

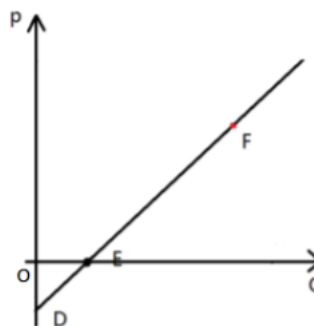
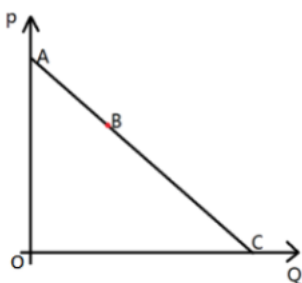
Midterm

Suggested Solutions

i. Multiple Choices (2 Points Each)

1. There are three activities you can go to tonight: A is a party whose enjoyment benefit you value at \$50. B is a concert whose ticket price is \$60 and you value it at \$100. C is a football game whose ticket price is \$100 and you value it at \$200. What is the opportunity cost of going to the concert?
 - (a) 50
 - (b) 100
 - (c) 110
 - (d) **160**
 - (e) 200
 - (f) 260
2. Which of the following events would unambiguously cause a decrease in the equilibrium price of coffee?
 - (a) An increase in the price of tea and an increase in the price of coffee machines
 - (b) An increase in the price of tea and a decrease in the price of coffee machines
 - (c) A decrease in the price of tea and a decrease in the price of coffee machines
 - (d) **A decrease in the price of tea and an increase in the price of coffee machines**
3. Which of the following might cause the demand for an inferior good to decrease?
 - (a) A decrease in income
 - (b) An increase in the price of a substitute
 - (c) **An increase in the price of a complement**
 - (d) None of the above

4. Milk is one of the ingredients of ice cream. All else being the same, when the price of the milk increases, the total expenditure on ice cream increases. The price elasticity of demand for ice cream is
- (a) Larger than 1
 - (b) 1
 - (c) **Smaller than 1**
5. The elasticity of point B and point F equal:



- (a) AB/BC , DE/FD
 - (b) AB/BC , FD/EF
 - (c) **BC/AB , EF/DF**
 - (d) BC/AB , DE/EF
6. Suppose the shoe market is perfectly competitive. Last year, shoe manufacturers sold 10 million pair of shoes at a price of \$100 per pair. This year, due to an increase in demand, the market price increased to \$120 per pair. We are now at the end of this year. Suppose the demand for shoes is highly inelastic, which of the following statements is most likely to be true?
- (a) Shoe manufacturers sold 8 million pair of shoes this year and their total revenue has increased.
 - (b) Shoe manufacturers sold 8 million pair of shoes this year and their total revenue has decreased.
 - (c) **Shoe manufacturers sold 12 million pair of shoes this year and their total revenue has increased.**
 - (d) Shoe manufacturers sold 12 million pair of shoes this year and their total revenue has decreased.

7. When the price of a pair of Levy jeans is \$50, the quantity demanded is 500. When the price of Levy jeans is \$70, the quantity demanded is 400 units. Based on this information, the arc price elasticity of demand for Levy jeans is
- (a) 1.50
 - (b) 1.33
 - (c) 0.67
 - (d) **Cannot be determined**
8. When the government imposes a tax on a good with no externalities, which of the following statement is not true:
- (a) The initial tax incidence falls entirely on the sellers when supply is perfect inelastic.
 - (b) The initial tax incidence falls entirely on the sellers when demand is perfectly elastic.
 - (c) There is no deadweight loss if supply is perfectly inelastic.
 - (d) **By the Ramsey principle, government should tax the sellers if supply is more inelastic than demand.**
9. Kate is a personal trainer whose client William pays \$80 per hour-long session. William values this service at \$100 per hour, while the opportunity cost of Kate's time is \$75 per hour. The government places a tax of \$10 per hour on personal trainers. After the tax, what is likely to happen in the market for personal training?
- (a) **Kate and William will agree to a new price somewhere between \$85 and \$100.**
 - (b) Kate and William will agree to a new price somewhere between \$70 and \$110.
 - (c) Kate will no longer offer personal training services to William because she must charge more than \$100 in order to cover her opportunity costs and pay the tax.
 - (d) The price will remain at \$80, and Kate will pay the \$10 tax.
10. Who shares the burden of a higher gas tax?
- (a) Tire manufacturers
 - (b) Car owners who no longer drive
 - (c) Tesla buyers
 - (d) **All of the above**

11. Assume the price of gasoline is \$2.00 per gallon, and the equilibrium quantity of gasoline is 10 million gallons per day with no tax on gasoline. Starting from this initial situation, which of the following scenarios would result in the largest deadweight loss?
- (a) The price elasticity of demand for gasoline is 0.1; the price elasticity of supply for gasoline is 0.6; and the gasoline tax amounts to \$0.20 per gallon.
 - (b) The price elasticity of demand for gasoline is 0.1; the price elasticity of supply for gasoline is 0.4; and the gasoline tax amounts to \$0.20 per gallon.
 - (c) **The price elasticity of demand for gasoline is 0.2; the price elasticity of supply for gasoline is 0.6; and the gasoline tax amounts to \$0.30 per gallon.**
 - (d) There is insufficient information to make this determination.
12. Suppose that the market for large, 64-ounce soft drinks in the town of Pudgyville is characterized by a typical, downward-sloping, linear demand curve and a typical, upward-sloping, linear supply curve. The market is initially in equilibrium with 1,000 soft drinks sold per day. The newly-elected Mayor of Pudgyville wants to tax 64-ounce soft drinks. She is considering either a \$0.10 tax or a \$0.30 tax. Her chief economic advisor estimates that the number of soft drinks sold after a \$0.10 tax will be 900 and after a \$0.30 tax will be 500. Which tax is better?
- (a) The \$0.10 tax is better because it raises more revenue and creates a lower deadweight loss than the \$0.30 tax.
 - (b) The \$0.30 tax is better because it raises more revenue and creates a lower deadweight loss than the \$0.10 tax.
 - (c) **It is not clear which tax is better because although the \$0.30 tax raises more tax revenues, it creates a larger deadweight loss than the \$0.10 tax.**
 - (d) It is not clear which tax is better because although the \$0.10 tax raises more tax revenues, it creates a larger deadweight loss than the \$0.30 tax.
13. Who benefits from government financial aid for college students?
- (a) College professors
 - (b) High-tech companies
 - (c) Textbook publishers
 - (d) **All of the above**

14. Which of the following statements is not true?
- (a) **The U.S. has the highest effective corporate tax rates among OECD countries.**
 - (b) High-tech companies in the U.S. tend to pay the lowest effective corporate tax rates.
 - (c) Transfer-pricing of intellectual property is a key component of the Double Irish Dutch Sandwich strategy.
 - (d) Profits made by foreign subsidiaries of U.S. corporations are not taxed until they are repatriated to the U.S. in the form of dividends.
15. Which of the following is not an example of externality?
- (a) Lung cancer caused by second-hand exposure to cigarette smoke
 - (b) Pollution from a factory on the health of people in the vicinity of the factory.
 - (c) **Increase in health care costs on the health of individuals in society.**
 - (d) Traffic accidents caused by alcohol consumption
16. Which of the following is not one of the reasons that a pollution tax on greenhouse gases (GHG) could be preferable to a cap-and-trade program?
- (a) For GHGs, the marginal benefit of abatement curve is essentially flat.
 - (b) There are large fluctuations in the demand for GHG emissions due to changes in economic conditions.
 - (c) **Pollution taxes have more political appeal than cap-and-trade programs.**
 - (d) None of the above.

17. Two firms, A and B, each currently dump 20 tons of chemicals into the local river. The government has decided to reduce the pollution and from now on will require a pollution permit for each ton of pollution dumped into the river. The government gives each firm 10 pollution permits, which it can either use or sell to the other firm. It costs Firm A \$100 for each ton of pollution that it eliminates before it reaches the river, and it costs Firm B \$50 for each ton of pollution that it eliminates before it reaches the river. After the two firms buy or sell pollution permits from each other, we would expect that
- (a) Firm A will no longer pollute, and Firm B will not reduce its pollution at all.
 - (b) **Firm B will no longer pollute, and Firm A will not reduce its pollution at all.**
 - (c) Firm A will dump 10 tons of pollution into the river, and Firm B will dump 10 tons of pollution into the river.
 - (d) Firm A will increase its pollution and Firm B will reduce its pollution.
18. Information tends to be non-excludable because it can be spread easily, and non-rival in consumption because one person's "consumption" of information does not directly diminish another person's "consumption" of information. Hence, information tends to be a
- (a) Private good
 - (b) **Public good**
 - (c) Club good
 - (d) Common resource
19. The tragedy of the commons is
- (a) A problem due to common resources being over-consumed
 - (b) A problem due to negative externality
 - (c) A song
 - (d) **All of the above**

20. Suppose that Company A's railroad cars pass through Farmer B's corn fields. The railroad causes an externality to the farmer because the railroad cars emit sparks that cause \$1,500 in damage to the farmer's crops. There is a special soy-based grease that the railroad could purchase that would eliminate the damaging sparks. The grease costs \$1,200. Suppose that the railroad is not liable for any damage caused to the crops. Assume that there are no transaction costs. Which of the following characterizes the efficient outcome?
- (a) The railroad will continue to operate but will pay the farmer \$1,500 in damages.
 - (b) The railroad will purchase the grease for \$1,200 and pay the farmer nothing because no crop damage will occur.
 - (c) The farmer will incur \$1,500 in damages to his crops.
 - (d) **The farmer will pay the railroad \$1,200 to purchase the grease so that no crop damage will occur.**

ii. Questions (50 Points)

Problem 1 (4 Points)

Suppose that there are 10000 consumers in a market of good X who want to buy it. The demand curve of each person follows the equation: $Q_D = 12 - 2P$. At the same time, there are 1000 suppliers who produce X, and the supply curve of each supplier follows the equation: $Q_S = 20P$. If all the consumers' income increased and cause an increase in demand of each person by 2 at each price, what will be the equilibrium price and equilibrium quantity?

Solution: Aggregate demand: $Q_D = 140000 - 20000P$; Aggregate supply: $Q_S = 20000P$
 \Rightarrow

$$\begin{aligned} P^* &= 3.5 \\ Q^* &= 70000 \end{aligned}$$

Problem 2 (10 Points)

When the government impose a tax on a good,

1. the price received by producers generally _____,
 - (a) does not change
 - (b) increases
 - (c) **decreases**
2. the price paid by buyers generally _____.
 - (a) does not change
 - (b) **increases**
 - (c) decreases
3. However, under the case(s) of _____, the price received by producers does not change. (check whatever applies)
 - (a) demand is perfectly elastic
 - (b) **demand is perfectly inelastic**
 - (c) **supply is perfectly elastic**
 - (d) supply is perfectly inelastic
4. Under the case(s) of _____, the price paid by buyers does not change. (check whatever applies)
 - (a) **demand is perfectly elastic**
 - (b) demand is perfectly inelastic
 - (c) supply is perfectly elastic
 - (d) **supply is perfectly inelastic**
5. The increase in price paid by buyers, is generally smaller than the tax except _____ (check whatever applies)
 - (a) demand is perfectly elastic
 - (b) **demand is perfectly inelastic**
 - (c) **supply is perfectly elastic**
 - (d) supply is perfectly inelastic

Problem 3 (4 Points)

If the total revenues at 2 points on a linear demand curve are equal, let ϵ_1 and ϵ_2 be the price elasticity of demand at these two points. Prove that $\epsilon_1\epsilon_2 = 1$.

Solution: Let the linear demand curve be $Q = a - kP$, then at point 1 and 2, we have

$$\begin{aligned} P_1Q_1 &= P_2Q_2 \\ \Rightarrow \frac{1}{k}(a - Q_1)Q_1 &= \frac{1}{k}(a - Q_2)Q_2 \\ \Rightarrow a &= Q_1 + Q_2 \end{aligned}$$

Hence,

$$\begin{aligned} \epsilon_1\epsilon_2 &= \left(k\frac{P_1}{Q_1}\right) \times \left(k\frac{P_2}{Q_2}\right) \\ &= \frac{a - Q_1}{Q_1} \times \frac{a - Q_2}{Q_2} = 1 \end{aligned}$$

Problem 4 (4 Points)

There are 2 points on a linear demand curve. The price elasticity of demand is equal to 2 at the first point and 5 at the second point. Let Q_1 and Q_2 be the quantity demanded at these two points. Calculate $\frac{Q_1}{Q_2}$.

Solution: Let the linear demand curve be $Q = a - kP$, then

$$\begin{aligned} \epsilon_1 &= 2 \\ \Rightarrow k\frac{P_1}{Q_1} &= 2 \\ \Rightarrow \frac{a - Q_1}{Q_1} &= 2 \\ \Rightarrow a &= 3Q_1 \end{aligned}$$

Similarly, $\epsilon_2 = 5 \Rightarrow a = 5Q_2$. Hence, $\frac{Q_1}{Q_2} = 2$.

Problem 5 (4 Points)

Maria has decided always to spend one-third of her income on clothing.

1. Calculate her income elasticity of clothing demand. (2 Points)

Solution: $Q = \frac{I}{3p} \Rightarrow$

$$\epsilon_{i,d} = \frac{dQ}{dI} \frac{I}{Q} = \frac{1}{3p} \times 3p = 1$$

2. Calculate her price elasticity of clothing demand. (2 Points)

Solution: $Q = \frac{I}{3p} \Rightarrow$

$$\epsilon_{p,d} = \left| \frac{dQ}{dp} \right| \frac{p}{Q} = \frac{I}{3p^2} \times \frac{3p^2}{I} = 1$$

Problem 6 (6 Points)

The following table shows the private value, private cost, and external cost for various quantities of output in a market.

Quantity	Private Value	Private Cost	External Cost
1	\$14	\$10	\$1
2	13	11	2
3	12	12	3
4	11	13	4
5	10	14	5
6	9	15	6
7	8	16	7

1. Find the equilibrium quantity of output in the market. (2 Points)

3

2. Find the socially-optimal quantity of output in the market. (2 Points)

2

3. How large would a corrective tax need to be to move this market from the equilibrium outcome to the socially-optimal outcome? (2 Points)

2

Problem 7 (4 Points)

One way to deal with price volatility under cap-and-trade is to set a price ceiling. Suppose the government sets a price ceiling equal to \bar{p} . Then when the market permit price rises above \bar{p} , the government can supply additional permits until the price falls back to \bar{p} . When market price is low, the government can buy those permits back. Explain in what sense, under this policy, the cap-and-trade program becomes a pollution tax when the market price rises above the ceiling.

Solution: When the market price hits the ceiling \bar{p} , the government will issue additional permits to keep the price at \bar{p} . In this case, all firms pay the same price \bar{p} and total pollution is not bound by the cap anymore. This becomes essentially a pollution tax equal to \bar{p} .

Problem 8 (6 Points)

The following table shows the total costs for each of four firms (A, B, C, and D) to eliminate units of pollution from their production processes. For example, for Firm A to eliminate one unit of pollution, it would cost \$46, and for Firm A to eliminate two units of pollution, it would cost a total of \$103.

Abatement cost	A	B	C	D
1 unit	46	45	42	49
2 units	103	100	98	108
3 units	180	173	169	188
4 units	282	263	258	285

1. If the government charged a fee of \$85 per unit of pollution, how many units of pollution would the firms eliminate altogether? (2 Points)

Solution: The marginal cost table:

Abatement cost	A	B	C	D
1 st unit	46	45	42	49
2 nd unit	57	55	56	59
3 rd unit	77	73	71	80
4 th unit	98	90	89	96

So a \$85/unit pollution price would induce 12 units of pollution abatement.

2. Suppose there is presently no pollution fee, and the government wishes to eliminate exactly 8 units of pollution. What are the fees per unit of pollution that would achieve that goal? (4 Points)

Solution: Any price larger than 59 and smaller than 71 will do.

Problem 9 (8 Points)

There are three industrial firms in Happy Valley. The government wants to reduce pollution to 120 units, so it gives each firm 40 tradable pollution permits.

Firm	Initial Pollution Level	Abatement Cost per Unit
A	70 Units	\$20
B	80	25
C	50	10

1. Who sells permits and how many do they sell? Who buys permits and how many do they buy? (4 Points)

C will sell 40 permits. B will buy 40 permits.

2. How much higher would the costs of pollution reduction be if the permits could not be traded? (4 Points)

Cost without trading: $30 \times 20 + 40 \times 25 + 10 \times 10 = 1700$

Cost with trading: $50 \times 10 + 30 \times 20 = 1100$

So the cost saving is 600.

iii. More Questions (10 Points)

Problem 1 (2 Points)

There is a phenomenon before every Mathematical Analysis class called seat occupying. It means that some students who arrive very early at the classroom will occupy the seats in the front of the classroom for his or her friends so that they can listen to the teacher better. Other students have no legal right to prevent this kind of behavior.

Based on this information, classroom seats in the Mathematical Analysis class are (excludable/**non-excludable**) and (**rival**/non-rival in consumption), and are a type of (private good/public good/**common resource**).

Problem 2 (2 Points)

Suppose you are a student in the Mathematical Analysis class. You value the reward of sitting in the front at ¥70, while you value the reward of sitting at back at ¥50. Now that you have four choices:

- Option 1: You would ask a friend to occupy a seat for you, so that you can sleep late and still sit in the front. You value the enjoyment of sleeping late at ¥30. In return, you need to treat your friend, which cost you ¥10.
- Option 2: You get up early yourself to get the seat in the front.
- Option 3: You sleep late without seat occupying so you have to sit at the back.
- Option 4: Just sleep and ignore the class. You value that at ¥40.

What is the opportunity cost of choosing option 2, i.e getting up early to get the seat in the front yourself?

Solution: Net benefit of option 1: $70 + 30 - 10 = 90$

Net benefit of option 3: $30 + 50 = 80$

Net benefit of option 4: 40

Hence the opportunity cost of option 2 is 90.

Problem 3 (2 Points)

Assuming that you picked up 20 dollars in the street, and you are going to use the money to watch a football match whose ticket price is 20, then what is the opportunity cost of watching the game?

- (a) 0
- (b) The time used for watching the game
- (c) **The time used for watching the game and \$20**
- (d) The time used for watching the game, \$20 and the money used for buying lunch during the game.

Problem 4 (2 Points)

There are four people who need haircut and four barbers. The WTP of each person and the cost of each barber are shown below.

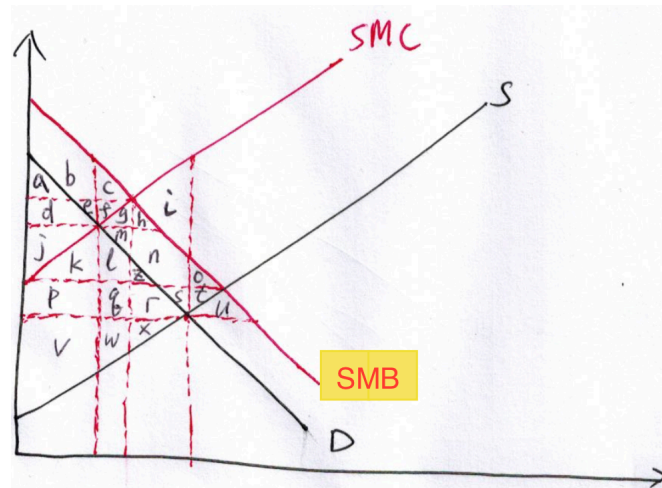
Customer	WTP	Barber	Cost
Jerry	\$7	A	\$3
Oprah	2	B	6
Ellen	8	C	4
Phil	5	D	2

Suppose each barber can provide service for at most one consumer. What is the maximum total surplus that can be achieved?

Solution: $8 + 7 + 5 - 2 - 3 - 4 = 11$. Oprah will not be served and Barber B will not cut hair for anyone.

Problem 5 (2 Points)

The following graph illustrates the market for a good that generates both positive and negative externalities¹.



SMB: social marginal benefit; SMC: social marginal cost

Find out the following:

1. Consumer surplus + Producer surplus
2. External benefit
3. External cost
4. Deadweight loss

Solution: Consumer surplus + Producer surplus: $a+d+j+k+l+p+q+r+v+w+x+z$

External benefit: $b+c+e+f+g+h+m+n+s$

External cost: $g+h+i+k+l+m+n+p+q+r+s+v+w+x+z$

Deadweight loss: i

¹For example, self-driving cars can both reduce road accidents and generate pollution and congestion.