Midterm 2 - Solutions

You have until 11:50am 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 short 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. Suppose that x and y are the only two goods Abel consumes and he always consumes positive quantities of both goods. If the price of x changes and the substitution effect for y is positive, we can say for certain that:

   (a) The price of x must have gone up.
   (b) The price of x must have gone down.
   (c) The answer depends on whether x is a Giffen good.
   (d) The answer depends on whether y is a Giffen good.

   > (a) The substitution effect is always positive for the good that got relatively cheaper. For y to have gotten relatively cheaper, it must be the case the the price of x went up.

2. There are four consumers in the market for soda. For each individual consumer, if the price of soda falls by \$1, his individual consumption of soda increases by 2 units. The slope of an individual consumer's demand curve will be _____ and the slope of the market demand curve will be _____.

   (a) $-\frac{1}{2}$, $-\frac{1}{8}$.
   (b) $-\frac{1}{2}$, -2.
   (c) -2, $-\frac{1}{2}$.
   (d) -2, -8.

   > (a) For a single customer, the for every change in price of -1, demand changes by 2. So the slope of the demand curve, which is change in price over change in quantity, will be $-\frac{1}{2}$. For the market demand curve, for every change in price of -1, demand changes by 8 (two units for each of the four individuals). So the slope of the market demand curve will be $-\frac{1}{8}$.

3. A firm only uses capital and labor in production. Suppose that the firm improves its technology such that any particular combination of capital and labor produces twice as much output as it did before. Which of the following statements is not true?

   (a) The marginal product of labor will be twice as large as before.

(b) The marginal product of capital will be twice as large as before.

(c) The technical rate of substitution will be twice as large before (assume we are looking a graph with labor on the horizontal axis and capital on the vertical).

(d) All of the above are true.

(c) Notice that the new production function is just two times the old production. So the derivative of the new production function with respect to labor will just be two times the derivative of the old production function with respect to labor. This means the the marginal product of labor is double the old marginal product of labor. The same logic holds for the marginal product of capital. The technical rate of substitution is the ratio of these two marginal products, so if both double the ratio remains the same as before.

4. Which of the following is the best ordering of goods from most elastic to most inelastic in terms of the price elasticity of demand?

(a) Ham sandwiches, sandwiches of any kind, food of any kind.

(b) Ham sandwiches, food of any kind, sandwiches of any kind.

(c) Food of any kind, sandwiches of any kind, ham sandwiches.

(d) Food of any kind, ham sandwiches, sandwiches of any kind.

(a) The more close substitutes a good has, the more elastic we expect the demand for that good to be. Ham sandwiches have close substitues in the form of other sandwiches. Sandwiches of any kind have fewer close subsitutes. Food in general has almost no close substitutes.

5. Suppose that for the same demand and supply curves, a quantity tax of $2 per unit and a value tax of 15% would generate the same tax revenue. Which of the following is true?

(a) The quantity tax would create a larger deadweight loss than the value tax.

(b) The value tax would create a larger deadweight loss than the quantity tax.

(c) The quantity tax and the value tax would generate the same deadweight loss.

(d) Not enough information.

(c) If the two different taxes are generating the same tax revenue based on the same supply and demand curves, they must lead to the same new equilibrium prices and quantity. This means that they will lead to the same changes in consumer and producer surplus and the same deadweight loss.

6. Suppose that capital and labor are the only two inputs a firm uses, the marginal product of capital and the marginal product of labor are both constant, and the firm's technology is monotonic. We can say for certain that:

(a) A graph of output as a function of labor holding capital fixed will be a straight line.

(b) A graph of output as a function of capital holding labor fixed will be a straight line.

(c) The isoquants will be straight lines.

(d) All of the above.

(d) The slope the curve giving output as a function of labor is just the marginal product of labor. We know that this is constant, giving us a straight line. The

same thing will be true for capital. If both the marginal product of capital and the marginal product of labor are constant, the technical rate of substitution will be constant, giving us straight isoquants.

7. Demand for medicine is perfectly inelastic. The supply of medicine is an upward sloping line. If a \$5 quantity tax is placed on the producers of medicine:

   (a) The price consumers pay for medicine will stay the same.
   (b) The price consumers pay for medicine will increase but by less than \$5.
   (c) The price consumers pay for medicine will increase by \$5.
   (d) The price consumers pay for medicine will decrease by \$5.

   (c) If demand is perfectly inelastic, the entire tax will get passed on to consumers, raising the price they pay by the full amount of the tax.

8. Suppose the price of a Giffen good changes. The income and substitution effects for the good will:

   (a) Have the same sign if the price went up.
   (b) Have the same sign if the price went down.
   (c) Both (a) and (b) are true.
   (d) Neither (a) nor (b) are true.

   (d) If the price went up, the substitution effect will be negative since the good got relatively more expensive and the income effect will be positive because effective income has decreased and Giffen goods are inferior. If the price went down, the substitution effect will be positive and the income effect will be negative.

9. The demand function for candy bars is given by $C = \frac{I}{p_c}$ where C is the number of candy bars, I is income and p_C is the price of a candy bar. The income elasticity for candy bars will:

   (a) Increase if income increases.
   (b) Decrease if income increases.
   (c) Stay the same when income increases.
   (d) Not enough information.

   (c) We can calculate the income elasticity as follows:

   $$\text{income elasticity} = \frac{I}{C}\frac{dC}{dI}$$

   $$\text{income elasticity} = \frac{I}{\frac{I}{p_C}}\frac{1}{p_C}$$

   $$\text{income elasticity} = 1$$

   So the income elasticity is a constant.

10. Consumers for DVDs have a downward sloping demand curve and are currently buying 100 DVDs. If the price of a DVD drops by \$1, consumer surplus will:

    (a) Go up by less than 100.
    (b) Go up by 100.

(c) Go up by more than 100.

(d) Go down.

(c) The consumer surplus goes up by 100 on the DVDs they are already buying since they now get to pay $1 less on each one of those DVDs. However, they also get an increase in consumer surplus from the new DVDs they buy because the price is now lower. So the change in consumer surplus will be greater than 100.

11. The clothing store estimates that the price elasticity of demand for hats is -0.40. If the clothing store decreases the price of hats by a small amount:

(a) The store will sell fewer hats and earn less revenue.

(b) The store will sell fewer hats and earn more revenue.

(c) The store will sell more hats and earn less revenue.

(d) The store will sell more hats and earn more revenue.

(c) Demand is currently inelastic. So raising price would increase revenue. This also implies that lowering price would decrease revenue even though it would lead to more units being sold.
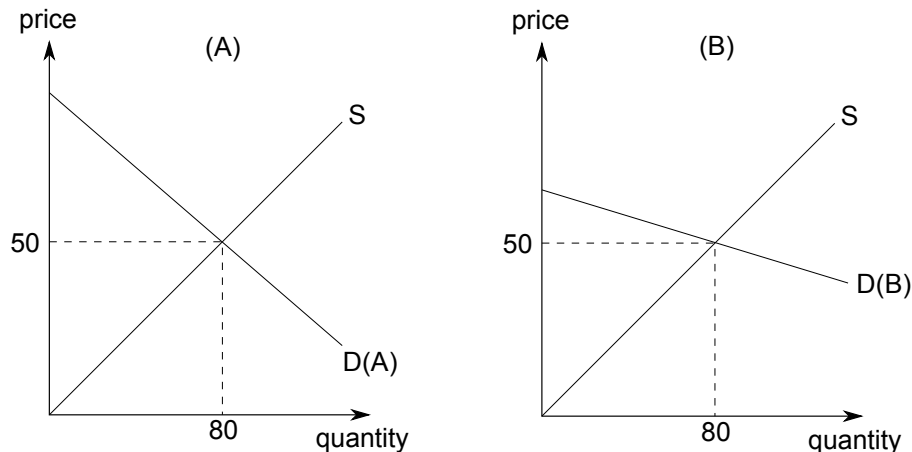
Use the figures above to answer questions 12 and 13. The supply curves are identical for Figure A and Figure B. The only difference between the figures is the slope of the demand curve. Demand curve A is steeper than demand curve B.

12. Suppose that a $5 quantity tax is placed on consumers. When comparing the equilibrium after the tax to the equilibrium before the tax, which of the following is true?

(a) The price paid by consumers will increase and the increase will be larger for market A than market B.

(b) The price paid by consumers will increase and the increase will be larger for market B than market A.

(c) The price paid by consumers will increase by the same amount for market A and market B.

(d) The price paid by consumers will not change.

(a) The consumers will pay a greater portion of the tax when demand is more inelastic. Demand curve A is more inelastic than demand curve B.

13. When the $5 quantity tax is placed on consumers, producer surplus will:

    (a) Decrease, with the decrease being larger in market A than in market B.
    (b) Decrease, with the decrease being larger in market B than in market A.
    (c) Increase, with the increase being larger in market A than in market B.
    (d) Increase, with the increase being larger in market B than in market A.

    (b) For both markets, producer surplus will decrease because the quantity sold will decline and the price producer's receive will go down. Based on the previous question, we know that consumers pay a greater portion of the tax in market A. This means that the producer's price drops by less in market A than in market B. This will lead to a smaller decrease in producer surplus for market A than for market B.

14. A firm uses an increasing returns to scale technology and decides to double output by scaling up all of its inputs by the same amount. This will require:

    (a) Doubling the number of inputs used.
    (b) Increasing the number of inputs used but by less than double.
    (c) Increasing the number of inputs used by more than double.
    (d) Not enough information.

    (b) With an increasing returns to scale technology, doubling inputs will more than double output. So if we just need to double output, it will requiring increasing inputs but by less than double.

15. Every extra worker a firm uses increases output by five units no matter how many workers the firm is already using. On a graph with output on the vertical axis and workers on the horizontal axis, output as a function of the number of workers will be:

    (a) A straight line with a positive slope.
    (b) An upward sloping curve that gets flatter as the number of workers increases.
    (c) A horizontal line.
    (d) An upward sloping curve that gets steeper as the number of workers increases.

    (a) The slope of the curve is just the change in output divided by the change in workers. If output goes up by five units every time the number of workers is increased by one, this slope will always be positive five.

<div align="center">SECTION II: SHORT ANSWER (40 points)</div>

1. (15 points) The two graphs below give the demand curves for two different consumers, Adam and Bob. Both demand curves are straight lines. The horizontal and vertical intercepts are labeled on the graphs.

(a) Draw a graph of the market demand curve, assuming that Adam and Bob are the only two consumers in the market. Be certain to label all intercepts, kinks and slopes with their numerical values.

> See the graph at the end of the problem. To get the graph, first note that Bob starts consuming when the price drops below \$75 and Adam starts consuming when the price drops below \$50. So the market demand will be zero above a price of \$75, equivalent to Bob's demand curve for prices between \$75 and \$50, and equal to the sum of Adam and Bob's demands for prices below \$50. So the upper segment of the demand curve will be identical to Bob's demand curve, having a vertical intercept of 75 and a slope of -1. At a price of \$50, Adam enters the market and we get a kink. At this price, Bob's demand would be 25 (his demand goes up by one unit for every \$1 decrease in price). So the kink is at the point (\$50, 25). The horizontal intercept of the demand curve will be equal to the sum of the Adam's demand at a price of zero and Bob's demand at a price of zero, giving us a total of 125. To get the slope of the lower segment of the demand curve, we can just calculate the change in price over the change in demand for that segment:
> $$\text{slope} = \frac{\Delta p}{\Delta x}$$
> $$\text{slope} = \frac{50 - 0}{25 - 125}$$
> $$\text{slope} = -\frac{1}{2}$$

(b) Write down an expression for market demand as a function of price (note that your market demand equation may be different for different price ranges).

To get the equation for market demand, we first need to write down the individual demand equations. From the demand curves, it is easy to see that both demand functions have a slope of -1. Given this slope and the intercepts on the graphs, we get the following demand equations:

$$x_A = 50 - p$$

$$x_B = 75 - p$$

For prices above 75, market demand is zero. At prices below 75 but above 50, only Bob demands a positive quantity so the market demand curve is equal to Bob's demand curve. For prices below 50, both Adam and Bob demand positive quantities of the good. So to get the equation for this segment of the demand curve, we need to add the two individual demand equations together:

$$D(p) = x_A + x_B = 50 - p + 75 - p$$

$$D(p) = 125 - 2p$$

So our final expression for the market demand curve is the following:

$$D(p) = 0 \text{ for } p > 75$$

$$D(p) = 75 - p \text{ for } 50 < p \leq 75$$

$$D(p) = 125 - 2p \text{ for } p \leq 50$$

(c) Suppose that the supply function for this market is given by:

$$S(p) = 10p \tag{1}$$

Solve for the equilibrium market price, the number of units Adam buys at the equilirium price and the number of units Bob buys at the equilibrium price.

First we need to determine which segment of the demand curve the supply curve will pass through. Notice that at a price of 50, supply is equal to 500. This is well to the right of the demand curve at a price of 50. So the supply curve will pass through the lower segment of the demand curve. Setting the equation for this segment of the demand curve equal to supply will give us the equilibrium price.
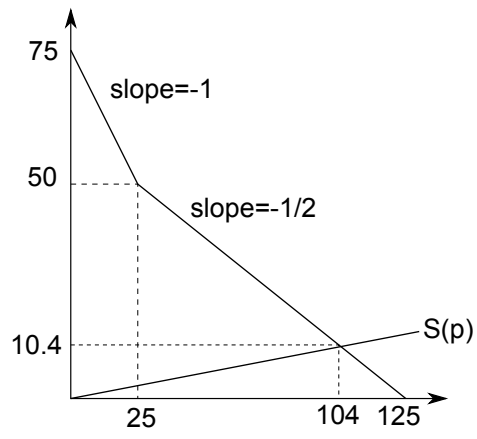
$$D(p) = S(p)$$

$$125 - 2p = 10p$$

$$12p = 125$$

$$p = 10.4$$

So the equilbrium price will be $10.40. Plugging this price in to the individual demand functions gives us Adam's demand and Bob's demand:

$$x_A = 50 - 10.4 = 39.6$$

$$x_B = 75 - 10.4 = 64.6$$

2. (15 points) A firm uses metal and wood to produce chairs. They can make chairs entirely out of metal, entirely out of wood, or out of a combination of metal or wood. They can always replace two units of wood with one unit of metal or one unit of metal with two units of wood without affecting the level of output. If they use only metal, it takes four units of metal to produce a single chair.

(a) Write down the production function for the firm, $f(M, W)$, where M is the number of units of metal used and W is the number of units of wood used. The production function should give the total number of chairs produced.

Notice that they can always substitute metal for wood at a constant rate, so we are looking at a perfect substitutes technology which will have a linear production function of the form:

$$f(M, W) = a \cdot M + b \cdot W$$

In this equation, a is simply the marginal product of M and b is the marginal product of W. We know from the problem that it takes four units of M to produce one unit of output. So one unit of M will produce $\frac{1}{4}$ units of output. In other words, the marginal product of M is $\frac{1}{4}$. Now we know that our production function looks like:

$$f(M, W) = \frac{1}{4}M + b \cdot W$$

We are also told that you can replace two units of wood with one unit of metal. This means that metal is twice as productive as wood, implying a marginal product of wood of $\frac{1}{8}$. This give us the last piece of information we need for the production function:

$$f(M, W) = \frac{1}{4}M + \frac{1}{8}W$$

(b) On a graph with wood on the horizontal axis and metal on the vertical axis, draw the isoquant for an output level of 20 chairs. Label any intercepts or slopes with their numerical values where possible.

The slope of the the isoquant will be given by the technical rate of substitution:

$$TRS = -\frac{MP_W}{MP_M} = -\frac{\frac{1}{8}}{\frac{1}{4}}$$
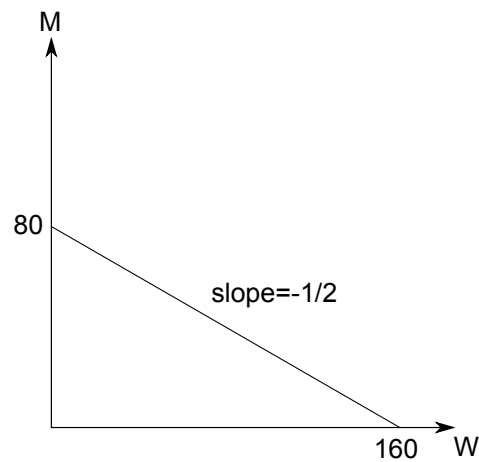
$$TRS = -\frac{1}{2}$$

So the isoquants will be straight lines with a slope of $-\frac{1}{2}$. To get the intercepts of the output equal to 20 isoquant, we can simply plug in zero for one input and twenty for output in the production function and solve for the value of the other input:

$$20 = f(M, 0) = \frac{1}{4}M + 0$$

$$M = 80$$

$$20 = f(0, W) = 0 + \frac{1}{8}W$$

$$W = 160$$

M

80

slope=-1/2

160 W

(c) Using your production function from part (a), show whether the firm exhibits decreasing returns to scale, constant returns to scale or increasing returns to scale.

Suppose that we increase both inputs by a factor of λ. The new level of output will be:

$$f(\lambda M, \lambda W) = \frac{1}{4}(\lambda M) + \frac{1}{8}(\lambda W)$$

$$f(\lambda M, \lambda W) = \lambda(\frac{1}{4}M + \frac{1}{8}W)$$

$$f(\lambda M, \lambda W) = \lambda f(M, W)$$

So the new level of output is exactly λ times bigger than the original level of output. This tells us the production function exhibits constant returns to scale.

3. (10 points) The graph below shows the demand and supply curves in the market for food. Suppose that the city of Davis decides to place a 10% value tax on food. The tax will be placed on consumers. On the graph, show the effects of this tax on consumer surplus and producer surplus. Be certain to carefully label your graph (note that for many items of the graph you will not be able to give numerical values, you should still label these items in a way that makes it clear what they are).
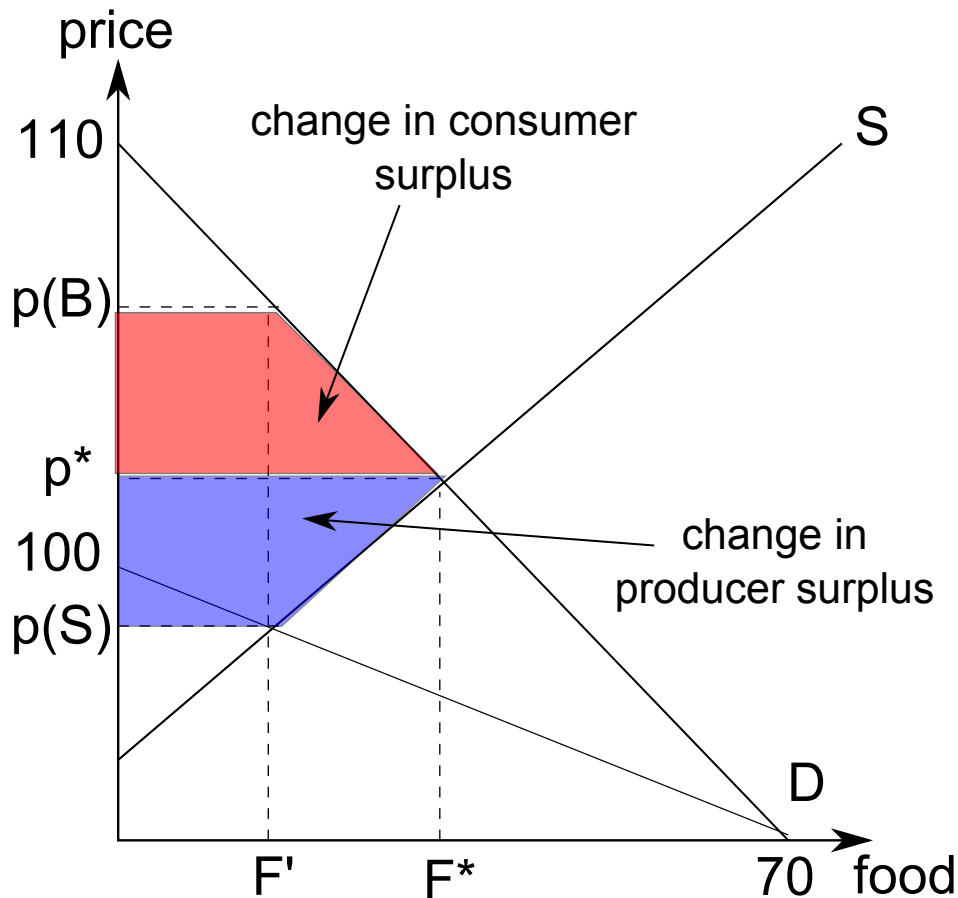
The original equilbrium price and quantity are where the original demand curve intersects the supply curve ($p*$ and $F*$ on the graph). The value tax will rotate the demand curve down. The new vertical intercept will be at a price of 100 dollars ($100 plus the 10% tax would bring the final price for consumers back up to $110). The intersection of this rotated demand curve and the supply curve will determine the new price received by sellers ($p(S)$ on the graph) and the new quantity (F' on the graph). Following this new quantity up to the original demand curve will give the new price paid by buyers ($p(B)$ on the graph). The change in consumer surplus is negative and given by the red area on the graph. The change in producer surplus is negative and given by the blue area on the graph.