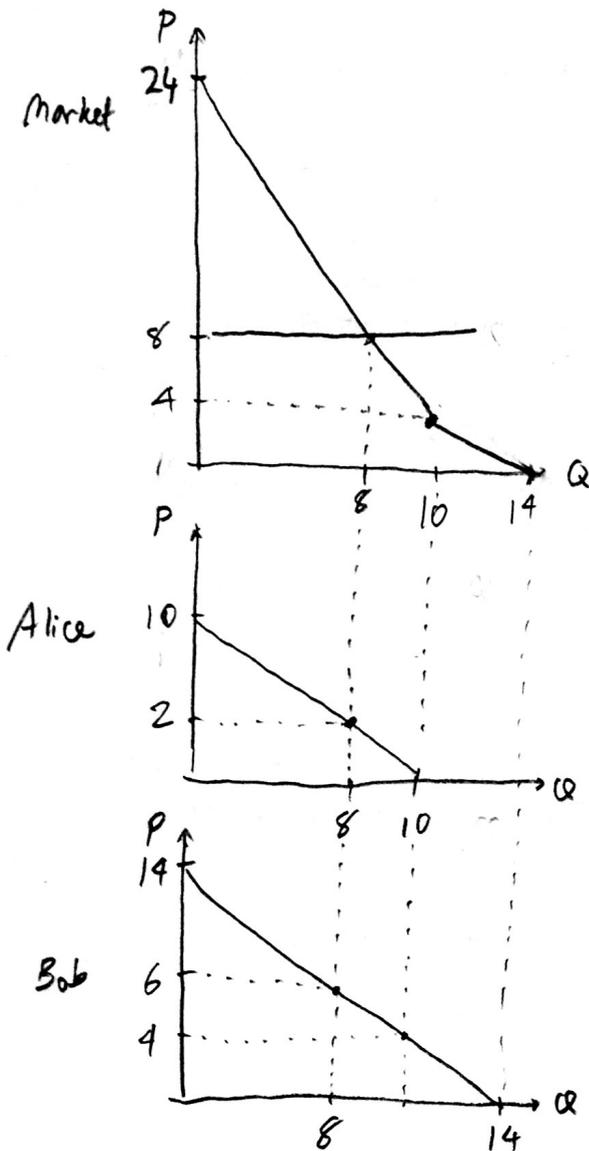
3) Public good is under-provided.

4) since the socially optimal quantity is

$$Q_{\text{so}} = 8.$$

Alice values  $Q = 8$  at  $P = 2$

Bob values  $Q = 8$  at  $P = 6$

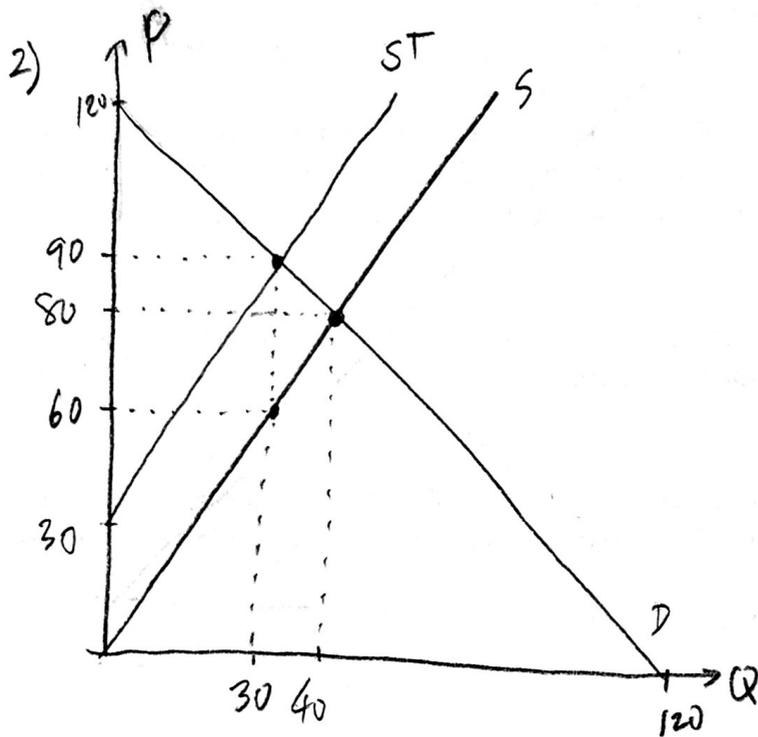


5) If  $MC = 16$  and Alice free-rides Bob

$$\text{Then } P_{\text{Bob}} = MC \Rightarrow 14 - Q = 16 \quad Q < 0 !$$

So:  $Q = 0$   $\rightarrow$  No cleaning is done!

- (Q4) 1)  $P = 120 - Q$  Demand  
 $P = 2Q$  Supply before tax  
 $P = 2Q + 30$  Supply after tax



Equilibrium with tax

$$120 - Q = 2Q + 30$$

$$Q = 30$$

$$P = 120 - 30 = 90$$

$$\text{or } P = 2Q + 30$$

$$= 2(30) + 30 = 90$$

Consumers pay \$90, Producers receive \$60

$$3) \text{ DWL} = \frac{1}{2} \times (40 - 30) \times (90 - 60) = \$150$$

$$\text{Consumers' Incidence} = (90 - 80) \times 30 = \$300$$

$$\text{Producers' Incidence} = (80 - 60) \times 30 = \$600$$

} \$900.

$$\text{Tax Revenue} = \$30 \times 30 = \$900$$

Producers are less elastic (steeper supply)

⇒ bear more tax incidence.

**Review Questions from Midterm 1 and Midterm 2**

Question 1 (PPF and Opportunity Costs)

Suppose a working day in Hotel Hell is 12 hours. In a day, Alice can cook at most 18 meals but it takes her 2 hours to clean a room, while it takes bob 1 hour to cook a meal and 4 hours to clean a room.

1. Who has the absolute advantage in cooking meals? In cleaning rooms?
2. Who has the comparative advantage in cooking meals? In cleaning rooms?
3. Sketch the PPFs of each person, putting meals (M) on the vertical axis.
4. Who should be the person to clean the first room? Sketch the PPF when both are working together.
5. Working together, is the combination of 20 meals and 3 rooms efficient, attainable, or unattainable?
6. If both have been cooking 10 meals, what is the maximum numbers of rooms that could be cleaned?

Question 2 (Demand and Supply)

1. Write down the effects towards equilibrium price and equilibrium quantity (increase/decrease/ambiguous) when:

	Supply does not change	Supply increases	Supply decreases
Demand does not change	No change	P Q	P Q
Demand increases	P Q	P Q	P Q
Demand decreases	P Q	P Q	P Q

2. Suppose the demand curve is given by  $P = 100 - Q$  and the supply curve is  $P = 20 + Q$ . Find the equilibrium price and quantity, consumer surplus, and producer surplus.

Question 3 (Price Ceiling and Price Floor)

1. Price ceiling [ above / below ] the market equilibrium price is effective. Price floor [ above / below ] the market equilibrium price is effective.
2. Suppose the demand curve is given by  $P = 100 - Q$  and the supply curve is  $P = 20 + Q$ . A price ceiling of \$40 is enforced. Find the price and quantity that is consumed/sold, consumer surplus, producer surplus, and deadweight loss.
3. Suppose the demand curve is given by  $P = 100 - Q$  and the supply curve is  $P = 20 + Q$ . A price floor of \$80 is enforced. Find the price and quantity that is consumed/sold, consumer surplus, producer surplus, and deadweight loss.

Question 4 (International Trade and Tariffs)

Assume small open economy. Suppose the demand curve is given by  $P = 100 - Q$  and the supply curve is  $P = 20 + Q$ . The world price for this good is \$40.

1. Find the price and quantity that is consumed/sold, the amount of goods exported/imported, consumer surplus, producer surplus, and deadweight loss (if any).

Comprehensive Review Questions

- Suppose a tariff of \$10 per unit is imposed on any imported goods. Find the price and quantity that is consumed/sold, the amount of goods exported/imported, consumer surplus, producer surplus, and deadweight loss (if any).

Question 5 (Elasticities)

- If the price of a good has increased from \$10 to \$20, causing the quantity demanded of this good to decrease from 100 to 80 units, find the price elasticity of demand using midpoint formula? Is this demand for this good currently elastic or inelastic?
- What do you expect the sign (positive/negative) of cross-price elasticity of demand between Coke and Pepsi? Explain this when the price of Pepsi increases. What happens to the producer surplus of Coke when the price of Pepsi increases?
- If the cross-price elasticity of demand between good A and good B is  $-0.05$ , what can we say about the relationship of the two goods?
- If income elasticity of demand for good X is  $-2$ , what can we say about this good?
- At what price does the monopolist facing a demand curve of  $P = 100 - 2.718281828459045Q$  maximize his revenue? What is the price elasticity of demand at that price?

Question 6 (Consumer Theory)

- What happens to the budget line when prices of both goods and income all triple?
- Suppose good X and good Y are indivisible, that is, must be consumed in exact units.

Quantity (Units)	Good X			Good Y		
	Total Utility	Marginal Utility		Total Utility	Marginal Utility	
0	0	-		0	-	
1	50			40		
2	80			60		
3	100			70		
4	110			75		

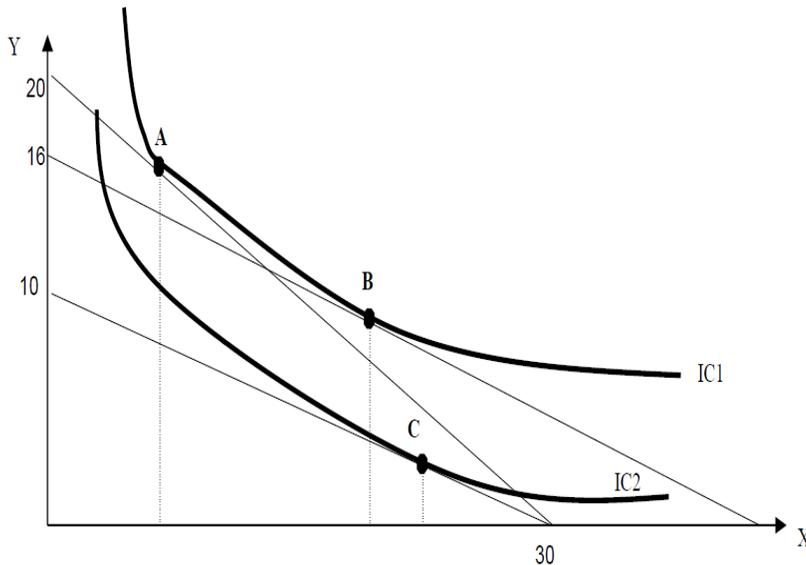
- Fill in the marginal utilities in the table above.  
Suppose the price of good X is \$5, the price of good Y is \$10
  - If the income is \$40, what is the optimal consumption bundle of good X and Y?
  - If the income is \$25, what is the optimal consumption bundle of good X and Y?
  - If the income is \$30, what is the optimal consumption bundle of good X and Y?
- If price of good X is \$10, and price of good Y is \$20
    - What is the marginal rate of substitution of the optimal consumption bundle?
    - If currently the marginal rate of substitution ( $MU_X/MU_Y$ ) is 4, then one is consuming [ too much / too few ] of good X and [ too much / too few ] of good Y.
    - If currently the marginal rate of substitution ( $MU_X/MU_Y$ ) is 0.5, then one is consuming [ too much / too few ] of good X and [ too much / too few ] of good Y.
  - The marginal rate of substitution is given by  $MRS = MU_X/MU_Y = 3Y/X$ . If prices of good X and good Y are \$10 and \$5, respectively, and you have the income of \$120, what is your optimal consumption bundle? Draw the solution in the budget line and indifference curve.

Question 7 (Consumer Theory)

- Let there be two goods – X and Y. If good X is normal, an increase in the price of good X will result in the [ increase / decrease ] of quantity demanded of good X due to substitution effect and the [ increase / decrease ] of quantity demanded of good X due to income effect.

Comprehensive Review Questions

2. If good X is inferior, a decrease in the price of good X will result in the [ increase / decrease ] of quantity demanded of good X due to substitution effect and the [ increase / decrease ] of quantity demanded of good X due to income effect. Comment on the strengths of both effects.
3. If good X is Giffen, an increase in the price of good X will result in the [ increase / decrease ] of quantity demanded of good X due to substitution effect and the [ increase / decrease ] of quantity demanded of good X due to income effect. Comment on the strengths of both effects.
4. If the income elasticity of demand for good X is positive, then good X is [ normal / inferior / Giffen ]. Therefore, the Engel curve is [ upward / downward ] sloping.
5. The diagram above exhibits [ an increase / a decrease ] in the price of [ good X / good Y ].



The price effect is exhibited by the movement from point \_\_\_\_\_ to point \_\_\_\_\_.  
 The substitution effect is exhibited by the movement from point \_\_\_\_\_ to point \_\_\_\_\_.  
 The income effect is exhibited by the movement from point \_\_\_\_\_ to point \_\_\_\_\_.  
 When price of good Y increases, the substitution effect causes the [ increase / decrease ] in the consumption of good Y, and the consumption of good X [ increases / decreases ]. The income effect causes the [ increase / decrease ] in the consumption of good Y, and the consumption of good X to [ increase / decrease ]. Therefore, good Y is [ a normal / an inferior ] good and good X is [ a normal / an inferior ] good.

Question 8 (Producer Theory)

1. Consider the following information table regarding costs of production.

Quantity	Fixed Cost (\$)	Variable Cost (\$)
0	12	0
1		24
2		32
3		48
4		68
5		108
6		168

- a. If the market price is \$40, this firm should produce \_\_\_\_\_ units to maximize its profits, which is \_\_\_\_\_.

## Comprehensive Review Questions

- b. If the market price is \$20, this firm should produce \_\_\_\_\_ units to maximize its profits, which is \_\_\_\_\_.
  - c. If the market price is \$16, this firm should produce \_\_\_\_\_ units to maximize its profits, which is \_\_\_\_\_.
  - d. If the market price is \$8, this firm should produce \_\_\_\_\_ units to maximize its profits, which is \_\_\_\_\_.
2. Suppose a firm uses ten variable inputs. As this firm increases the quantity produced using twice as much of all variable inputs, the average total cost increases. Given this information, this firm is experiencing [ increasing marginal returns / diminishing marginal returns / increasing returns to scale / decreasing returns to scale ].

Problem 9 (Producer Theory – Perfectly Competitive Market)

1. Suppose the market for bicycle is perfectly competitive. Each identical firm has cost functions in producing  $q$  bicycles described by the following equations

$$\text{Total cost function: } TC = 5q^2 + 2q + 125$$

$$\text{Marginal cost function: } MC = 10q + 2$$

Let  $P$  and  $Q$  be the market dollar price per unit and market quantity of bicycles, the market demand function for bicycles is given by the following equation

$$\text{Market demand: } P = 82 - Q$$

There are initially 10 firms in the market.

- a. What are the equilibrium market price and equilibrium market quantity of bicycles in the short run?
  - b. What are the equilibrium market price and equilibrium market quantity of bicycles in the long run?
  - c. Since there are initially 10 firms in the market, how many firms will enter or exit from this industry in the long run?
2. Assume that all firms – incumbent and prospective entrant – have the same cost structure
- $$\text{Total cost: } TC = q^2 + 5q + 25$$
- $$\text{Marginal cost: } MC = 2q + 5$$
- $$\text{Average total cost: } ATC = q + 5 + 25/q$$
- Furthermore, the market demand is given by  $P = 105 - Q$
- a. If the current market price is \$45, what is the quantity each firm should produce to maximize its profit?
  - b. What is the size of the industry with current market price of \$45? That is, how many firms are there in the short-run?
  - c. Given the current market price of \$45 in the short-run, the profit of each firm is positive. What do you expect to happen in the long-run?
  - d. What is the breakeven price of each firm?
  - e. If there are new firms entering the industry in the long-run, what is the quantity produced by all firms in the market?
  - f. How many firms are there in the industry in the long-run and how many units each firm is producing?
  - g. Given the number of firms in the long-run found in above sub-question, what is the industry supply curve?
3. Due to environmental law infraction, a fixed amount of penalty will result in [ lower / the same ] profit-maximizing quantity of output, while a penalty dependent on the quantity produced will result in [ lower / the same ] profit-maximizing quantity of output.

## Business Learning Center - Econ 101 (Hansen)

Review Sheet (also known as “The Giant Flash Card”) for Topics Covered in Final Exam<sup>1</sup>

The following topics have been covered in lectures and discussion sections after Midterm 2 and will be asked in Final Exam. The final exam is cumulative, so all the material from the beginning is covered! **If you can’t remember what we have done so far, a good starting point is the review sheet I made for Midterm 1 and Midterm 2.** (They are still on my website!) You are expected to know all these topics and be able to solve the problems with accuracy and speed.

There will be 50 questions in 120 minutes, so you should average out 2 minutes 24 seconds per question. Even if some questions might take you less than 30 seconds, others might take as long as 5 minutes, spare your time accordingly. *Rule of thumb: if the additional (marginal) benefit is greater than additional (marginal) cost, do it! Otherwise, don’t! (In fact, this is the main idea of every economic concepts!) You are maximizing the probability of getting the questions right, subject to the time constraint – if the additional time cost needed to get them right is higher the additional benefit, then you should do other questions!*

Topics studied so far are inter-related, you should expect something to cross-over with each other, e.g. production and cost will show up in perfect competition or monopoly problem, price discrimination and topics in efficiency, etc.

### Market Structures Comparison

	Perfect Competition	Monopolistic Competition	Oligopoly	Monopoly
Number of Firms	Many	Many or Few	Few (2, 3 or more)	One
Product	Homogeneous	Slightly Different	Different or Same	Unique
Demand Curve Facing	Perfectly Elastic	Market for Your Good	??	Market
Profit Max. Rule	$P = MR = MC$	$MR = MC$	Game Theory	$MR = MC$
Pricing Power of Firm	Price Taker	To a certain degree		Price Setter
Barrier to Entry	None	Slightly/None	Maybe	Yes (What?)
Production Technology	Same	Same or Different	Same or Different	Exclusive
Short-run Equilibrium	Pos. or Neg. Profit	Pos. or Neg. Profit	Not applicable	Pos. or Neg. Profit
Long-run	Zero Profit	Zero Profit		Pos. or Zero Profit
Example	...	...	...	...

### Monopoly

- What is the demand curve facing the firm? Why is it different from the case firms in perfectly competitive market? What is marginal revenue? How to find marginal revenue?
- What is the profit maximizing rule for a monopolist? What does it mean? At such quantity, what is the cost to monopolist? What is the price charged to consumers? What is the total revenue? What is the profit? Should monopolist produce in the short-run or shutdown? Should monopolist exit in the long-run? Why? (Be sure you don’t get tangled in the spaghetti of curves!)
- Why does monopolist not exist in the inelastic portion of demand curve?
- What is the consumer surplus? What is producer surplus? (This is clearly different from the profit! How and why?) What is the deadweight loss?
- Why are there deadweight losses? (Monopolist, in the effort to maximize profit, do what?) What is allocative efficiency? Why there is none of the efficiency? How to restore efficiencies? What is the social optimum? How to achieve such social optimum? Is it possible to sustain social optimum?

<sup>1</sup>Prepared by Kanit Kuevibulvanich. (<http://www.kanitk.com>) This version: December 4, 2015. Disclaimer: Although summarized from textbook, homework and lectures, this note does not constitute as the official guidelines for the course, comments welcomed.

## Natural Monopoly

- Again, answer the same questions as the usual monopolist for the natural monopolist. What is natural monopoly? Why there is such characteristic? Why do there exist such monopolist? Why going bigger in scale is better and not going smaller? Is it beneficial to have smaller firms in this kind of industry? How do the cost curves look like?

## Price Discrimination

- What is price discrimination? What are the requirements (initial conditions/rules) for a firm (in what market?) to price discriminate? How does the monopolist discriminate prices?
- First-degree price discrimination: How does a monopolist charge each consumer? How many demand curves are there? What is the rule of charging prices and how many prices are there? At what price and sell at what quantity? What are the consumer surplus, producer surplus and deadweight loss? Do we have allocative efficiency?
- Third-degree price discrimination: What gives rise to the rationale of doing third-degree instead of first-degree?
  - If a monopolist cannot distinguish between groups of consumers (How many groups?), how would the monopolist charge the consumers and sell at what quantity? How many prices are there? How to find the market demand curve (recall before Midterm 1) and the market marginal revenue? Should the monopolist ignore any type at all and what is the criteria?
  - If a monopolist can distinguish between groups of consumers, how does a monopolist charge each consumer? How many demand curves are there? Why elasticities have anything to do with? What price must the monopolists never drop below? What is the rule of charging prices and how many prices are there? At what price and sell at what quantity? What are the consumer surplus, producer surplus and deadweight loss? Do we have allocative efficiency? Why does deadweight loss look like so?

## Oligopoly (Collusion Model/Price Leadership Model/Cournot Model)

- What is oligopoly? What are the characteristics of firms in oligopoly? How is game theory applied to the interactions of firms in the oligopoly settings?
- What is a collusion? What is a tacit collusion? What is a cartel? What are firms acting like when they collude? What is the starting point where we are dividing the profits pie? How would each of the firms under collusion produce? Are there incentives to cheat?
- What is a price leadership model? How many firms are there in the model and who are they? How is this game played? From the market demand and the supply curve of small firms, can you find the residual demand (demand for dominant firms)? What is the demand each firm is facing? What is the relationship between the three? ( $Q_{Market} = Q_{Dominant} + Q_{Small}$ ) What is the marginal revenue for the dominant firms? How does the dominant firm act like in the leading phase given its marginal cost? What is the price and quantity that the leader sells? What is the price that the followers take? What is the marginal revenue for the follower firms? What is the decision of the small firms? How to find the quantity the followers produce? How to verify your answers? What is the final price being sold in the market and the quantity? Can you work backward and trace out the marginal cost of the dominant firms or the market demand when the information is missing?
- What is a Cournot model? How many firms are there in the model and who are they? How is this game played? Given the market demand and the marginal costs of each firm, how do you find the quantity a firm produces given what the rival does? When the rival does not produce anything, what do you become and what do you produce? When do you not produce anything (no room for you) if the rival produce which quantity? How do you find the reaction functions (the best response functions) of each firm? How to find the Cournot equilibrium? What quantity each firm produces? What is the profits

to each firm? Why is the intersection of both reaction functions the equilibrium in Cournot model? If he produces this much, I will respond by producing that much, so he sees me producing this much and respond by producing that much, etc.

## Game Theory

- What is a game? A game (in Econ 101) consists of PAP “Players-Actions-Payoffs.” How to write a payoff table with all the elements of PAP?
- What is a dominant strategy? Action A is a dominant strategy if “No matter what my opponent does, I’m always better off doing action A.” Can you find the outcome of the game? What is the equilibrium of a game under dominant strategy? Recall the PAP – Players do what Actions and receive what Payoffs. Are there always equilibrium under dominant strategy?
- What is a Nash strategy? Action A is a Nash strategy if “Given what my opponent does, Action A is my best response.” Can you find the outcome of the game? What is the Nash equilibrium of a game? Are there always Nash equilibrium, or are they unique?
- What is a Collusion equilibrium? How to find the best possible outcomes/size of pie to share among the two players? Is it sustainable? Are there incentives to cheat?
- What is a Maxmin strategy? Action A is a Maxmin strategy if “Given the worst possible outcomes from each of the actions, Action A gives the best payoff given all the worst possible that could happen to me.” Can you find the outcome of the game? What is the equilibrium of a game under Maxmin strategy? Are there always equilibrium under Maxmin strategy, or are they unique?
- Can you find the possible values of payoffs that makes an action the dominant, Nash, or Maxmin strategy?

## Monopolistic Competition

- What are the characteristics of monopolistic competition market? What are the characteristics of products in this market? Can firm enter or exit, when and why? What is the profit-maximizing quantity and price? How to differentiate products? What is the optimal sales effort, i.e. advertising?
- The basic problem – In the short-run, it is essentially a monopolist problem with positive economic profit. So what is the economic incentives to make entry occur? So in the long-run what happen? Is it actually the demand side or producer side who make the changes? Is it converging to the perfect competition or zero economic profit and how? Be careful with how you draw the demand curve in the long-run and clearly  $P \neq \min ATC$  necessarily!

## Externalities

- What we have studied so far consider only private side of costs and benefits, what is the consequences of such thoughts? What is externality? What is positive externality? What is negative externality?
- What is the difference between Marginal Private Benefits and Marginal Social Benefits? What is the difference between Marginal Private Costs and Marginal Social Costs?
- What is Coase Theorem? What is property rights? How would this solve the problem in the case of externalities?
- Without the consideration of externality, what would happen in the optimal quantity? Are there any underproduction or overproduction? Why?
- How to find Marginal Social Benefits and Marginal Social Costs? What is the socially optimal quantity? Is it solving the problem of underproduction or overproduction? What should be the socially optimal price of a good?

- As government, how to intervene? What kind of tax or subsidy should incentivize the firms or consumers? Which side should the tax or subsidy be applied?
- When the tax is applied, how to calculate the new price, new quantity, price of goods traded to consumer's hand, price that producer receives, government cost/revenue, deadweight loss? What is the consumer's burden and producer's burden of taxation?

## Public Goods and Common Resources

- Classification of goods, according to exclusivity and rivalry:

	Non-rivalry	Rivalry
Non-excludable (Non-exclusivity)	Public Goods	Common Resources
Excludable (Exclusivity)	Club Goods	Private Goods

- What are the differences between excludable and non-excludable? What are the differences between rivalry and non-rivalry? In each of the characteristics, what are examples? Why there are such phenomena in each case?
- What is property rights? How would this solve the problem in the case of common resources?
- Public good
  - Why does public good admit vertical summation? What is the meaning of vertical summation? Does one unit or that unit of a public good have the value to only one person or more than one person? How to find the market demand/total demand for public good? (Recall what does the demand curve represent? Recall that the commodities we have studied so far are private goods, when we find the market demand for the private good, we do horizontal summation. What does it mean? Does one unit of that good has any value to other person? How have we done that?)
  - If there is a free-riding, what is the output being produced? (When  $P = MC$ , but what demand curve? Why? When there is a free-riding, only who sees the value of public good?) Why there is underprovision of public goods?
  - If everyone contributes and sees the value, how to find the socially optimal outcome/provision of public good? (When  $P = MC$ , but what demand curve?) Who should contribute how much per unit?

☺ *THE END — Good Luck for Your Final Exam!* ☺