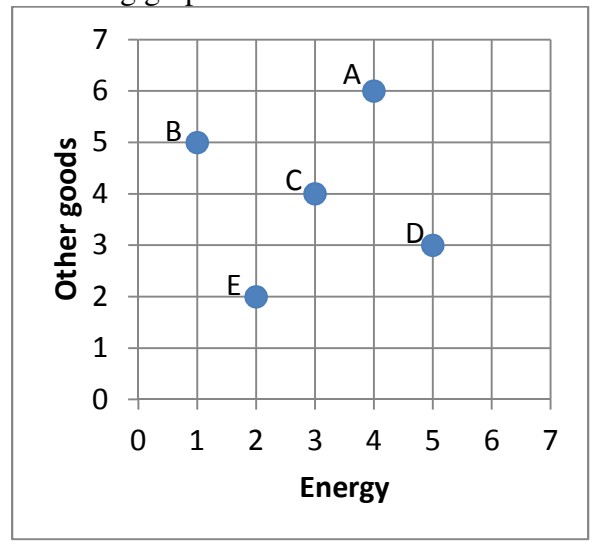


## FINAL EXAMINATION VERSION B December 10, 2013

**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. Maximum total points are 100.

**I. MULTIPLE CHOICE:** Circle the one best answer to each question. Use margins for scratch work. [1 pt each—20 pts total]

The next two questions refer to the following graph of consumer bundles.



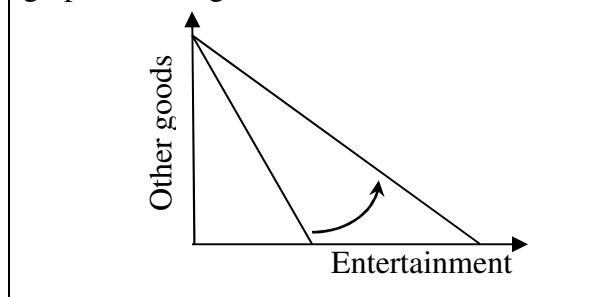
(1) According to the assumption of "monotonicity" or "more is better," which bundle is surely preferred by any consumer to bundle E?

- a. Bundle A.
- b. Bundle B.
- c. Bundle C.
- d. Bundle D.
- e. Bundles A,C, and D.
- f. All of the above.

(2) Suppose that bundles B and D are equally preferred. According to the assumption of "diminishing marginal rate of substitution," bundle C must be

- a. more preferred than bundle A.
- b. equally preferred to bundles A and E.
- c. equally preferred to bundles B or D.
- d. more preferred than bundles B or D.
- e. more preferred than bundle D, but less preferred than bundle B.
- f. less preferred than bundles B or D.

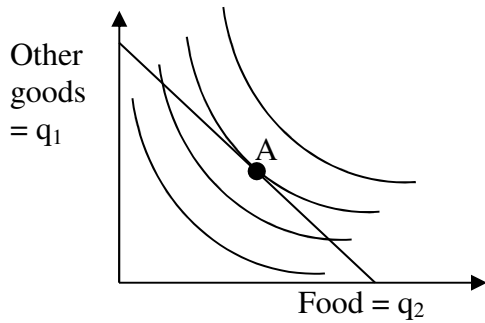
The next question refers to the following graph of a budget line.



(3) In the graph above, the shift in the budget line could be caused by

- a. an increase in income.
- b. a decrease in income.
- c. an increase in the price of entertainment.
- d. a decrease in the price of entertainment.
- e. an increase in the price of other goods.
- f. a decrease in the price of other goods.

The next two questions refer to the following graph of a consumer's budget line and indifference curves. Suppose the consumer is currently at bundle A for some reason.



(4) This consumer could enjoy higher utility, without increasing total spending, by

- purchasing less food and more other goods.
- purchasing more food and fewer other goods.
- purchasing less food and fewer other goods.
- any of the above.
- none of the above.

(5) Let  $MU_1$  denote the marginal utility of other goods and  $MU_2$  the marginal utility of food for this consumer. Let  $p_1$  denote the price of other goods and  $p_2$  denote the price of food. At bundle A,

- $MU_2 = MU_1$  and  $p_2 = p_1$ .
- $MU_2/MU_1 = p_2/p_1$ .
- $MU_2/MU_1 < p_2/p_1$ .
- $MU_2/MU_1 > p_2/p_1$ .
- cannot be determined from information given.

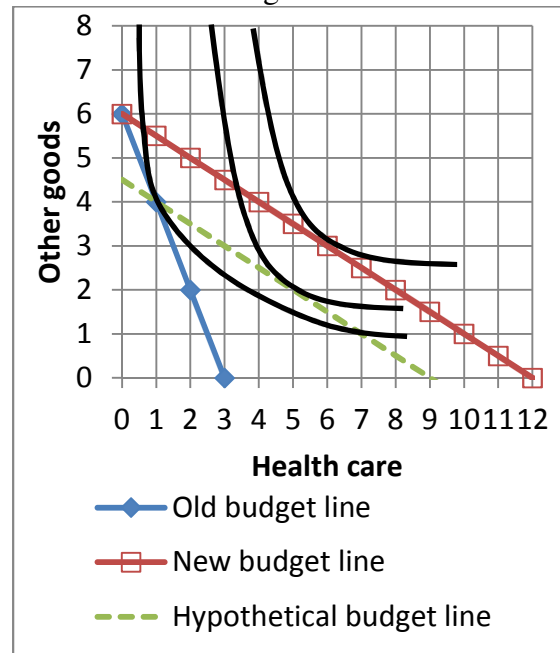
(6) Which function is *not* homogeneous of degree zero in income and prices?

- $q_1^* = I / (p_1 + p_1^{1/2} p_2^{1/2})$ .
- $q_1^* = I / (8p_1) + 7$ .
- $q_1^* = 0.05 I - 2p_1 + 0.1 p_2$ .
- $q_1^* = 2p_2/p_1 + I / (6p_1)$ .
- All are homogeneous of degree zero.

(7) Which of the following demand functions exhibits a constant price elasticity of demand?

- $q_1^* = I / (6p_1) + 3$ .
- $q_1^* = 50 - 2 p_1 + 0.08 I - 0.01 p_2$ .
- $q_1^* = 5 p_1^{-1.2} I^{1.1} p_2^{0.2}$ .
- $q_1^* = 2 + 0.9 p_2/p_1 + I / (4p_1)$ .
- None of the above.

The next two questions refer to the graph below. The black curves are the consumer's indifference curves. The straight lines are the consumer's budget lines.



(8) The substitution effect of the price change causes the quantity demanded of health care to increase by

- one unit.
- two units.
- three units.
- four units.
- five units.

- (9) The income effect of the price change causes the quantity demanded of health care to increase by
- one unit.
  - two units.
  - three units.
  - four units.
  - five units.

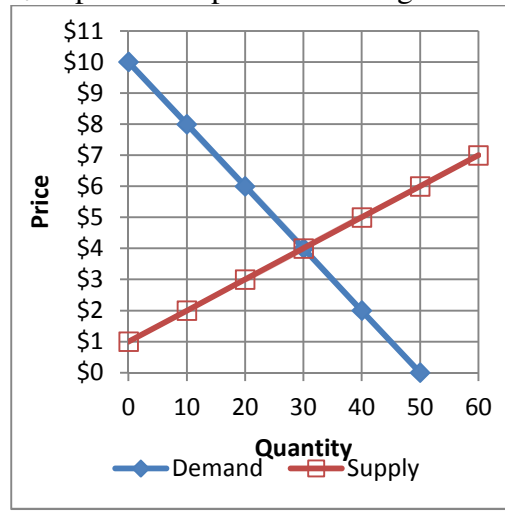
- (10) Which production function below violates the assumption of "diminishing marginal rate of substitution"?
- $q = x_1^1 x_2^3$ .
  - $q = 1 x_1 + 3 x_2$ .
  - $q = x_1^{1/4} x_2^{3/4}$ .
  - $q = 1 x_1^{1/2} + 3 x_2^{1/2}$ .

The next two questions refer to the following information. Suppose a firm's long-run total cost function is given by  $TC(q) = 0.005 q^3 - 0.5 q^2 + 20 q$ .

- (11) The firm's *marginal cost* function is  $MC(q) =$
- $0.01 q - 0.5$ .
  - $0.03 q - 1$ .
  - $0.005 q^2 - 0.5 q + 20$ .
  - $0.015 q^2 - q + 20$ .
  - $0.005 q^3 - 0.5 q^2 + 20 q$ .
- (12) The firm's *average cost* function is  $AC(q) =$
- $0.01 q - 0.5$ .
  - $0.03 q - 1$ .
  - $0.005 q^2 - 0.5 q + 20$ .
  - $0.015 q^2 - q + 20$ .
  - $0.005 q^3 - 0.5 q^2 + 20 q$ .

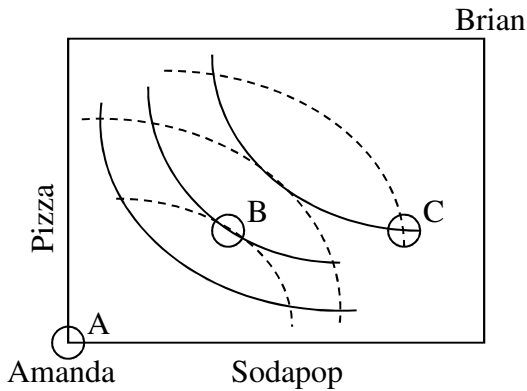
- (13) Price equals *marginal cost* in
- short-run competitive equilibrium.
  - long-run competitive equilibrium.
  - both short-run and long-run competitive equilibrium.
  - none of the above.
- (14) A *Pareto improvement* is defined as a change in the economy where
- everyone gains.
  - at least one person gains.
  - at least one person gains and no one loses.
  - the gains to the winners exceed the losses to the losers.

The next two questions refer to the following graph, which shows supply and demand for a particular good. Suppose a tax of \$3 per unit is placed on this good.



- (15) The deadweight social loss from the tax is
- \$3.
  - \$10.
  - \$15.
  - \$20.
  - \$25.
  - \$30.
  - \$60.

The next question refers to the following Edgeworth box diagram for consumption. The solid curves are Amanda's indifference curves. The dashed curves are Brian's indifference curves.



- (16) From allocation B, *both* consumers can enjoy greater utility if
- Amanda gives Brian some pizza, and Brian gives Amanda some sodapop.
  - Amanda gives Brian some sodapop, and Brian gives Amanda some pizza.
  - Amanda gives Brian some pizza and some sodapop.
  - Brian gives Amanda some pizza and some sodapop.
  - No trade will allow both consumers to enjoy greater utility.

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

- $AC(q) = 0.5q$ .
- $AC(q) = 2 - 0.1q^{-1}$ .
- $AC(q) = 5 + 200q^{-1}$ .
- $AC(q) = 0.002q^2 + 0.01q + 4$ .
- $AC(q) = 3$ .

(18) Unlike other taxes, a pollution tax (also called a Pigou tax)

- causes deadweight loss.
- does not generate any revenue for the government.
- affects only producers.
- does not cause deadweight loss.

(19) Which utility function does *not* show risk aversion?

- $U(I) = \ln(I)$ , where  $\ln(\cdot)$  denotes the natural logarithm.
- $U(I) = I^{3/4}$ .
- $U(I) = -1/I$ .
- $U(I) = I^{1/3}$ .
- $U(I) = 3 + 4I$ .

(20) Healthy individuals are less likely to apply for health insurance. This is an example of

- adverse selection.
- moral hazard.
- exchange efficiency.
- market power.
- risk aversion.

**II. SHORT ANSWER:** Please write your answers in the boxes on this question sheet. Use margins for scratch work. [10 pts total]

(1) [Price elasticity of demand: 5 pts] Suppose the price elasticity of demand for water is  $-0.6$ , and the water utility raises its rates by 5 %.

- a. Is the demand for water *elastic* or *inelastic* ?
- b. Will the quantity demanded of water *increase* or *decrease*?
- c. By about how much?
- d. Will the revenue received by the water utility *increase* or *decrease*?
- e. By about how much?

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|  |   |
|  | % |
|  |   |
|  | % |

(2) [Technical change: 2 pts] The elasticity of output with respect to labor input for the US economy as a whole is about  $2/3$ . The elasticity of output with respect to capital input is about  $1/3$ . Suppose labor input increases by 1.5% and capital input increases by 2.4%.

- a. By how much would output increase, without any technical change?
- b. Suppose output in fact increases by 4.0%. What is the increase in multifactor or total factor productivity (also called the Solow residual)?

|  |   |
|--|---|
|  | % |
|  | % |

(3) [Marginal revenue: 3 pts] Suppose a coffee vendor with market power is now selling 20 cups of coffee per hour at a price of \$3.00. If she cuts the price to \$2.95, she can sell one more cup of coffee per hour (that is, a total of 21 cups of coffee per hour).

- a. Compute the vendor's marginal revenue for the 21st 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 \$2.95 to sell 21 cups of coffee per hour.

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

|    |
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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. [62 pts total]

(1) [Budgets and choice: 6 pts] A consumer has the following utility function:  
 $U(q_1, q_2) = q_1 q_2^4$ , where  $q_1$  denotes the quantity of energy and  $q_2$  denotes the quantity of other goods. The price of energy is \$2 and the price of other goods is \$5. The consumer has \$100 in income to spend on these items.

- a. Give an equation for the consumer's budget line. The variables  $q_1$  and  $q_2$  should be the only unknowns.

- b. Find a formula for the consumer's marginal rate of substitution in consumption of other goods for energy—that is, the slope of the consumer's indifference curve with energy on the vertical axis and other goods on the horizontal axis. The variables  $q_1$  and  $q_2$  should be the only unknowns. Circle your final answer.

- c. Solve for the quantities of energy ( $q_1^*$ ) and other goods ( $q_2^*$ ) that this consumer will choose. Circle your final answers.

(2) [Production functions: 6 pts] Suppose a production function is given by  $q = 12 x_1^{2/4} x_2^{3/4}$ .

- a. Find an expression for the marginal product of input 1. Are there diminishing returns to input 1? Justify your answer.

- b. Find an expression in terms of  $x_1$  and  $x_2$  for the marginal rate of substitution of input 2 for input 1—that is, the absolute value of the slope of an isoquant, with  $x_1$  on the vertical axis and  $x_2$  on the horizontal axis. Does production show a diminishing marginal rate of substitution? Justify your answer.

- c. Does this production function have *constant* returns to scale, *increasing* returns to scale, or *decreasing* returns to scale? Justify your answer.

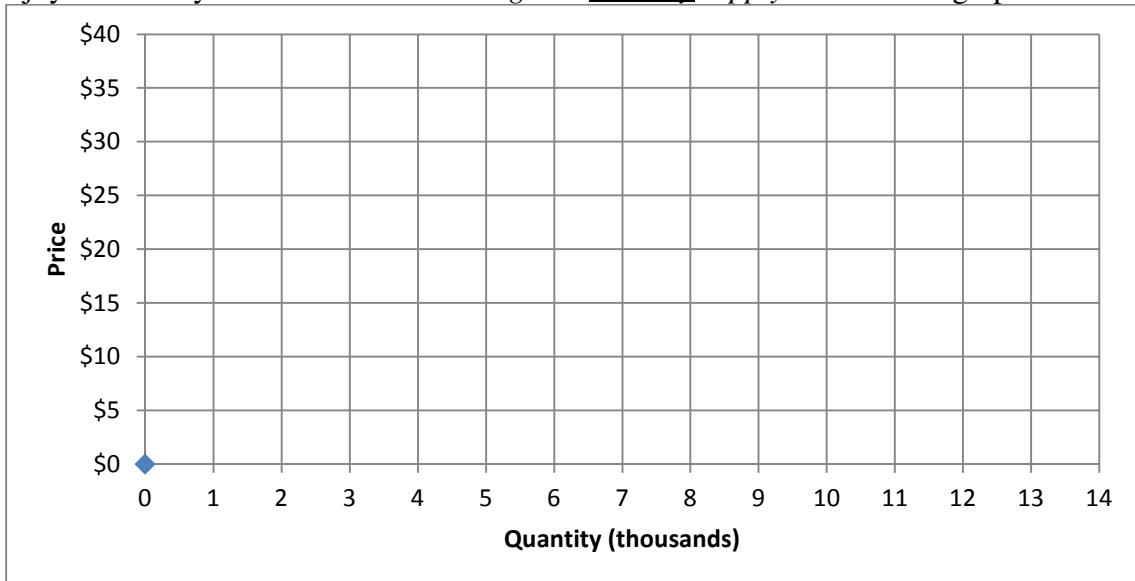
(3) [Long-run profit maximization and supply: 8 pts] Suppose a firm faces a (long-run) total cost function given by  $TC(q) = q^3 - 100q^2 + 2510q$ .

- a. Compute the representative firm's efficient scale  $q_{ES}$ . Show your work and circle your final answer.

- b. Compute the firm's breakeven price—the minimum price at which it will avoid losses. Show your work and circle your final answer.

- c. Find an equation for the *firm's supply curve*. Show your work and circle your final answer.

- d. Suppose all firms in this industry have the same costs, and these costs are not affected by other firms in the same industry or by total industry output. Further assume the industry enjoys free entry and exit. Draw the *long-run industry supply curve* in the graph below.





(4) [Monopoly pricing, deadweight loss: 8 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.]

(5) [Game theory: 6 pts] Two big-box retailers, A and B, are choosing locations for a new store. The downtown location is more profitable than the uptown location, but if the retailers choose the same location, they split the business. Their situation is expressed by the following game in normal form.

|            |                 | Retailer B                                  |   |
|------------|-----------------|---|---|
|            |                 | Locate uptown                               | Locate downtown                             |
| Retailer A | Locate uptown   | A gets \$4 million.<br>B gets \$4 million.  | A gets \$8 million.<br>B gets \$10 million. |
|            | Locate downtown | A gets \$10 million.<br>B gets \$8 million. | A gets \$5 million.<br>B gets \$5 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."

(6) [External cost and Pigou tax: 8 pts] Suppose supply and demand for a particular chemical are given by the following equations. Use the space at the bottom of this page for scratch work.

Demand:  $P_D = 12 - (Q/100)$

Supply:  $P_S = 2 + (Q/100)$ .

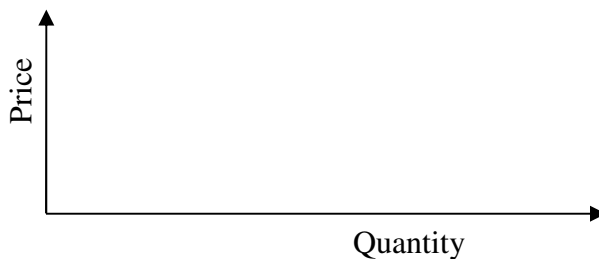
- a. Compute the unregulated equilibrium price and quantity.

Unfortunately, the use of this chemical causes harm to ocean fisheries, creating an external cost. Marginal external cost per unit is estimated to be  $MEC = 1 + Q/100$ .

- b. Find a formula for the marginal social cost of the chemical.

- c. Compute the socially-optimal quantity of output.

- d. Compute the Pigou tax rate on this chemical, in dollars per unit, that would result in the socially-optimal quantity of the chemical.



(7) [Demand for insurance: 10 pts] Suppose someone has utility function  $U(W) = -120/W$ , where  $W$  denotes wealth. Suppose this person now has wealth of \$60 but faces a 50% chance of losing \$30 of that wealth.

- a. Compute this person's expected wealth without insurance (in dollars). Call this value  $EW$ .

- b. Compute this person's expected utility without insurance (in "utils"). Call this value  $EU$ .

- c. Compute the amount of wealth that, if had for certain, would bring the same utility as the person's current situation. [Hint: Solve  $U(W^*) = EU$  for  $W^*$ .]

- d. Compute the maximum premium amount this person would be willing to pay for full insurance against losing \$30.

- e. Compute the actuarially fair premium amount for full insurance against losing \$30.

(8) [Hidden characteristics and adverse selection: 10 pts] Suppose the market for homeowners insurance consists of 1000 people. Order these people from high-risk to low-risk, and index them by  $Q = 0$  to 1000. The expected loss of the  $Q$ th person is given by  $EL = 200 - 0.1 Q$ . (Thus the last person's expected loss is about \$100.) Everyone is risk-averse, and willing to pay \$20 more than their expected loss (EL) for insurance.

- a. Give an equation for the demand for insurance, with  $P$  (or willingness-to-pay) as a function of  $Q$ .

- b. Give an equation for the marginal cost of insurance  $MC$  as a function of  $Q$ . (Assume there are no administrative costs.)

- c. If the market were efficient, how many people would get insurance?

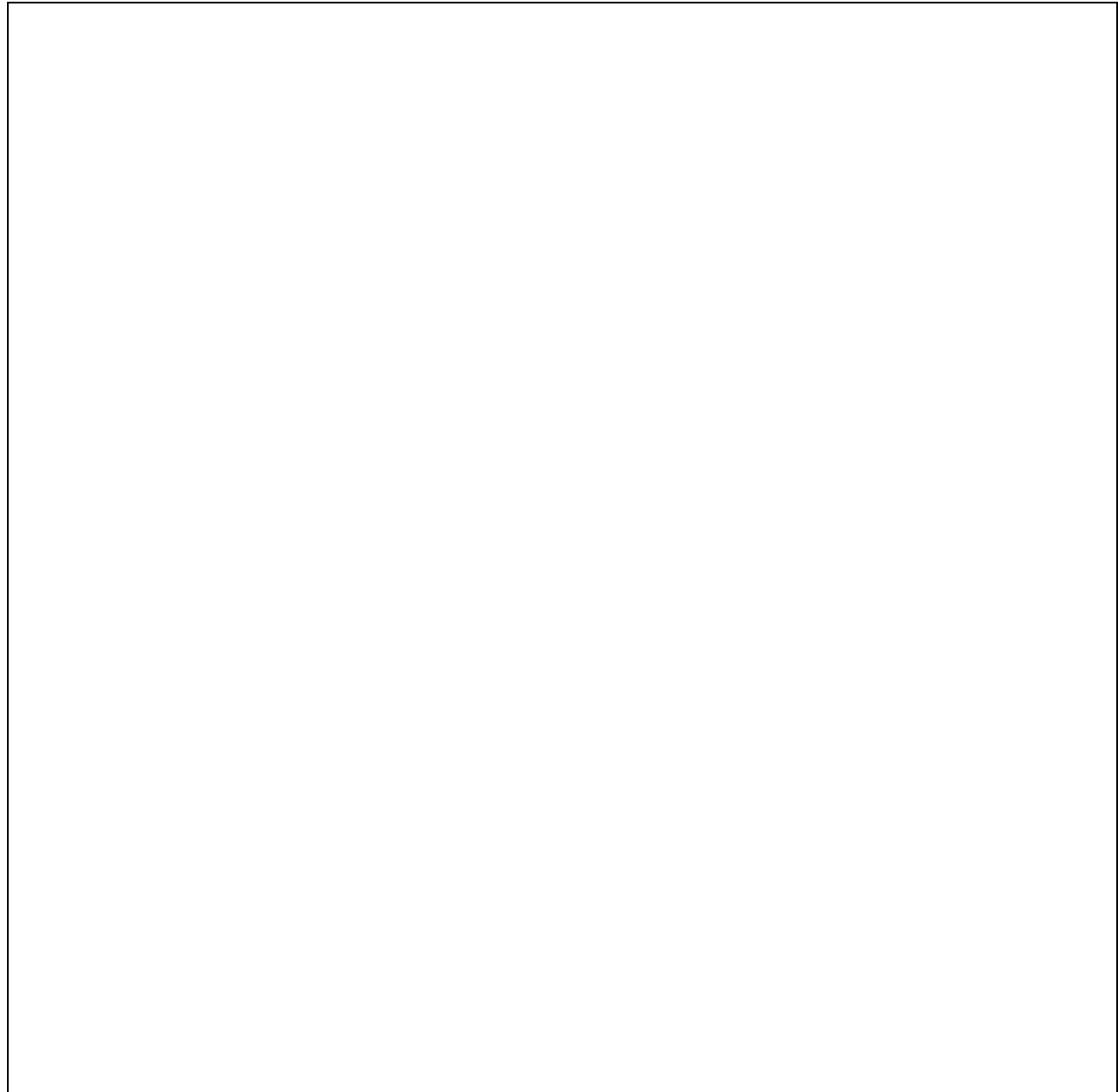
- d. Give an equation for the average cost of insurance  $AC$  as a function of  $Q$ .

- e. Assume the market is competitive, but that insurance companies cannot observe individual persons' expected loss. Find the equilibrium price  $P$  and quantity  $Q$  of insurance.

**IV. ESSAY:** Write an essay of at least 100 words answering the following question. [8 pts]  
Continue on the next page if necessary. Full credit requires good grammar, accurate spelling,  
and correct reasoning.

“As long as there is more than one firm in an industry, and each firm maximizes its own profit, then **economic theory predicts that** competition will drive the market price down to marginal cost in that industry.” Do you agree or disagree? Explain why.

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**SCORING RUBRIC**

- 2 pts Explanation shows very limited understanding of the underlying concepts needed to analyze the information. Explanation is difficult to understand and is missing several components.
- 4 pts Explanation shows some understanding of the economic concepts and models needed to analyze the information. Explanation is a little difficult to understand but includes critical components.
- 6 pts Explanation shows substantial understanding of the economic concepts and models used to analyze the information. Explanation is clear.
- 8 pts Explanation shows complete understanding of the economic concepts and models used to analyze the information. Explanation is detailed and clear.

[end of exam]