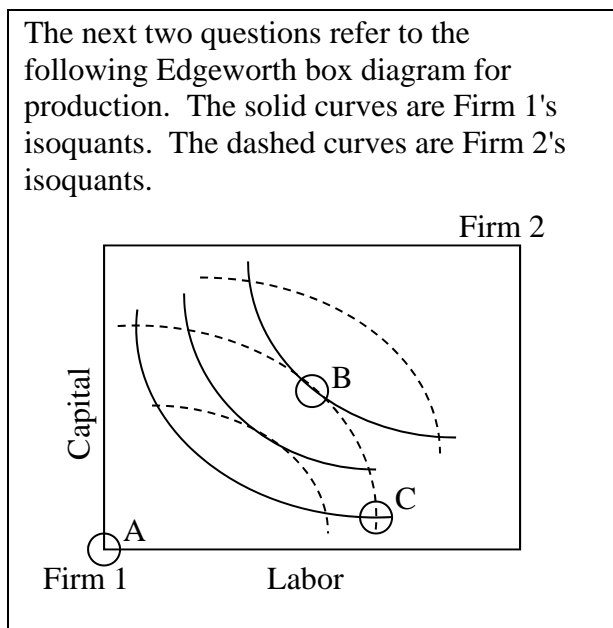


**EXAMINATION #4 VERSION B**  
**“General Equilibrium and Market Power”**  
**November 26, 2013**

**INSTRUCTIONS:** This exam is closed-book, closed-notes. Calculators, mobile phones, and wireless devices are NOT permitted. Point values for each question are noted in brackets.

**I. MULTIPLE CHOICE:** Circle the one best answer to each question. Feel free to use margins for scratch work [1 pt each—9 pts total].

The next two questions refer to the following Edgeworth box diagram for production. The solid curves are Firm 1's isoquants. The dashed curves are Firm 2's isoquants.



(2) Firm 1 and Firm 2 have identical marginal rates of substitution in production at

- a. allocation B only.
- b. allocation C only.
- c. both allocations B and C.
- d. neither allocation B nor C.

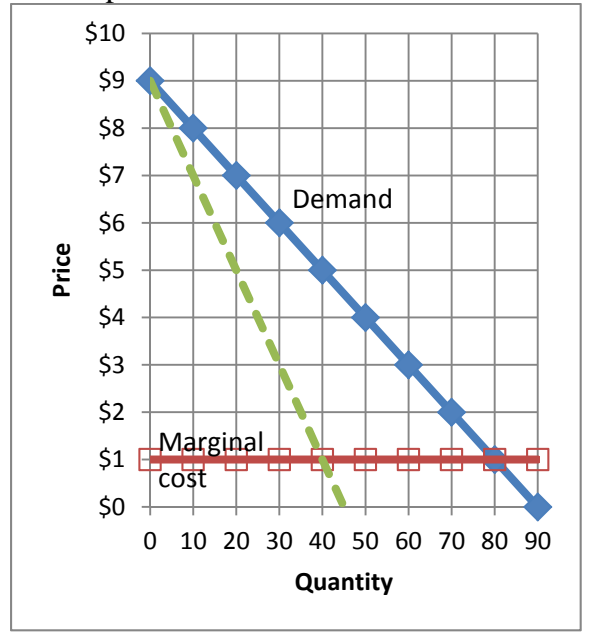
(3) Which equation for average cost implies that the firm enjoys a natural monopoly?

- a.  $AC(q) = 0.001 q^2 + 0.02 q + 6$ .
- b.  $AC(q) = 7$ .
- c.  $AC(q) = 2 + 0.03 q$ .
- d.  $AC(q) = 8 - 0.01 q^{-1}$ .
- e.  $AC(q) = 10 + 500 q^{-1}$ .

(1) From allocation C, both firms can produce more output if

- a. Firm 1 gives Firm 2 some capital, and Firm 2 gives Firm 1 some labor.
- b. Firm 1 gives Firm 2 some labor, and Firm 2 gives Firm 1 some capital.
- c. Firm 1 gives Firm 2 some capital and some labor.
- d. Firm 2 gives Firm 1 some capital and some labor.
- e. No trade will allow both firms to produce more output.

The next two questions refers to the graph of a monopolist below.



- (4) What quantity of output will the monopolist choose if it must charge the *same* price to all customers?
- 90 units.
  - 80 units.
  - 45 units.
  - 40 units.
  - 0 units.
- (5) What quantity of output will the monopolist choose if it can engage in *perfect price discrimination*?
- 90 units.
  - 80 units.
  - 45 units.
  - 40 units.
  - 0 units.

- (6) The Cournot model of oligopoly assumes that each firm maximizes its profit while taking its rivals'
- costs as given.
  - prices as given.
  - output quantities as given.
  - all of the above.

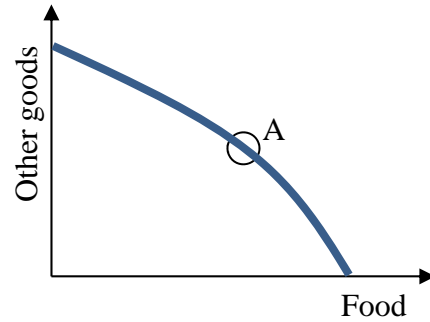
- (7) A certain industry is served by a symmetric Cournot oligopoly of 2 firms. If the elasticity of market demand is -2, the Lerner index (or "price-cost margin") in equilibrium equals
- 0.1 .
  - 0.2 .
  - 0.25 .
  - 0.3 .
  - 0.5 .

- (8) Which market model predicts the lowest equilibrium price?
- Price competition.
  - Collusion to maximize joint profits.
  - Cournot oligopoly.
  - All models predict the same equilibrium price, if all use the same assumptions about market demand and marginal cost.

- (9) Suppose consumers do not view breakfast cereal brands as perfect substitutes. For example, some consumers prefer Cheerios while others prefer Kellogg's Corn Flakes. Then breakfast cereals are said to be \_\_\_\_\_ products.
- normal.
  - efficient.
  - elastic.
  - complementary.
  - differentiated.

**II. SHORT ANSWER:** Please write your answers in the boxes on this question sheet. Use margins for scratch work.

(1) [General equilibrium: 8 pts] Consider the graph at right of an economy's production-possibility curve. Assume this economy is in general competitive equilibrium at point A, where the slope of the production-possibility curve is  $-2$ .



- What is the opportunity cost of a unit of food? In other words, how many units of other goods must be given up in order to produce one more unit of food?
- What is the opportunity cost of a unit of other goods? In other words, how many units of food must be given up in order to produce one more unit of other goods?
- Consider the typical consumer's budget line with food on the horizontal axis and other goods on the vertical axis. What must be the slope of every consumer's budget line in this economy?
- If the price of other goods is \$ 6 per unit, then what must be the price of food?

	units of other goods
	units of food
	\$

(2) [Marginal revenue: 6 pts] Suppose a coffee vendor with market power is now selling 20 cups of coffee per hour at a price of \$2.00. If she cuts the price to \$1.95, she can sell one more cup of coffee per hour (that is, a total of 21 cups of coffee per hour).

- Compute the vendor's marginal revenue for the 21<sup>st</sup> cup of coffee.

\$
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Suppose the marginal cost of making a cup of coffee is \$1.00 per cup of coffee, and suppose the vendor does lower her price to \$1.95 to sell 21 cups of coffee per hour.

- Will the vendor's hourly profit *increase* or *decrease*?
- By how much?

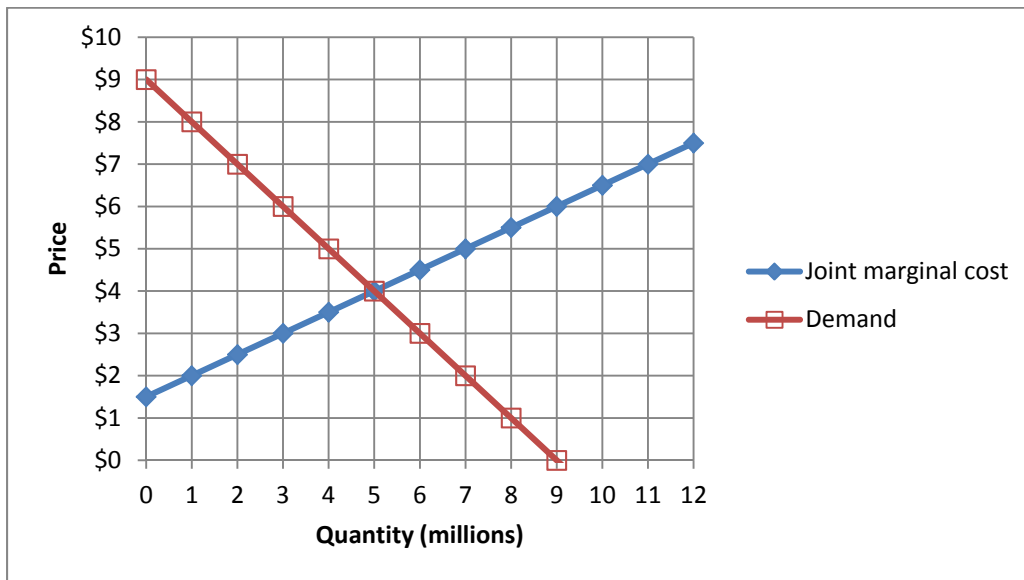
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(3) [Monopoly price discrimination: 4 pts] Suppose a movie theatre believes that the elasticity of demand for tickets by adults is  $-2$ , and the elasticity of demand by children is  $-5$ . Assume the movie theatre has a marginal cost of \$4 per ticket.

- Compute the movie theatre's profit-maximizing ticket price for adults.
- Compute the movie theatre's profit-maximizing ticket price for children.

\$
\$

(4) [Collusion/joint profit maximization: 16 pts] Three firms produce a food additive. Market demand and the three firms' joint marginal cost are shown in the graph below.



First, suppose the three firms form a cartel to maximize jointly the sum of their profits. The equation for demand is  $P = 9 - Q$ , where  $Q$  = quantity in millions.

a. Find the equation for the cartel's marginal revenue.

MR =
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b. Plot and label the cartel's marginal revenue curve in the graph above.

c. What price will the firms jointly set?

\$
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d. How much output will the firms produce, in total?

million
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e. Compute the amount of deadweight loss.

\$	million
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Alternatively, suppose the three firms engage in price competition.

f. Compute competitive equilibrium market price.

\$
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g. Compute competitive equilibrium market quantity.

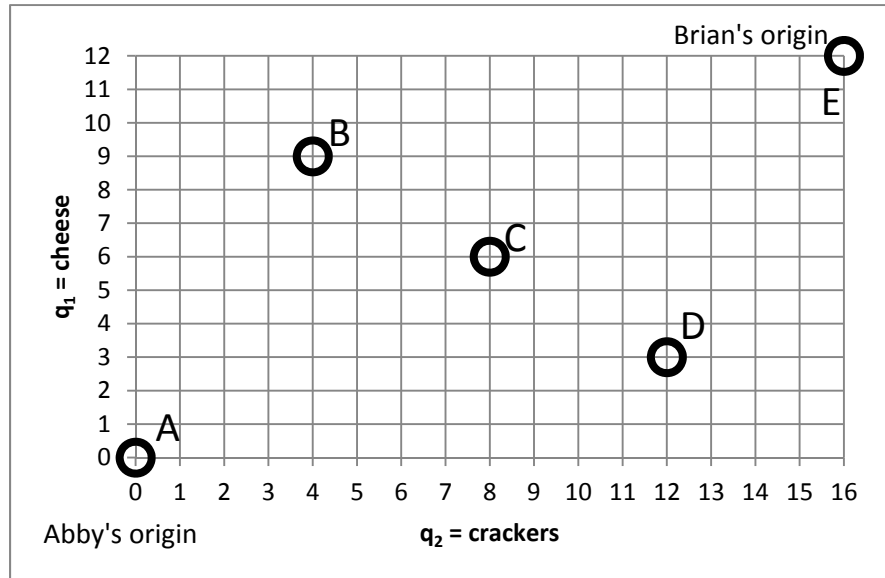
million
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h. Compute the amount of deadweight loss.

\$	million
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**III. PROBLEMS:** Please write your answers in the boxes on this question sheet. Show your work and circle your final answers.

(1) [Exchange efficiency: 12 pts] Abby and Brian both like cheese ( $q_1$ ) and crackers ( $q_2$ ). Abby's utility function is  $U_A = q_{1A} q_{2A}^3$ . Brian's utility function is  $U_B = q_{1B}^3 q_{2B}$ . A total of 16 crackers and 12 pieces of cheese must be divided between them. Consider the allocations depicted in the Edgeworth box below.



a. Is allocation A Pareto-efficient? Why or why not?

b. Is allocation B Pareto-efficient? Why or why not?

c. Is allocation C Pareto-efficient? Why or why not?

d. Is allocation D Pareto-efficient? Why or why not?

e. Is allocation E Pareto-efficient? Why or why not?

f. Sketch the contract curve in the Edgeworth box above.

(2) [Cost minimization across firms: 6 pts] Suppose Firm A and Firm B must together produce a total of **200** units of output at *minimum total cost*. Firm A's total cost function is given by  $TC_A = 12 q_A + (q_A^2/40)$ , where  $q_A$  denotes Firm A's output level. Firm B's total cost function is given by  $TC_B = 13 q_B + (q_B^2/80)$ , where  $q_B$  denotes Firm B's output level.

a. [4 pts] What output levels  $q_A$  and  $q_B$  should be produced by Firm A and Firm B? Justify your answers.

b. [2 pts] Suppose Firm A and Firm B are competitive firms, taking price as given. What market price would motivate Firm A and Firm B to produce these output levels? Justify your answer.

(3) [Monopoly pricing, deadweight loss: 12 pts] An electronics company is considering whether to develop and patent a new computer chip. Annual demand for the chip is predicted to be given by  $P = 25 - (Q/50)$ . Marginal and average cost of production is predicted to be constant and equal to \$5. There are also up-front costs of developing the chip and acquiring a patent.

- a. If the company were to develop and patent the chip, what quantity would it produce and what price would it set?

- b. What is the maximum amount of up-front costs the company would pay for developing and patenting the chip? For simplicity, assume the patent would be valid for only one year. [Hint: What level of up-front costs would reduce profits to zero?]

- c. After the patent runs out, other companies could produce the chip with same marginal cost, but without having to incur up-front costs. What quantity would then be produced and what price would prevail in the market, which is now competitive?

- d. Compute the predicted deadweight loss to society from monopoly pricing of this chip. [Hint: First sketch the graph.]

(4) [Cournot duopoly: 14 pts] Suppose two makers of an industrial part form a symmetric Cournot duopoly, each firm setting its own quantity while taking the other firm's quantity as given. Let  $q_1$  = firm #1's quantity and  $q_2$  = firm #2's quantity, so that total market quantity  $Q = q_1 + q_2$ . The market demand curve is  $P = 20 - (Q/100)$ . Each firm has constant marginal and average cost equal to \$2. Use the space at the bottom of the next page for scratch work. Note: question continues on next page.

- a. Find an expression for firm #1's revenue, as a function of its own quantity and the quantity produced by the other firm:  $Rev_1(q_1, q_2)$ .

- b. Find an expression for firm #1's marginal revenue, as a function of its own quantity and the quantity produced by the other firm:  $MR_1(q_1, q_2)$ .

- c. Find an expression for firm #1's reaction function, showing how much firm #1 will produce for any given level of quantity set by the other firm:  $q_1^* = f(q_2)$ .

- d. Assume the equilibrium is symmetric (that is, assume  $q_1^* = q_2^*$ ) and compute firm #1's equilibrium quantity  $q_1^*$ .



e. Compute total market quantity  $Q^*$  and the equilibrium price  $P^*$ .

f. Compute the total profit of both firms.

g. Compute the social deadweight loss.



(5) [Game theory: 9 pts] Firms A and B produce competing brands of toothpaste. Each firm finds that advertising is costly but helps attract customers away from its rival. Their situation is expressed by the following game in normal form.

		Firm B	
		Advertise	Do not advertise
Firm A	Advertise	A gets \$5 million. B gets \$5 million.	A gets \$12 million. B gets \$2 million.
	Do not advertise	A gets \$2 million. B gets \$12 million.	A gets \$10 million. B gets \$10 million.

- a. Which of the four outcomes of this game (if any) are Pareto-optimal? Describe each such outcome by listing the *strategies* chosen by each retailer.

1.
2.
3.
4.

- b. Which of the four outcomes of this game (if any) are dominant-strategy equilibria<sup>1</sup>? Describe each such equilibrium by listing the *strategies* chosen by each retailer.

1.
2.
3.
4.

- c. Which of the four outcomes of this game (if any) are Nash equilibria in pure strategies? Describe each such equilibrium by listing the *strategies* chosen by each retailer.

1.
2.
3.
4.

<sup>1</sup> "Equilibria" is the plural form of "equilibrium."

**IV. CRITICAL THINKING:** Answer the question below. Show your work and circle your final answers. [4 pts]

(1) Firm A and Firm B produce similar items, but their designs are distinctive, so their products are not perfect substitutes. Firm A's demand is given by  $Q_A = 120 - 20 P_A + 10 P_B$ . Firm B's demand is given by  $Q_B = 120 - 20 P_B + 10 P_A$ . Each firm sets its own *price*, taking as given the *price* of the other firm. Assume the firms have no costs, so each firm simply seeks to maximize its own revenue.

- a. What price should Firm A set, given Firm B's price  $P_B$ ? Give an expression in terms of  $P_B$ . In other words, give Firm A's *best reply function*.
- b. Compute the (Nash) equilibrium prices  $P_A^*$  and  $P_B^*$ .

[end of exam]