
Midterm 2 - Solutions

You have until 1:50pm to complete this exam. Be certain to put your name, id number and section on both the exam and your scantron sheet and fill in test form A on the scantron. Answer all multiple choice questions on your scantron sheet. Choose the single best answer for each question; if you fill in multiple answers for a question you will be marked wrong. Answer the long answer questions directly on the exam. You must show your work for full credit. Answers may be left as fractions. Please place a box around final answers when appropriate. Good luck!

Name:

ID Number:

Section:

SECTION I: MULTIPLE CHOICE (60 points)

1. If the market demand curve is downward sloping and the market supply curve is upward sloping, a quantity tax placed on producers will:
 - (a) Increase the price paid by consumers by the amount of the tax.
 - (b) Increase the price received by producers by the amount of the tax.
 - (c) Increase the price paid by consumers by an amount less than the tax.
 - (d) Increase the price received by producers by an amount less than the tax.

(c) The price consumers pay will go up but not by the full amount of the tax. Some of the tax burden is shared by producers who receive a lower price than they did before the tax.
2. Suppose a firm produces chairs using an increasing returns to scale technology for which wood is the only input. Suppose it takes 10 units of wood to produce 10 chairs. It will take:
 - (a) 40 units of wood to produce 40 chairs.
 - (b) More than 40 units of wood to produce 40 chairs.
 - (c) Fewer than 40 units of wood to produce 40 chairs.
 - (d) None of the above.

(c) Since the firm has increasing returns to scale, using four times as much wood would lead to more than four times as many chairs. To firm will be able to produce 40 chairs with fewer than 40 units of wood.
3. Suppose that the demand curve for toys is linear and downward sloping. At the current price, the price elasticity of demand for toys is -2 . If toystores raise their prices by a small amount:
 - (a) The number of toys sold will increase and revenues will increase.
 - (b) The number of toys sold will decrease and revenues will increase.
 - (c) The number of toys sold will decrease and revenues will decrease.
 - (d) The number of toys sold will increase and revenues will decrease.

(c) With a downward sloping demand curve, any increase in price will lead to a decrease in the quantity sold. Because demand is currently elastic, revenues will also fall (the loss in revenue from the drop in demand will be greater than the gain in revenue from charging more for the units that are still sold).

4. When the price of apples increases, demand for bananas decreases. When the price of apples goes up, which of the following statements is definitely true?
- (a) The substitution and income effects for bananas have opposite signs.
 - (b) The substitution and income effects for bananas have the same signs.
 - (c) The magnitude of the substitution effect is larger than the magnitude of the income effect for bananas.
 - (d) The magnitudes of the substitution and income effects for bananas are equal.
- (a) We know that the substitution effect for bananas will be positive regardless of what kind of good they are. If overall demand for bananas goes down when the price of apples goes up, the income effect for bananas must be negative and larger in magnitude than the substitution effect.
5. Milk is the only input used to make butter and butter-making technology exhibits constant returns to scale. If 30 cups of milk produce 2 pounds of butter, how many pounds of butter will 45 cups of milk make?
- (a) 5 pounds.
 - (b) 4 pounds.
 - (c) 3 pounds.
 - (d) 2 pounds.
- (c) If we use 1.5 times as many inputs, we will get 1.5 times as much output which is 3 pounds of butter.
6. Assume the market demand curve is downward sloping and the market supply curve is upward sloping. As the size of a quantity tax placed on consumers increases, which of the following is definitely true? (Assume we are only considering a range of taxes for which the quantity sold will still be positive.)
- (a) Consumer surplus increases.
 - (b) Tax revenue increases.
 - (c) Producer surplus increases.
 - (d) Deadweight loss increases.
- (d) Deadweight loss increases as the size of the tax increases. Consumer surplus and producer surplus both decrease. Tax revenue will increase at first and then decrease at higher levels of taxes.
7. Suppose that the quantity of x demanded does not depend on the price of y , demand for x and demand for y are always positive, and a consumer spends all of his money on x and y . If the price of y goes up:
- (a) The substitution effect for x will be zero and the income effect for x will be negative.
 - (b) Both the substitution and income effects for x will be zero.
 - (c) The income and substitution effects for y will have opposite signs but be equal in magnitude.
 - (d) The income and substitution effects for x will have opposite signs but be equal in magnitude.

(d) If demand for x does not depend on the price of y , the net effect of a price change of y on demand for x must be zero implying that the income and substitution effects cancel each other out. If demand for x does not change, spending on x will not change. This means that the same amount of money is spent on y as before but y costs more. The consumer must buy fewer units of y implying that the income and substitution effects for y do not cancel each other out.

8. Suppose that the demand function for good x is given by $x = \frac{I}{4p_x}$. The income elasticity of demand for x is:

- (a) Constant.
- (b) Increasing as income gets larger.
- (c) Decreasing as income gets larger.
- (d) None of the above.

(a) Notice that the income elasticity is $\varepsilon = \frac{I}{x} \frac{dx}{dI} = \frac{I}{\frac{I}{4p_x}} \frac{1}{4p_x} = 1$.

9. All of the consumers in the market for bagels have downward sloping, linear demand curves. On a graph with price on the vertical axis and bagels on the horizontal axis, the market demand curve hits the vertical axis at a price of \$20, hits the horizontal axis at a quantity of 500 bagels, and has kinks at the points (\$15, 50), (\$10, 150) and (\$5, 300). Which of the following statements is definitely true?

- (a) There are four consumers in the market for bagels.
- (b) There are more than four consumers in the market for bagels.
- (c) There are four or more consumers in the market for bagels.
- (d) There may be fewer than four consumers in the market for bagels.

(c) The fewest number of consumers we could have is four since there are four different segments of the market demand curve (four changes on the extensive margin). However, there can be more than four consumers if some consumers have identical demand curves (an extra consumer with the same demand function as another consumer would not lead to an extra kink, just different slopes).

10. A firm uses screws (S) and nails (N) to produce widgets and the firm's production technology exhibits a diminishing technical rate of substitution. The firm can produce 10 widgets with either 2 screws and 10 nails or 10 screws and 2 nails. Which of the following is true? (Assume the firm can use fractions of screws and nails and produce fractions of widgets.)

- (a) If the firm uses 6 screws and 6 nails, it can produce 10 widgets.
- (b) If the firm uses 6 screws and 6 nails, it can produce more than 10 widgets.
- (c) If the firm uses 6 screws and 6 nails, it will produce less than 10 widgets.
- (d) (a) or (c) may be true.

(b) The firm has a convex production technology. Since the points (2 screws, 10 nails) and (10 screws, 2 nails) lie on the same isoquant an average of those input bundles (6 screws, 6 nails) will lie above the isoquant.

11. Demand for donuts is given by a downward sloping, linear demand curve. Supply of donuts is perfectly elastic. Before a tax on donuts, the equilibrium price of a donut was \$2 and the equilibrium quantity was 500. A quantity tax of \$1 is placed on consumers. This tax will:

- (a) Lead to a new price paid by consumers greater than \$2 but less than \$3.
- (b) Lead to a new price paid by consumers of \$3.
- (c) Leave the price paid by consumers unchanged.
- (d) Leave the quantity of donuts sold unchanged.

(b) With perfectly elastic supply, the consumer will bear the full burden of the tax. This means that the price paid by consumers will rise by the full amount of the tax, the price received by producers will stay the same, and the quantity of donuts sold will decrease.

12. As the number of workers used by a firm gets larger but the level of capital stays the same, each additional worker the firm adds increases output but by a smaller amount than the previous worker. Which of the following equations could describe the firm's production function (K represents units of capital, L represents units of labor)?

- (a) $f(K, L) = K^2L^2$.
- (b) $f(K, L) = K^2 + L^2$.
- (c) $f(K, L) = KL^{-\frac{1}{2}}$.
- (d) $f(K, L) = KL^{\frac{1}{2}}$.

(d) The functions in (a) and (b) both have an increasing marginal product of labor. The function in (c) actually has a negative marginal product of labor (more workers lead to less output). It is only the function in (d) that has a positive, diminishing marginal product of labor.

Use the following information to answer questions 13 and 14. A firm produces widgets using labor as the only input. The firm has two different technologies, A and B , available. The production functions for the two technologies are:

$$f_A(L) = L^2$$

$$f_B(L) = 10L$$

13. Suppose that the firm wants to minimize the amount of money they spend on labor. Which of the following statements is true?
- (a) The firm will always use technology A .
 - (b) The firm will always use technology B .
 - (c) When producing less than 100 widgets, the firm will use technology A . When producing more than 100 widgets, the firm will use technology B .
 - (d) When producing less than 100 widgets, the firm will use technology B . When producing more than 100 widgets, the firm will use technology A .

(d) At low levels of labor, technology A produces less than technology B . However, technology A exhibits increasing returns to scale while technology B exhibits constant returns to scale. There will be a point at which technology A starts to produce more output for a given amount of labor than technology B . We can find this point by setting the two equations equal to each other and solving for L equal to 10. At 10 units of labor, output is 100 widgets.

14. At what level of labor would the slopes of the two production functions be the same (in other words, at what level of labor would the output of an additional worker be the same under either technology)?
- (a) When L equals 0.
 - (b) When L equals 5.
 - (c) When L equals 10.
 - (d) (a) and (c).

(b) The marginal product of labor for technology A is $2L$. The marginal product of labor for technology B is simply 10. Setting these two equal to each other gives us a level of labor equal to 5.

15. Market demand for comic books is given by $D(p) = 100 - 2p$. At the current price, if a store raised the price by a small amount there would be no change in the store's revenue. What is the current quantity of comic books being sold?
- (a) 25.
 - (b) 50.
 - (c) 100.
 - (d) 150.

(b) A price change will have no effect on revenue when demand is unit elastic. To find the quantity at which demand is unit elastic, we can do the following calculation:

$$\begin{aligned}\varepsilon &= \frac{p}{q} \frac{dp}{dq} \\ -1 &= \frac{p}{100 - 2p} (-2) \\ p &= 25 \\ q &= 100 - 2 \cdot 25 = 50\end{aligned}$$

16. There are two consumers in the market for oranges. They both have identical, linear demand curves with a slope of -4 . What is the slope of the market demand curve for oranges? (Assume we are referring to demand curves plotted with price on the vertical axis and quantity on the horizontal axis).
- (a) -2 .
 - (b) -4 .
 - (c) -8 .
 - (d) -16 .

(a) For each consumer, when the price drops by $\$4$, demand increases by one unit. With the two consumers combined, demand will increase by two units when price drops by $\$4$. This gives us a slope of $-\frac{4}{2}$ or -2 for the market demand curve.

17. On a graph with capital on the vertical axis and labor on the horizontal axis, a firm's isoquants are parallel straight lines with a negative slope. Which of the following is definitely true?
- (a) Capital and labor are perfect substitutes.

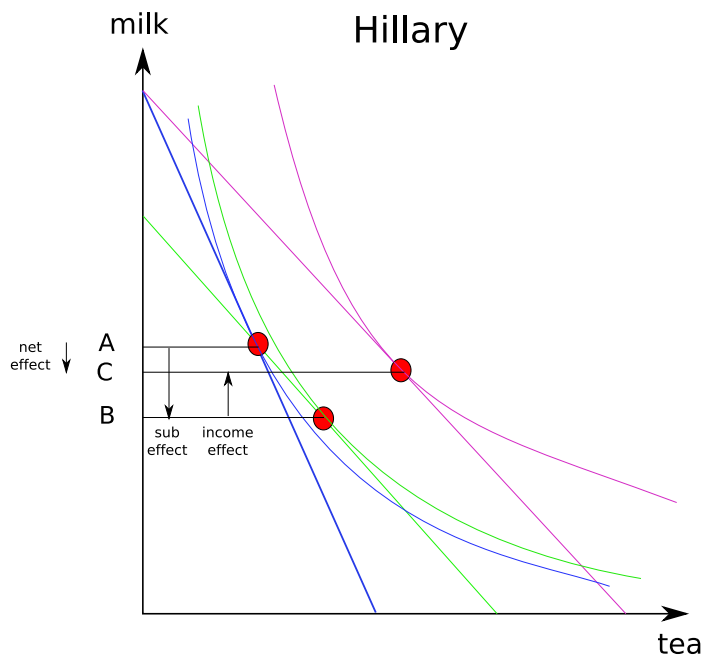
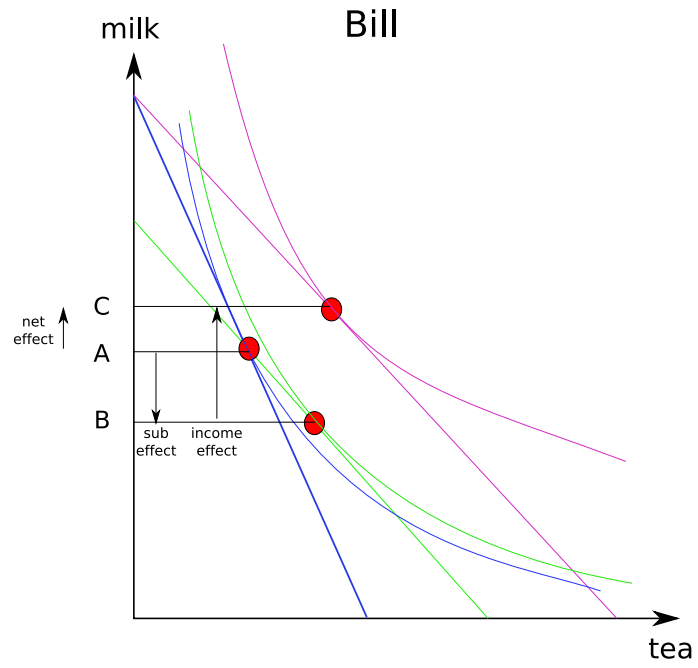
- (b) The technical rate of substitution is diminishing.
 - (c) One unit of capital produces the same amount of output as one unit of labor.
 - (d) Capital and labor must be used in fixed proportions.
- (a) The straight isoquants imply that capital can always be substituted for labor at a constant rate. It does not tell us that the rate is one for one.
18. When the demand curve is downward sloping and the supply curve is upward sloping, as a quantity tax gets larger:
- (a) Both tax revenue and deadweight loss will increase but deadweight loss will increase at a faster rate.
 - (b) Tax revenue will increase at first but then decrease while deadweight loss will continue to increase at a constant rate.
 - (c) Deadweight loss will continue to increase but at a decreasing rate.
 - (d) Deadweight loss will continue to increase and do so at an increasing rate.
- (d) Recall from Problem Set 2 that tax revenue first increases and then decreases as the tax gets larger. Deadweight loss increased with the square of the size of the tax.
19. A person consumes only candy and soda. If the income elasticity of candy is greater than one:
- (a) The income elasticity of soda must be negative.
 - (b) The income elasticity of soda must be less than one.
 - (c) The income elasticity of soda must be between zero and one.
 - (d) Soda may be a luxury good.
- (b) If candy and soda are the only two goods, both cannot have income elasticities greater than one. If they did, it would mean that a one percent increase in income would lead to an increase in spending of greater than one percent which is not feasible.
20. Suppose a firm uses only capital and labor as inputs, the marginal product of capital is constant and independent of the level of labor and the marginal product of labor is constant and independent of the level of capital. We can say for certain that:
- (a) The firm's technical rate of substitution will be diminishing.
 - (b) A firm can substitute one unit of capital for one unit of labor and output will stay the same.
 - (c) The firm's isoquants will be straight lines.
 - (d) Output plotted as a function of capital would be a horizontal line (assume capital is on the horizontal axis).
- (c) The description is that of the case where capital and labor are perfect substitutes where the technical rate of substitution is constant (but not necessarily equal to one).

SECTION II: SHORT ANSWER (40 points)

1. (16 points) Milk and tea are normal, ordinary goods. Bill likes to have milk with his tea so for him, the two goods are complements. Hillary likes to drink either milk or tea so for her, the two goods are substitutes. Suppose that the price of tea decreases.
 - (a) On a graph with milk on the vertical axis and tea on the horizontal axis, show the overall effect of the change in the price of tea on milk consumption and the effect decomposed into the part due to the income effect and the part due to the substitution effect. Be certain to clearly label the effects (including their directions) as well as any relevant budget lines, indifference curves and consumption bundles. Note that you do not have to show the income and substitution effects for tea.
 - (b) Repeat part (a) for Hillary using a second graph. Assume that Hillary has the same income as Bill and sees the same prices.

The price of tea decreased so the new budget line (shown in purple on the graphs) is rotated out but has the same vertical intercept as the original budget line (shown in blue on the graphs). The intermediate budget line (shown in green on the graphs) should be parallel to the new budget line and pass through the original consumption bundle.

The intermediate bundle (B) should be down and to the right of the original bundle (A) on both graphs because tea became relatively cheaper. The final bundle (C) should be up and to the right of the intermediate bundle on both graphs because both milk and tea are normal goods. For Bill, the final bundle should be above the original bundle because milk consumption will go up when the price of tea falls. For Hillary, the final bundle should be below the original bundle because milk consumption will go down when the price of tea falls. The fully labeled graphs are provided on the next page.



2. (9 points) For each scenario described below, write down a production function consistent with the description of the firm's technology.

- (a) A firm uses bolts (B) and screws (S) to produce output. The firm can always use two screws in place of one bolt. If no bolts are used, it takes ten screws to produce one unit of output.

Based on the description, screws and bolts are perfect substitutes. This tells us that we have a linear production function. The fact that two screws can be substituted for one bolt tells us that the coefficient on bolts is twice as large as the coefficient on screws. The coefficient on screws must be $\frac{1}{10}$ if ten screws produce one unit of output. Putting all of this together gives us the following production function:

$$f(B, S) = \frac{1}{5}B + \frac{1}{10}S$$

- (b) A firm uses capital (K) and labor (L) as its only inputs. The marginal product of capital is diminishing as the amount of capital gets larger and the marginal product of labor is diminishing as the amount of labor gets larger.

Many production functions would work for this example. The key thing is that both the marginal product of capital and the marginal product of labor must be diminishing. The simplest production function to use is the Cobb-Douglas production function. To get diminishing marginal products with the Cobb-Douglas production function, we need the exponents to be between zero and one. One such production function would be:

$$f(K, L) = K^{\frac{1}{2}}L^{\frac{1}{2}}$$

- (c) The only input used by a firm is labor (L). The firm's production technology exhibits increasing returns to scale.

If labor is the only input and there are increasing returns to scale, increasing labor by a factor λ should increase output by a factor greater than λ . This tells us that the marginal product of labor is increasing. We can get a production function with increasing marginal product of labor by putting an exponent greater than one on L . One such production function would be:

$$f(L) = L^2$$

3. (15 points) There are ten consumers in the market for concert tickets (T). Five of the consumers are of type A and five are of type B . The individual inverse demand function for a type A consumer is:

$$p(T) = 10 - T$$

The individual inverse demand function for a type B consumer is:

$$p(T) = 10 - 2T$$

The market supply of concert tickets is fixed and equal to the number of seats in the theater which is 15. The theater will sell 15 and only 15 tickets no matter what the market price is.

- (a) Derive the market demand equation and graph it with price on the vertical axis and quantity on the horizontal axis. Also include the market supply curve on your graph.

First notice that both types of consumers stop buying positive quantities when the price gets above 10. So we don't need to worry about kinks in the demand curve or different equations for different segments of the demand curve. To get the market demand curve, we first need to switch the inverse demand functions to regular demand functions (quantity as a function of price):

$$T_A = 10 - p$$

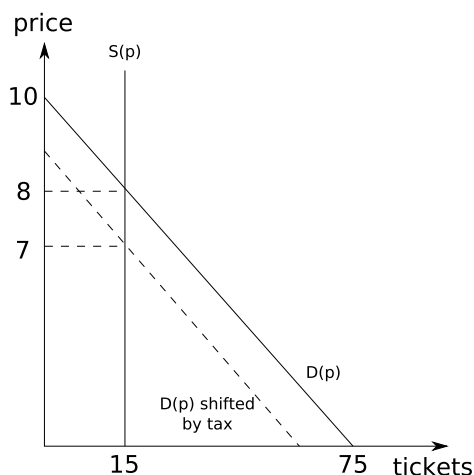
$$T_B = 5 - \frac{1}{2}p$$

With five consumers of each type, market demand is then:

$$D(p) = 5T_A + 5T_B$$

$$D(p) = 5(10 - p) + 5\left(5 - \frac{1}{2}p\right)$$

$$D(p) = 75 - 7.5p$$



- (b) Find the equilibrium price and quantity of tickets sold.

Since supply is perfectly inelastic, the equilibrium quantity will just be 15 tickets. To get equilibrium price, we can set this supply of 15 tickets equal to the market demand:

$$15 = 75 - 7.5p$$

$$7.5p = 60$$

$$p = 8$$

- (c) Suppose that a \$1 quantity tax is placed on consumers. Find the new equilibrium price paid by consumers, the new equilibrium price received by the theater, and the new quantity of tickets sold.

Let p be the price received by producers. Then the price paid by consumers is $p + 1$. We can find the new equilibrium price by setting demand at the price $p + 1$ equal to supply at the price p :

$$S(p) = D(p + 1)$$

$$15 = 75 - 7.5(p + 1)$$

$$7.5p = 52.5$$

$$p = 7$$

So the new price received by producers is \$7, the price paid by consumers is still \$8, and the quantity sold is still 15.

- (d) What is the change in consumer surplus resulting from the tax?

Notice that the price paid by consumers and the quantity purchased have not changed. This means that there is no change in consumer surplus (suppliers pay the full burden of the tax because supply is perfectly inelastic).