Final Exam - 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. A firm with smooth, convex isoquants and a diminishing technical rate of substitution is currently minimizing costs by using 10 units of capital and 10 units of labor. If the rental rate of capital increases and the firm wants to keep producing the same amount of output, it will:

   (a) Switch to using more than 10 units of labor and more than 10 units of capital.
   (b) Switch to using less than 10 units of labor and more than 10 units of capital.
   (c) Switch to using more than 10 units of labor and less than 10 units of capital.
   (d) Switch to using less than 10 units of labor and less than 10 units of capital.

   (c) If the rental rate of capital increases relative to the wage, the isocost lines will get flatter (on a graph with labor on the horizontal axis and capital on the vertical axis). At the old combination of capital and labor, there will now be points down and to the right along the isoquant that will lie below the isocost curve. So the firm can lower its costs by switching to using more labor and less capital.

2. Bundles on the same indifference curve:

   (a) Will give a consumer the same level of utility but may cost different amounts.
   (b) Will cost a consumer the same amount but may give the consumer different levels of utility.
   (c) Will be preferred to bundles lying above the indifference curve if preferences are monotonic.
   (d) None of the above.

   (a) By definition, two bundles on the same indifference curve give the consumer the same level of utility. Indifference curves don't tell us about how much the bundles cost.

3. If average variable costs are rising as output increases, which of the following must be true?

   (a) Average costs are rising as output increases.
   (b) Marginal costs are above average costs.

(c) Marginal costs are above average variable costs.

(d) Average costs are falling as output increases.

(c) When marginal costs are above average variable costs, the next unit produced will increase variable costs by an amount greater than the current average, pulling up the average variable costs. Average total costs may still be falling due to falling average fixed costs.

4. The demand curve for an ordinary good:

(a) Will be upward sloping.

(b) Will be downward sloping.

(c) Will be downward sloping only if the good is normal.

(d) Will be downward sloping only if the good is inferior.

(b) For ordinary goods, when price increases demand decreases. This leads to a downward sloping demand curve.

5. Suppose the government forces a monopoly to produce at the efficient quantity but lets them set whatever price they want. Which of the following is definitely true?

(a) The monopoly will earn zero profits.

(b) The monopoly will still earn positive profits.

(c) The monopoly will earn negative profits.

(d) Total surplus will be maximized.

(d) The efficient quantity is the quantity at which total surplus is maximized. Whether the monopoly will earn profits at that quantity depends on what the average cost curve looks like for the monopoly.

6. New health benefits are discovered for cranberry juice, shifting the demand curve for cranberry juice to the right. If the market for cranberry juice is perfectly competitive, then in the short run _____ and in the long run _____. (Assume all firms have identical, upward sloping marginal cost curves.)

(a) The price of cranberry juice will rise; the number of firms will increase and price will return to its original level.

(b) The price of cranberry juice will rise; the number of firms will decrease and price will return to its original level.

(c) Firm profits will stay constant; firm profits will increase.

(d) Firm profits will increase; the price of cranberry juice will increase.

(a) In the short run, the supply curve will be upward sloping so a shift in the demand curve to the right will lead to a higher quantity and higher price in the market. A higher price means that firms will be earning positive profits (assuming the market was at a long run equilibrium before the demand shift). Higher profits will lead to more firms entering until the price is driven back down to the minimum of the average cost curve.

7. After a price change, the substitution effect will be positive for the good that:

(a) Became relatively cheaper.

(b) Became relatively more expensive.

(c) It depends on whether the good is ordinary or Giffen.

(d) It depends on whether the good is normal or inferior.

(a) The substitution effect will be positive for the good that became relatively cheaper and negative for the good that became relatively more expensive. Whether a good is Giffen or ordinary will not affect the sign of the substitution effect, just the sign of the net effect.

8. In which scenario is a monopoly most likely to occur?

(a) An industry where minimum efficient scale is very small relative to demand.

(b) An industry where minimum efficient scale is very large relative to demand.

(c) An industry where there are low average costs at all levels of output and no barriers to entry.

(d) An industry where there are constant average costs and no barriers to entry.

(b) Even if there are few barriers to entry, a monopoly may occur when minimum efficient scale is large relative to demand. In this situation, a single firm may be profitable while two firms splitting the market demand would be unprofitable.

9. If a competitive firm is maximizing profits in the short run, which of the following is definitely true?

(a) The firm is producing at a quantity y where $p = MC(y)$.

(b) The firm is earning profits greater than or equal to zero.

(c) The firm's producer surplus must be greater than or equal to zero.

(d) The firm's average costs will be lower than the price of output.

(c) The firm can always earn a producer surplus of zero by shutting down. So if the firm is acting optimally, it will have a producer surplus greater than or equal to zero. Profits may be negative if the firm is covering all of the variable cost and some of their fixed cost (in this situation, the firm is losing money but not as much as if they shut down). If the firm is producing, they will produce where price equals marginal cost but it may be optimal to shut down.

10. In the short run, capital is a fixed input and labor is a variable input and has a diminishing marginal product. Which of the following would definitely not lead to an increase in output in the short run? (Assume firms always maximize profits in the short run.)

(a) An increase in the price of output and an increase in the wage.

(b) An increase in the price of output and a decrease in the wage.

(c) A decrease in the price of output and an increase in the wage.

(d) A decrease in the price of output and a decrease in the wage.

(c) If the price of output goes down but the wage goes up, the last worker hired is no longer cost effective. Originally, that worker brought in just as much revenue as he cost in terms of wages. Now the value of his marginal product is lower but his wage is higher, so that worker is no longer profitable. Fewer workers will be hired leading to a lower level of output.

11. Suppose that there are two types of firms producing toy cars. One type of firm has costs given by $C(y) = 8y$. The other type of firm has costs given by $C(y) = 10y$. If firms of both types can freely enter and leave the market, what will the long run price of toy cars be? (Assume that the demand curve is linear and downward sloping.)

    (a) It depends on the slope of the demand curve.
    (b) It depends on the number of firms.
    (c) $8.
    (d) $10.

       (c) Consider a short run price above $10. All firms are profitable so more firms will enter, driving down the price. Eventually the price will hit $10 and the second type of firm will be at zero profits. However, the first type of firm is still profitable so more firms will enter, driving the price down further until it hits $8, the average costs of the more efficient firm.

12. On a graph with cookies on the horizontal axis and milk on the vertical axis, the _____ the marginal utility of milk is, the _____ the indifference curves will be.

    (a) Larger, steeper.
    (b) Larger, flatter.
    (c) The slope of the indifference curve does not depend on the marginal utility of milk.
    (d) None of the above.

       (b) The magnitude of slope of the indifference curve will be the marginal utility of cookies divided by the marginal utility of milk. As the marginal utility of milk increases, the magnitude of the slope will decrease.

13. Suppose that metal and wood are the only inputs used by a firm, the firm has a diminishing technical rate of substitution, metal costs twice as much as wood and the marginal product of wood is twice as much as the marginal product of metal at the current levels of inputs. The firm can keep output the same and lower costs by:

    (a) Increasing the amount of wood used and decreasing the amount of metal used.
    (b) Increasing the amount of metal used and decreasing the amount of wood used.
    (c) Increasing both the amount of metal used and the amount of wood used.
    (d) Decreasing both the amount of metal used and the amount of wood used.

       (a) Currently metal costs more than wood but the marginal product of metal is smaller than that of wood. So a firm could substitute wood for metal to both save money and increase production.

14. Which of the following statements is true about the monopoly outcome relative to the perfectly competitive market outcome? (Assume demand is a downward sloping line and the firm's marginal cost curve is upward sloping.)

    (a) The monopoly generates a deadweight loss equal to the decrease in consumer surplus.
    (b) The monopoly generates a deadweight loss less than the decrease in consumer surplus.
    (c) The monopoly generates a deadweight loss greater than the decrease in consumer surplus.
    (d) The monopoly does not generate a deadweight loss relative to the competitive outcome.

(b) Let's call the component of lost consumer surplus that goes to monopoly profits A and the component that goes to deadweight loss B. Call the component of deadweight loss that came from producer surplus C. The total loss in consumer surplus is $A + B$. The increase in profits for the monopoly is $A - C$ and must be positive (otherwise the monopoly wouldn't have gone to the monopoly solution). We want to know whether $A + B$ is greater than $B + C$. Another way of saying this is we want to know whether $(A + B) - (B + C) > 0$ or whether $A - C > 0$. If $A - C$ weren't greater than C, the monopolist would have lost profits by moving to the monopoly outcome.

15. For a competitive firm, _____ while for a monopoly _____. (Assume market demand is a downward sloping line.)

   (a) Marginal revenue increases as output increases; marginal revenue decreases as output increases.
   (b) Marginal revenue decreases as output increases; marginal revenue increases as output increases.
   (c) Marginal revenue stays constant as output increases; marginal revenue increases as output increases.
   (d) Marginal revenue stays constant as output increases; marginal revenue decreases as output increases.

   (d) Marginal revenue for a competitive firm is simply equal to the market price. For a monoplist, marginal revenue decreases as output increases because the monopolist must lower their price in order to sell more units.

16. If a \$1 quantity tax is placed on consumers, the overall price paid by consumers rises by 75 cents. If the same tax was placed on producers rather than consumers (assume we are focusing on the short run):

   (a) The net price received by producers would go up by 75 cents.
   (b) The net price received by producers would go up by 25 cents.
   (c) The net price received by producers would go down by 75 cents.
   (d) The net price received by producers would go down by 25 cents.

   (d) It doesn't matter who the tax is placed on, the price changes will be the same. If the consumers' price went up by 75 cents, the producers' price must have gone down by 25 cents (the difference between them has to equal the \$1 tax).

17. If capital and labor are a firm's only inputs and capital is fixed in the short run, which of the following will be true at the short run profit-maximizing level of labor? (Assume the profit-maximizing level of labor is positive.)

   (a) The marginal product of labor will be equal to the price of output.
   (b) The marginal product of labor is equal to the wage.
   (c) The marginal product of labor is equal to wage divided by the rental rate of capital.
   (d) The marginal product of labor is equal to wage divided by the price of output.

   (d) The firm will choose the level of labor at which the value of the marginal product of the last worker just equalled the worker's wage.

18. For an ordinary but inferior good:

    (a) The Engel curve is upward sloping and the demand curve is downward sloping.
    (b) The Engel curve is upward sloping and the demand curve is upward sloping.
    (c) The Engel curve is downward sloping and the demand curve is downward sloping.
    (d) The Engel curve is downward sloping and the demand curve is upward sloping.

    (c) A good is ordinary if an increase in price leads to a decrease in demand. This implies a downward sloping demand curve. A good is inferior if an increase in income leads to a decrease in demand. This implies a downward sloping Engel curve.

19. In a competitive market, the long run supply curve is:

    (a) Perfectly inelastic.
    (b) Perfectly elastic.
    (c) Unit elastic.
    (d) None of the above.

    (b) The long run supply curve is horizontal in a competitive market meaning that it is perfectly elastic.

20. If a firm uses a technology that exhibits increasing returns to scale, doubling the level of output will:

    (a) Double total costs.
    (b) More than double total costs.
    (c) Less than double total costs.
    (d) Lower total costs.

    (c) If the firm is using an increasing returns to scale technology, doubling output will require inputs to be increased but by less than double. So costs will go up but they won't double.

SECTION II: SHORT ANSWER (40 points)

1. (16 points) Suppose that the market for toys is perfectly competitive and that all toy manu-
facturers have identical cost functions with the following features: marginal costs for a single
manufacturer are given by $MC(y) = \frac{1}{10}y$, the minimum of the average cost curve is $2 and
occurs at a quantity of 20 toys. Market demand for toys is given by:

$$D(p) = 1000 - 100p \tag{1}$$

(a) Suppose that in the short run, there are ten firms. Graph the short run industry supply
curve and the demand curve (with price on the vertical axis and quantity on the hori-
zontal axis). Find the equilibrium price and quantity in the short run and label these
values on your graph.

To get the short run industry supply curve, we need to add up the individual
firm supply curves. For each firm, the supply curve will be the marginal cost
curve above the average variable cost curve. Notice that marginal cost is always
rising. This means that the marginal cost curve is always above the average
variable cost curve which tells us that the firm will produce at all positive
prices. So the supply curve for a single firm, $S_i(p)$ is:

$$p = MC(y)$$

$$p = \frac{1}{10}y$$

$$y = 10p$$

$$S_i(p) = 10p$$

The market supply curve, $S(p)$ is then:

$$S(p) = \sum_{i=1}^{10} S_i(p) = 10S_i(p) = 10 \cdot 10p$$

$$S(p) = 100p$$

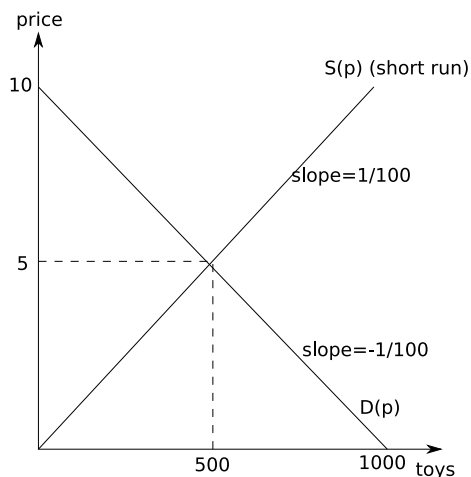The equilibrium prict and quantity will be where market supply intersects mar-
ket demand:

$$S(p^*) = D(p^*)$$

$$100p^* = 1000 - 100p^*$$

$$200p^* = 1000$$

$$p^* = 5$$

$$q^* = D(5) = 1000 - 100 \cdot 5 = 500$$

(b) Are firm profits positive or negative in the short run? Be certain to explain your answer. (Note: You may not be able to calculate the exact value of profits but you do have enough information to know the sign of the profits.)

> The equilibrium price found in part (a) was $5. At this price, each firm produces 50 toys (this comes from the firm supply function we found in part (a)). So each firm is at a point on the marginal cost curve above and to the right of the minimum of the average cost curve. For all quantities to the right of the minimum of the average cost curve, marginal cost is above average cost. So each firm is getting a price greater than their average costs implying that they are earning positive profits.

(c) Based on your answer in (b), what will happen to the number of firms in the industry? Can you say how many firms there will be in the long run? If so, find the number of firms. If not, explain what additional information you would need.

> With firms earning positive profits, more firms will enter the industry until the price is driven down to the minimum of the average cost curve, $2. At this price, each firm will produce 20 toys and market demand will be 800 toys (this number comes from plugging $2 into the market demand function). So there will be $\frac{800}{20}$ or 40 firms in the industry in the long run.

(d) Suppose that a quantity tax is placed on consumers. Use another graph that includes the demand curve, the short run industry supply curve you found in part (a) and the long run industry supply curve to show the effect of the tax on the price received by manufacturers in the short run and in the long run. Label your graph clearly and include a written explanation of the changes shown on the graph. Be as specific as possible.
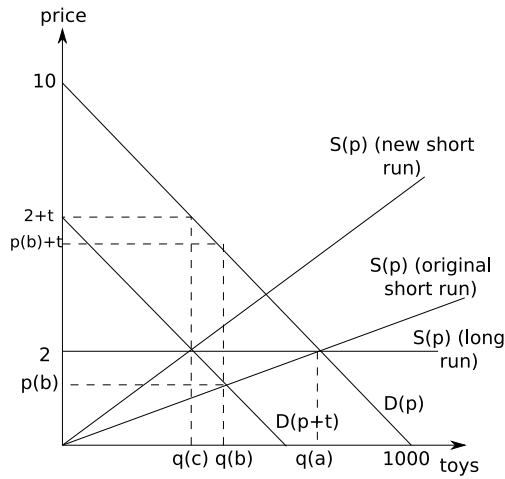
The market is initially at its long run equilibrium where the demand curve intersects the long run supply curve (a horizontal line at a price of $2). The tax shifts the demand curve down by the amount of the tax. In the short run, this leads to movement along the short run supply curve leading to a lower equilibrium quantity $(q(b))$, a lower price received by producers $(p(b))$, and a higher price paid by the consumers $(p(b) + t)$. At this lower price, firms will be earning negative profits so firms will exit the industry, rotating the short run supply curve as shown on the graph until the price received by producers returns to $2, leading to a new quantity of $q(c)$ and a price paid by consumers of $2 plus the full amount of the tax.

2. (10 points) A firm uses flour (F) and eggs (E) to make pasta. The price of flour is $2 per unit and the price of eggs is $4 per unit. The production function for the firm is given by:

$$f(F, E) = F^{\frac{1}{2}} E^{\frac{1}{2}} \qquad (2)$$

(a) Derive expressions for the marginal product of eggs, the marginal product of flour and the technical rate of substitution.

$$MP_E = \frac{df(F, E)}{dE} = \frac{1}{2} F^{\frac{1}{2}} E^{-\frac{1}{2}} = \frac{1}{2} \left(\frac{F}{E} \right)^{\frac{1}{2}}$$

$$MP_F = \frac{df(F, E)}{dF} = \frac{1}{2} F^{-\frac{1}{2}} E^{\frac{1}{2}} = \frac{1}{2} \left(\frac{E}{F} \right)^{\frac{1}{2}}$$

$$TRS = -\frac{MP_E}{MP_F} = -\frac{\frac{1}{2} \left(\frac{F}{E} \right)^{\frac{1}{2}}}{\frac{1}{2} \left(\frac{E}{F} \right)^{\frac{1}{2}}} = -\frac{F}{E}$$

(b) Derive an expression for the optimal number of eggs to use in terms of the amount of output (y). Also derive an expression for the optimal amount of flour to use in terms of the amount of output (y).

To optimal combination of eggs and flour will lie on the isoquant for the desired level of output y and be at a point of tangency between the isocost curve and the isoquant. We will begin with the tangency condition, setting the slope of the isocost curve equal to the slope of the isoquant:

$$-\frac{p_E}{p_F} = -\frac{MP_E}{MP_F}$$

$$-\frac{p_E}{p_F} = -\frac{F}{E}$$

$$F = \frac{p_E}{p_F} E$$

Now we can plug this into our production function to get E in terms of output:

$$y = F^{\frac{1}{2}} E^{\frac{1}{2}}$$

$$y = \left(\frac{p_E}{p_F} E \right)^{\frac{1}{2}} E^{\frac{1}{2}}$$

$$y = \left(\frac{p_E}{p_F} \right)^{\frac{1}{2}} E$$

$$E = \left(\frac{p_F}{p_E} \right)^{\frac{1}{2}} y$$

This is our expression for the optimal number of eggs to use in terms of the amount of output. We can plug this back into our expression relating F to E to get the optimal amount of flour in terms of the amount of output:

$$F = \frac{p_E}{p_F} \left(\frac{p_F}{p_E} \right)^{\frac{1}{2}} y$$

$$F = \left(\frac{p_E}{p_F} \right)^{\frac{1}{2}} y$$

Plugging in the actual values for the prices of eggs and flour gives us:

$$E = \left(\frac{2}{4} \right)^{\frac{1}{2}} y = \frac{1}{\sqrt{2}} y$$

$$F = \left(\frac{4}{2} \right)^{\frac{1}{2}} y = \sqrt{2} y$$

(c) Use your answers from part (b) to write total costs as a function of output (y).

$$C(y) = p_E E(y) + p_F F(y)$$

$$C(y) = p_E \left(\frac{p_F}{p_E} \right)^{\frac{1}{2}} y + p_F \left(\frac{p_E}{p_F} \right)^{\frac{1}{2}} y$$

$$C(y) = p_E^{\frac{1}{2}} p_F^{\frac{1}{2}} y + p_E^{\frac{1}{2}} p_F^{\frac{1}{2}} y$$

$$C(y) = 2 p_E^{\frac{1}{2}} p_F^{\frac{1}{2}} y$$

$$C(y) = 2 \cdot 4^{\frac{1}{2}} \cdot 2^{\frac{1}{2}} y$$

$$C(y) = 4\sqrt{2} y$$

3. (14 points) There is only one ice cream shop in town. Each additional bowl of ice cream costs the ice cream shop \$4 no matter how many bowls they have already sold and the shop has no fixed costs. The demand for ice cream is given by:

$$D(p) = 50 - \frac{1}{2}p \tag{3}$$

(a) Write down an expression for the costs of the ice cream shop in terms of the number of bowls of ice cream they sell and another expression for the revenues of the ice cream shop in terms of the number of bowls of ice cream they sell.

If there are no fixed costs, then total costs depend only on the number of bowls sold. Each bowl costs the shop \$4, so total costs are given by:

$$C(y) = 4y$$

where y is the number of bowls of ice cream.

(b) What price will the ice cream shop charge and how many bowls of ice cream will be sold? What are the shop's profits? (Note: Do not worry if prices or quantities seem unrealistic.)

From the cost function (and the problem description) we can see that marginal costs are \$4. The monopolist will set marginal cost equal to marginal revenue to find the profit-maximizing quantitiy to sell. To do this, we first need to find an expression for marginal revenue:

$$R(y) = p(y)y$$
$$R(y) = (100 - 2y)y = 100y - 2y^2$$
$$MR(y) = \frac{dR(y)}{dy} = 100 - 4y$$

Setting marginal revenue equal marginal costs gives us:

$$MC(y) = MR(y)$$
$$4 = 100 - 4y$$
$$4y = 96$$
$$y = 24$$

So the ice cream shop will sell 24 bowls of ice cream. To get the price they will charge, we can use the demand equation:

$$24 = 50 - \frac{1}{2}p$$
$$48 = 100 - p$$
$$p = 52$$

Finally, we can use the price, quantity and cost function to calculate profits:

$$\pi = R(y) - C(y) = py - 4y$$
$$\pi = 52 \cdot 24 - 4 \cdot 24$$
$$\pi = 1152$$

(c) What is the socially efficient amount of ice cream?

The socially efficient quantity will be the quantity at which the marginal cost curve intersects the demand curve. We can find this by setting marginal cost equal to demand:

$$MC(y) = p(y)$$

$$4 = 100 - 2y$$

$$y = 48$$

So total surplus is maximized when 48 bowls of ice cream are sold. Notice that this is substantially greater than the quantity sold by the monopolistic ice cream shop.

(d) How much deadweight loss is generated by the ice cream shop acting as a monopoly? Use a graph to show the equlibrium price and quantity, the socially efficient quantity, the deadweight loss, and the profits for the ice cream shop.

The deadweight loss will be the area under the demand curve, above the marginal cost curve between the monopoly quantity and the efficient quantity. This is a triangle with a width of $(48 - 24)$ and a height of $(52 - 4)$. So the deadweight loss is:

$$DWL = \frac{1}{2}(48 - 24)(52 - 4)$$

$$DWL = 576$$