

## FINAL EXAMINATION VERSION A

**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 200.

**I. MULTIPLE CHOICE:** Circle the one best answer to each question. Feel free to use margins for scratch work [2 pts each—40 pts total].

(1) The assumption of monotonicity implies that indifference curves

- a. slope up.
- b. slope down.
- c. get flatter as they approach the horizontal axis.
- d. get steeper as they approach the horizontal axis.
- e. none of the above.

(2) Which function below is homogeneous of degree zero in income and prices?

- a.  $q_1^* = 0.08 I - 3p_1 + 0.05 p_2$ .
- b.  $q_1^* = 0.05 I + 0.2/p_1$ .
- c.  $q_1^* = 0.03 I + 0.9 (p_2/p_1)$ .
- d.  $q_1^* = I/(5p_1) + 7$ .
- e. All are homogeneous of degree zero.

(3) Suppose the income elasticity of demand for beans is -0.2. Then beans are

- a. an inferior good.
- b. a necessary good.
- c. a luxury (or superior) good.
- d. None of the above.

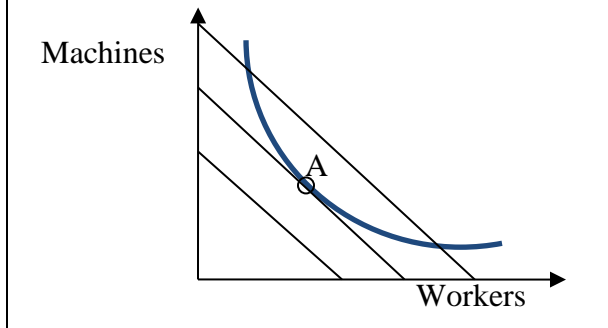
(4) Let  $q_1^{\text{old}}$  and  $q_2^{\text{old}}$  denote the quantities of good 1 and good 2 purchased by a typical consumer five years ago. Let  $p_1^{\text{old}}$  and  $p_2^{\text{old}}$  denote the prices of those goods five years ago. Let  $q_1^{\text{new}}$  and  $q_2^{\text{new}}$  denote the quantities of good 1 and good 2 purchased by a typical consumer this year. Let  $p_1^{\text{new}}$  and  $p_2^{\text{new}}$  denote the prices of those goods this year. Which formula below tends to *underestimate* the increase in the cost of living from five years ago to this year?

- a.  $\frac{p_1^{\text{new}} q_1^{\text{new}} + p_2^{\text{new}} q_2^{\text{new}}}{p_1^{\text{old}} q_1^{\text{new}} + p_2^{\text{old}} q_2^{\text{new}}}$
- b.  $\frac{p_1^{\text{new}} q_1^{\text{old}} + p_2^{\text{new}} q_2^{\text{old}}}{p_1^{\text{old}} q_1^{\text{old}} + p_2^{\text{old}} q_2^{\text{old}}}$

c.  $\sqrt{\frac{p_1^{\text{new}} q_1^{\text{old}} + p_2^{\text{new}} q_2^{\text{old}}}{p_1^{\text{old}} q_1^{\text{old}} + p_2^{\text{old}} q_2^{\text{old}}}} \times \frac{p_1^{\text{new}} q_1^{\text{new}} + p_2^{\text{new}} q_2^{\text{new}}}{p_1^{\text{old}} q_1^{\text{new}} + p_2^{\text{old}} q_2^{\text{new}}}$

- d. all of the above.
- e. none of the above.

The next two questions refer to the following diagram of a firm's isocost lines and an isoquant. Suppose the firm is currently at input combination A.



- (5) This firm could lower its total cost, without reducing output, by
- using fewer machines and more workers.
  - using more machines and fewer workers.
  - either (a) or (b).
  - neither (a) nor (b).
  - cannot be determined.

- (6) Let  $MP_1$  denote the marginal product of machines and  $MP_2$  the marginal product of workers for this firm. Let  $w_1$  denote the price of machines and  $w_2$  denote the price of workers. At input combination A,
- $MP_2/MP_1 < w_2/w_1$ .
  - $MP_2/MP_1 > w_2/w_1$ .
  - $MP_2/MP_1 = w_2/w_1$ .
  - $MP_2 = MP_1$  and  $w_2 = w_1$ .
  - cannot be determined from information given.

- (7) In the short run, a firm should shut down immediately if its
- revenue is less than producer surplus.
  - revenue is less than variable cost.
  - revenue is less than fixed cost.
  - profit is negative.

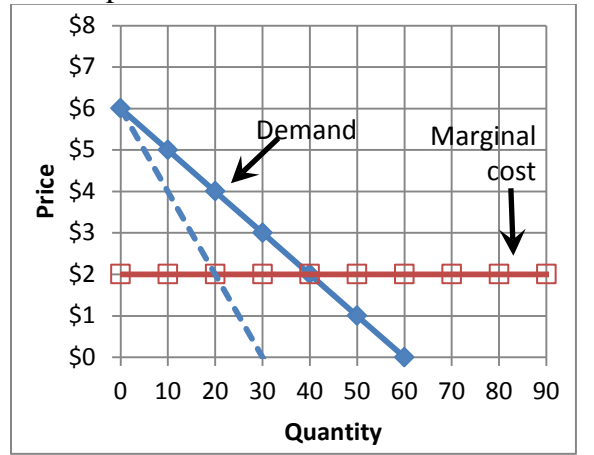
- (8) In *long-run* competitive equilibrium,
- price equals marginal cost.
  - price equals average cost.
  - average cost equals marginal cost.
  - all of the above.

- (9) Suppose the price of wheat rises. The increase in long-run producer surplus goes to farmers and
- food processing companies that use wheat to make other products.
  - all wheat buyers.
  - farmland owners.
  - ultimate consumers of wheat-based products.

- (10) 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.

- (11) Which equation for average cost implies that the firm enjoys a natural monopoly?
- $AC(q) = 0.5q$ .
  - $AC(q) = 2 - 0.1q^{-1}$ .
  - $AC(q) = 5 + 200q^{-1}$ .
  - $AC(q) = 0.002q^2 + 0.01q + 4$ .
  - $AC(q) = 3$ .

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



(12) What quantity of output will the monopolist choose if it must charge the *same* price to all customers?

- a. 20 units.
- b. 30 units.
- c. 40 units.
- d. 50 units.
- e. 60 units.

(13) What quantity of output will the monopolist choose if it can engage in *perfect price discrimination*?

- a. 20 units.
- b. 30 units.
- c. 40 units.
- d. 50 units.
- e. 60 units.

(14) The model of monopolistic competition assumes

- a. firms cooperate to maximize the sum of their profits.
- b. firms produce perfect substitutes.
- c. free entry of firms.
- d. marginal revenue equals price.
- e. All of the above.

(15) Which of the following characterizes a Nash equilibrium of a game?

- a. The sum of the payoffs for both players is maximized.
- b. Neither player wants to change strategies unilaterally.
- c. Neither player can be made better off without the other player being made worse off.
- d. Each player is receiving the highest possible payoff in the game.

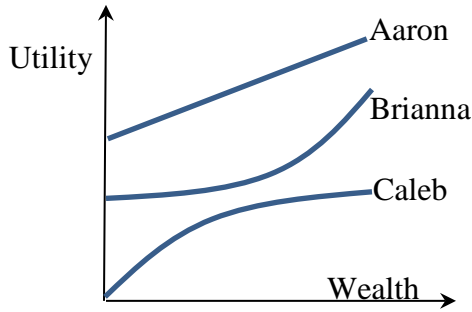
(16) Unlike other taxes, a pollution tax (also called a Pigou tax)

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

(17) The Des Moines Art Museum is spacious enough that it can accommodate many visitors without crowding. However, it *can* charge admission—and sometimes does so for special events. The Museum is thus

- a. a rival good.
- b. an excludable good.
- c. both of the above.
- d. none of the above.

The next question refers to the following graph.



- (18) The graph above shows utility functions for three people. Who is risk-averse?
- Aaron.
  - Brianna.
  - Caleb.
  - All of the above.
  - None of the above.

- (19) Clumsy smart phone users are more likely to apply for extended warranties. This is an example of
- moral hazard.
  - exchange efficiency.
  - market power.
  - adverse selection.

- (20) Sometimes people who lose their health insurance take greater care to avoid getting sick. This is an example of
- income and substitution effects.
  - adverse selection.
  - exchange efficiency.
  - moral hazard.

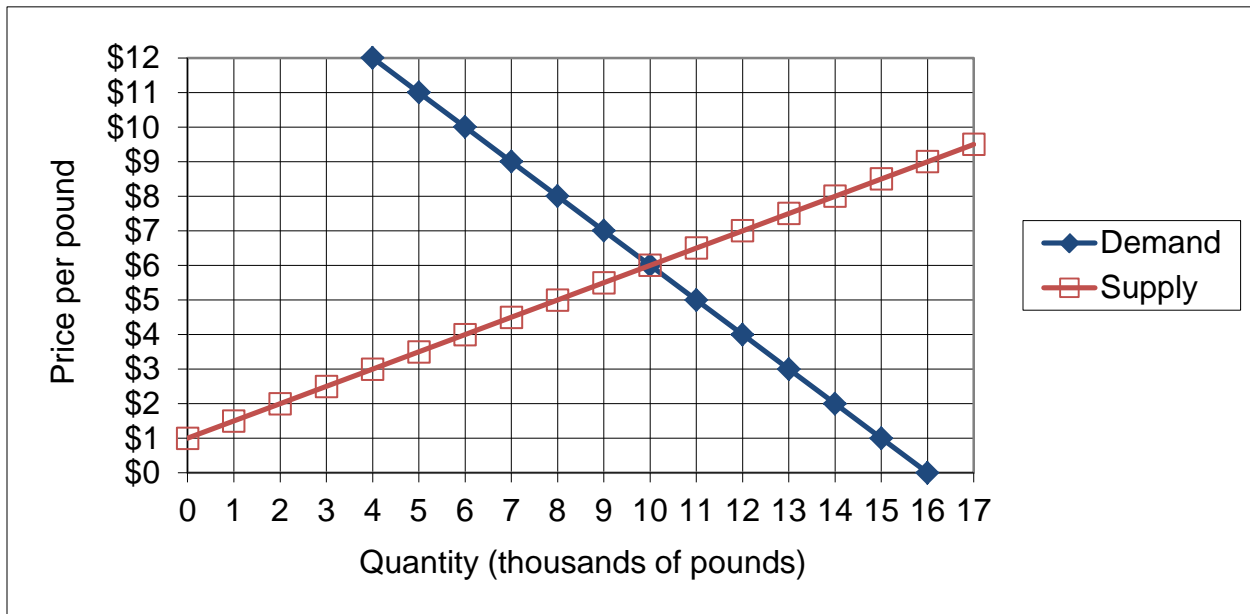
**II. SHORT ANSWER:** Please write your answers in the boxes on this question sheet. Use margins for scratch work.

(1) [Price elasticity of demand: 10 pts] Suppose the price elasticity of demand for water is  $-1.5$ , and the water utility raises the price of water by 4%.

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

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|  |   |
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(2) [Welfare effects of market controls: 16 pts] The following graph shows the market for blue cheese.

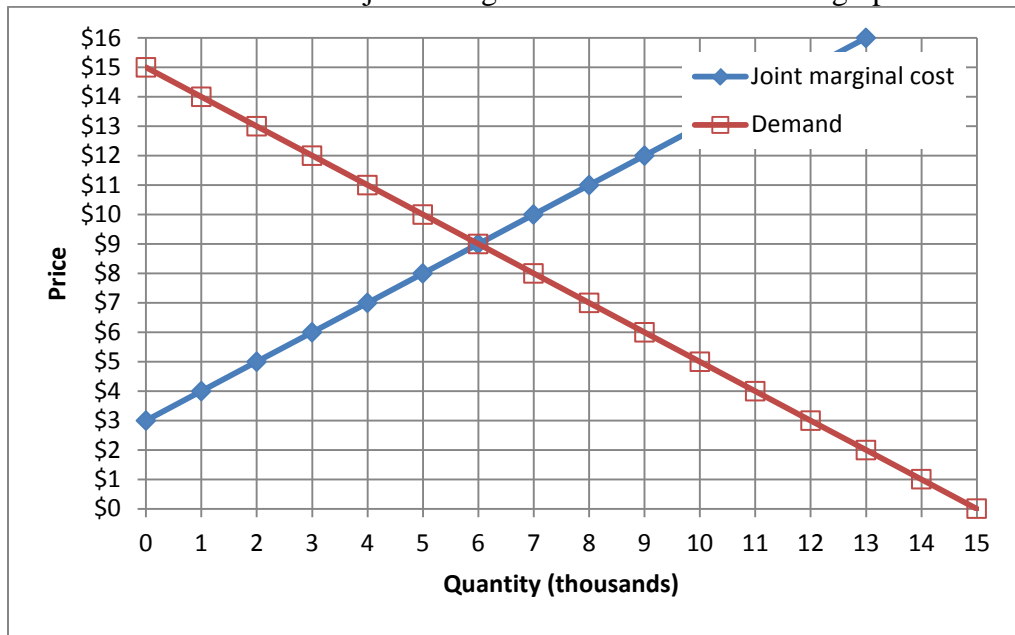


Suppose the government imposes a price floor (or legal minimum price) of \$ 8 per pound. No blue cheese may be sold for a price less than the price floor.

- How many pounds of blue cheese will actually be sold?
- Will there be *excess demand*, *excess supply*, or *neither*?
- How much?
- Does producer surplus *increase*, *decrease*, or *remain constant* because of the price floor, as compared to the market without government intervention? (Assume optimistically that blue cheese is sold by those producers who have the lowest cost.)
- By how much?
- Does consumer surplus *increase*, *decrease*, or *remain constant* because of the price floor, as compared to the market without government intervention?
- By how much?
- Compute the deadweight social loss caused by the price floor.

|    |                 |
|----|-----------------|
|    | thousand pounds |
|    |                 |
|    | thousand pounds |
|    |                 |
| \$ | thousand        |
|    |                 |
| \$ | thousand        |
|    |                 |
| \$ | thousand        |

(3) [Collusion/joint profit maximization: 16 pts] Three firms produce a particular product. 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  $P = 15 - Q$ , where  $Q$  = quantity in thousands.

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?

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|----------|
| thousand |
|----------|

e. Compute the amount of deadweight loss.

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|----|----------|
| \$ | thousand |
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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.

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|----------|
| thousand |
|----------|

h. Compute the amount of deadweight loss.

|    |          |
|----|----------|
| \$ | thousand |
|----|----------|

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

(1) [Budgets and choice: 16 pts] A consumer has the following utility function:

$U(q_1, q_2) = (q_1 - 5)^2 q_2^3$ , where  $q_1$  denotes the quantity of food and  $q_2$  denotes the quantity of other goods. The price of food is \$4 and the price of other goods is \$2. The consumer has \$50 in income to spend on these items.

- a. [4 pts] Give an equation for the consumer's budget line. The variables  $q_1$  and  $q_2$  should be the only unknowns.

- b. [4 pts] Find a formula for the consumer's marginal rate of substitution in consumption of other goods for food—that is, the |slope| of the consumer's indifference curve with food 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. [8 pts] Solve for the quantities of food ( $q_1^*$ ) and other goods ( $q_2^*$ ) that this consumer will choose. Circle your final answers.

(2) [Slutsky equation: 8 pts] The Slutsky equation in elasticity form is given by the following:

$\varepsilon = -S \eta + \varepsilon^{\text{comp}}$ , where, as usual,  $\varepsilon$  denotes the own-price elasticity of demand,  $S$  denotes the share of total consumer spending devoted to the good (a fraction),  $\eta$  denotes the income elasticity of demand, and  $\varepsilon^{\text{comp}}$  denotes the compensated demand elasticity.

Suppose that for energy,  $\varepsilon = -0.8$ ,  $S = 0.05$ , and  $\eta = 0.4$ . Now suppose that the price of energy increases by 10%.

- a. First, suppose nothing else changes. Will the quantity demanded of energy increase or decrease? By how much?

- b. Alternatively, suppose the government cushions the blow of higher energy prices by giving everyone a cash transfer equal to 10 percent of last year's spending on energy. Will the quantity demanded of energy increase or decrease? By how much? [Hint: first find  $\varepsilon^{\text{comp}}$ .]



- (3) [Production functions: 12 pts] Suppose a production function is given by  $q = 15 x_1^{2/5} x_2^{4/5}$ .
- 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 in production 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.

(4) [Welfare effects of international trade: 15 pts] Suppose domestic demand and supply for a good are given by the following equations. (Use the graph at right for scratch work.)

Domestic demand:

$$Q_D = 2000 - 100 P$$

Domestic supply:

$$Q_S = 200 P - 100$$



First consider the market without international trade.

a. Compute the equilibrium price and quantity.

Now suppose the market is opened to international trade, and the world price of the good turns out to be **\$9**.

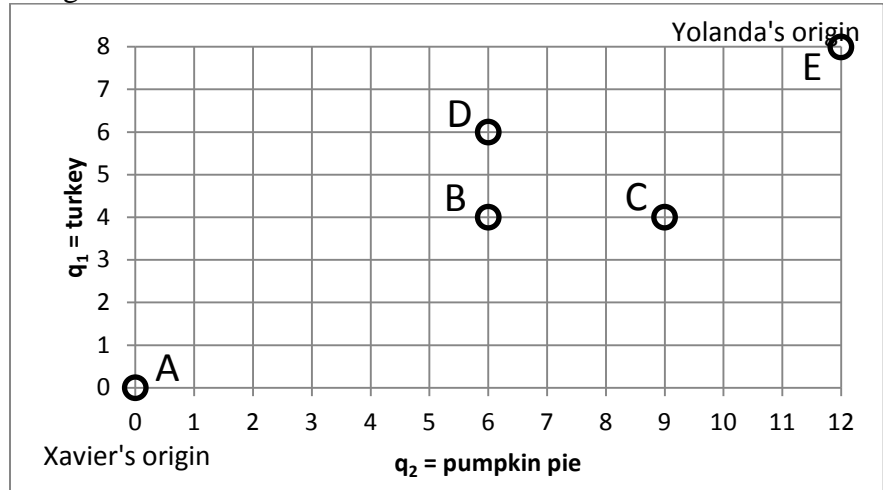
b. Will the country now *import* or *export* the good? How much?

c. Does consumer surplus *increase* or *decrease* as a result of international trade? By how much?

d. Does producer surplus *increase* or *decrease* as a result of international trade? By how much?

e. Does society as a whole *gain* or *lose* as a result of international trade? By how much?

(5) [Exchange efficiency: 12 pts] Xavier and Yolanda both like turkey ( $q_1$ ) and pumpkin pie ( $q_2$ ). Xavier's utility function is  $U_X = q_1 q_2^3$ . Yolanda's utility function is  $U_Y = q_1 q_2$ . A total of 8 units of turkey and 12 units of pumpkin pie 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 and label the contract curve in the Edgeworth box above.

(6) [Cournot duopoly: 14 pts] Suppose two makers of a consumer good 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  $P = 17 - (Q/5)$ . Each firm has constant marginal and average cost equal to \$5. Note: question continues on next page. Use graph at bottom of next page for scratch work.

- 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 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.



(7) [External cost and Pigou tax: 10 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:  $P_D = 11 - (Q/200)$

Supply:  $P_S = 1 + (Q/200)$ .

- 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  $MEC = 1 + (Q/200)$ .

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

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

- d. Compute the deadweight loss from unregulated competition.

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



(8) [Uncertainty, risk aversion, demand for insurance: 10 pts] Smith has \$9 in income but faces a 20% chance of losing \$5 and thus being reduced to only \$4 in income. Smith's utility function is given by  $U(I) = I^{1/2}$ , where  $I$  denotes income.

- a. Compute Smith's expected income (in dollars).

- b. Compute Smith's expected utility (in utils).

- c. Compute the level of risk-free income that would be just as desirable as Smith's current risky situation (in dollars).

- d. Compute the maximum insurance premium Smith would be willing to pay for full insurance against potential loss.

- e. Compute the so-called "fair insurance" premium for full insurance against Smith's potential loss.



(9) [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  $EL = 400 - 0.2 Q$ . (Thus the last person's expected loss is about \$200.) Everyone is risk-averse, and willing to pay \$70 more than their expected loss (EL) for insurance.

- a. Give an equation for the demand for insurance  $P_D$  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? Why?

- d. Give an equation for the average cost of insurance  $AC$  as a function of  $Q$ . [Hint:  $AC$  has the same intercept but half the slope of  $MC$ .]

- 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. CRITICAL THINKING:** Answer just *one* of the questions below (your choice). [11 pts]

(1) Consider the following statement. "Non-profit arts organizations—like museums, symphonies, operas, and ballets—give discount tickets to students and senior citizens because their focus is on benefiting the public, not on maximizing profit." Do you agree or disagree? Explain why.

(2) Suppose a consumer normally buys 20 gallons of gasoline per month at a price of \$3. Which would this consumer prefer: a reduction in price from \$3 to \$1, or an increase in income of \$40? Justify your answer with a graph of a demand curve.

Circle the question you are answering and write your answer below. Full credit requires good grammar, legible writing, accurate spelling, and correct reasoning.



[end of exam]