N. General Questions

1. (a) Is it possible for a decreasing-returns-to-scale industry to be in competitive very-long-run equilibrium? Why or why not?

   (b) Is it possible for an increasing-returns-to-scale industry to be in competitive very-long-run equilibrium? Why or why not?

   (c) Is it possible for an increasing-returns-to-scale monopolist to make positive profits? It is possible for this monopolist to make short-run negative profits? Explain your answers.

2. For all parts of this particular question: it is not necessary for you to derive all the other cost curves from the total cost curve. Nor is it necessary for you to derive the long-run curves from the short-run curves or to derive the very-long-run curves from the long-run curves. You can get full credit without any derivations. However, if you get some curves wrong, then showing at least a brief derivation might pinpoint exactly where your error is, and may therefore result in more partial credit being given.

   (a) Sketch everything you know about the graph of short-run: total cost, average total cost, average variable cost, and marginal cost. Be sure to include all possible cases; give the name or description of each case.

   (b) Sketch everything you know about the graph of long-run: total cost, average total cost, and marginal cost. Be sure to include all possible cases which were discussed in class; give the name of each case.

   (c) Sketch everything you know about the graph of the very-long-run supply curve. Be sure to include all possible cases which were discussed in class; give the name of each case.

3. Suppose a firm produces corn Q from water W and fertilizer F according to the production function $Q = W \cdot F$.

   (a) Suppose the market for water appears in Figure 2a and the market for fertilizer appears in Figure 2b. On a graph with W on the horizontal axis and F on the vertical axis, show me everything you know about the firm's choice of inputs.

(b) Suppose the market for water appears in Figure 3a and the market for fertilizer appears in Figure 3b. Why is it now impossible to explain the firm's input choices using the type of graph you drew in part (a)? [Hint: the difficulty is that the isocost line you drew in part (a)—and the *linear* cost equation $C(W, F; p_W, p_F) = p_W \cdot W + p_F \cdot F$ which gave rise to that isocost line—does not apply to part (b). Why?]

4. Very carefully distinguish between the following concepts:
   (a) Diminishing Marginal Rate of Substitution
   (b) Diminishing Returns
   (c) Diminishing Rate of Technical Substitution
   (d) Decreasing Returns to Scale
   (e) Decreasing Cost Industry

5. (a) By drawing a diagram, show that it is possible to have a Giffen good in a world in which the consumer purchases only two goods, X and Y. Show the income effect and the substitution effect.
   (b) Redraw the diagram you drew in part (a), except change the labels: the axes should be labeled W and F for water and fertilizer, and there should be isoquants instead of indifference curves. Then reinterpret the diagram as showing the actions of a firm instead of a consumer.
      i. What is the movement along the isoquant called?
      ii. What is the movement between isoquants called? Why might the firm go from one isoquant to another?
      iii. Is W an inferior input? Is F an inferior input? Why or why not?
      iv. Is the firm's demand curve for W upward-sloping, downward-sloping, constant, some other shape, or can you not tell? Answer the same question for the firm's demand curve for F.

6. (a) Suppose the price of good x is 1 and the price of good y is 2. If a consumer has indifference curves as shown in Fig. 5, how much x and y will he buy if his income is \$6?
   (b) Suppose the price of water is 1 and the price of fertilizer is 2. If a firm's production function yields isoquants as shown in Fig. 6, how much W and F will it buy if it decides to produce Q_1?

(c) If you knew the price of water p_w, the price of fertilizer p_f, the output price p, and a firm's isoquants, discuss how you would find the optimal output of a competitive firm.

7. (a) Mr. D gets utility from consuming good X and good Y. His utility function is $U(X,Y) = 2X + Y$, and the price of X is \$1. What percent of his income will Mr. D spend on good X if the price of Y is less than \$0.50? If the price of Y equals \$0.50? If the price of Y exceeds \$0.50? Draw at least one graph to explain your answers.

   (b) Firm E uses two inputs, W and F, to produce output, according to the production function is $Q = 2W + F$. The price of W is \$2. What percent of costs of firm E will go to buying W if the price of F is less than \$1? If the price of F equals \$1? If the price of F exceeds \$1? Draw at least one graph to explain your answers.

8. (a) Suppose that in an output market, the supply curve has the form $p = Q$ and the demand curve has the form $p = 12 - Q$ (where p is price and Q is market quantity).

      i. How much social surplus do the firms receive if the firms can perfectly price-discriminate?

      ii. How much social surplus do the consumers receive if the consumers can perfectly price-discriminate?

      iii. How much social surplus do the firms receive if there is a competitive equilibrium?

      iv. How much social surplus do the consumers receive if there is a competitive equilibrium? What is this area called?

      v. How much social surplus do the firms receive if there is a monopoly?

      vi. How much social surplus do the consumers receive if there is a monopoly?

   (b) Now suppose that in an input market, the supply curve has the form $p = Q$ and the demand curve has the form $p = 12 - Q$ (where p is price and Q is market quantity). Note that when relevant, if the supply curve in an input market is linear then the marginal expense curve in that market has the same intercept as the supply curve, but twice the slope.

      i. How much social surplus do the input purchasers (e.g., firms) receive if they can perfectly price-discriminate?

ii. How much social surplus do the input suppliers (e.g., workers) receive if they can perfectly price-discriminate?

iii. How much social surplus do the input purchasers (e.g., firms) receive if there is a competitive equilibrium?

iv. How much social surplus do the input suppliers (e.g., workers) receive if there is a competitive equilibrium? What is this area called?

v. How much social surplus do the input purchasers (e.g., firms) receive if there is a monopsony?

vi. How much social surplus do the input suppliers (e.g., workers) receive if there is a monopsony?

9. (a) Discuss difficulties in interpreting the concept of very long run equilibrium. (Recall that these difficulties do not occur if all industries are constant cost industries.)

   (b) In class I discussed Philip Mirowski's claim that the founders of neoclassical economics did not decide to use indifference curves and isoquants because they were a natural way to model economic behavior. According to the class discussion, why did they decide to use indifference curves and isoquants?

10. Briefly answer the following four questions.

   (a) Our theory of the consumer was based on indifference curves (and the assumption of "complete preferences"). Our theory of the firm was based on isoquants. In what sense do indifference curves and isoquants make unrealistic assumptions about complete knowledge, and the role of learning, on the part of consumers and firms?

   (b) To explain why the competitive equilibrium price is important, textbooks often teach that if a price above the competitive equilibrium price exists in a market, firms will lower the price. Similarly, they teach that if a price below the competitive equilibrium price exists in a market, consumers will bid up the price. Explain the inconsistency in this reasoning.

   (c) Suppose corn Q is produced using labor L and fertilizer F. Suppose one observes the following data:

year	L	Q	Q/L
1990	2	10	5
1991	3	21	7
1992	5	40	8

Is the Q/L column the average product of labor? Why or why not?

(d) Discuss why, in Figure 1, a price system is in some sense as good as face-to-face negotiation.

Figure 2a

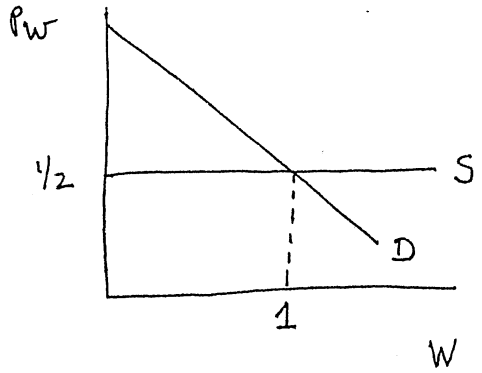
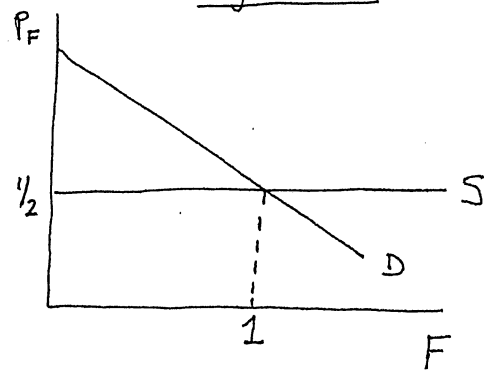


Figure 2b



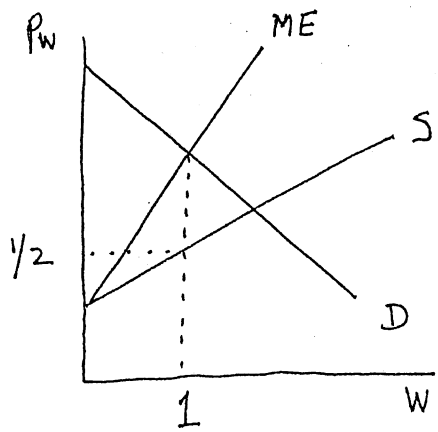


Figure 3a

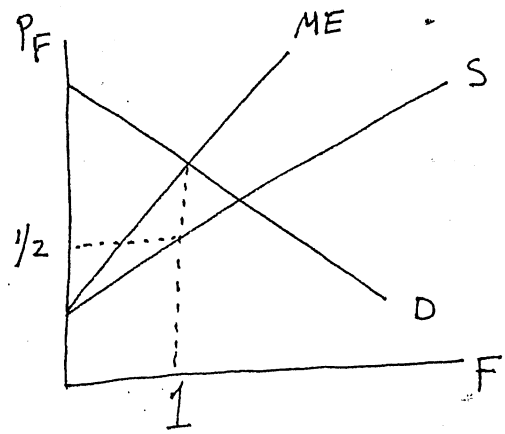
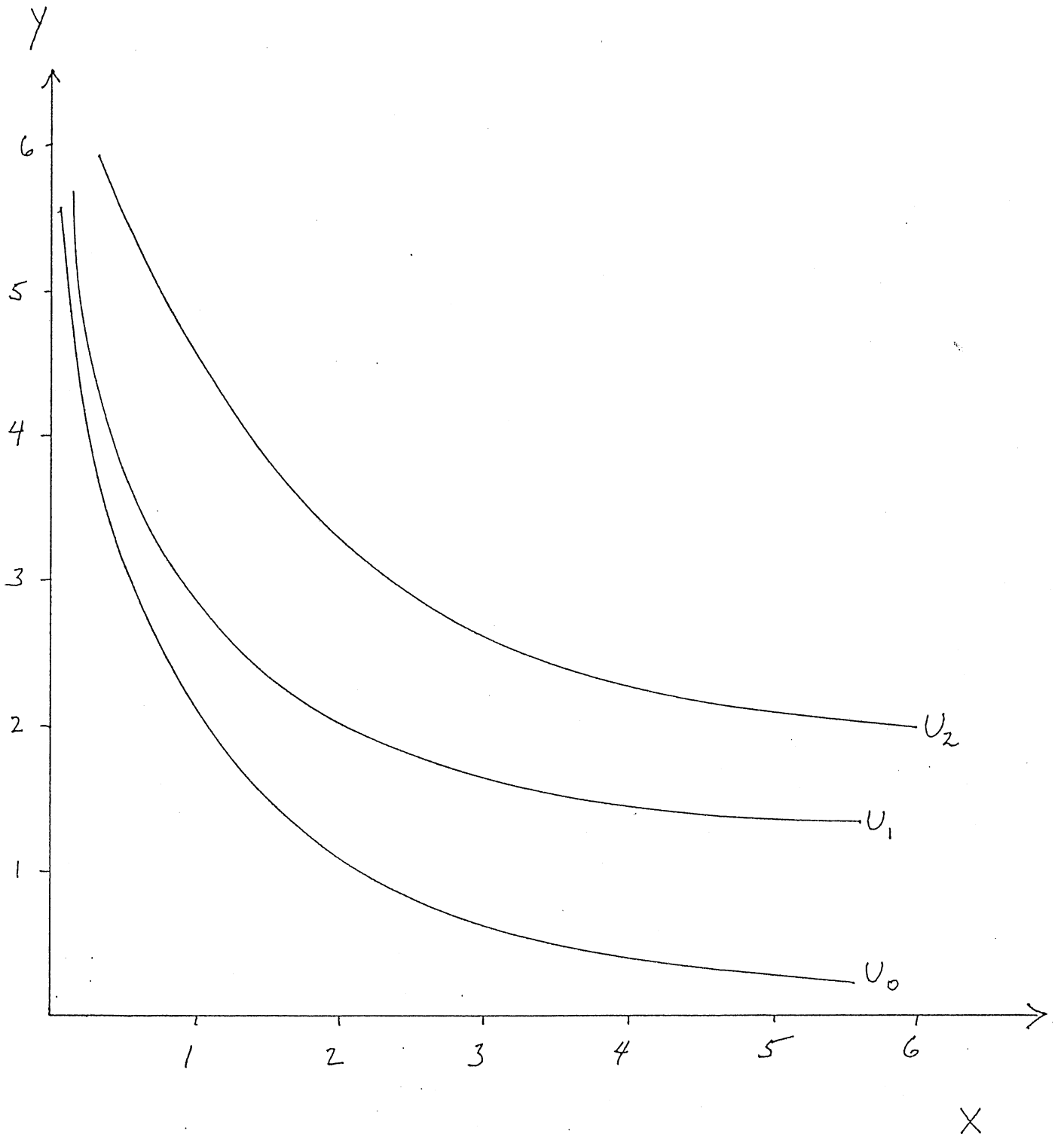


Figure 3b

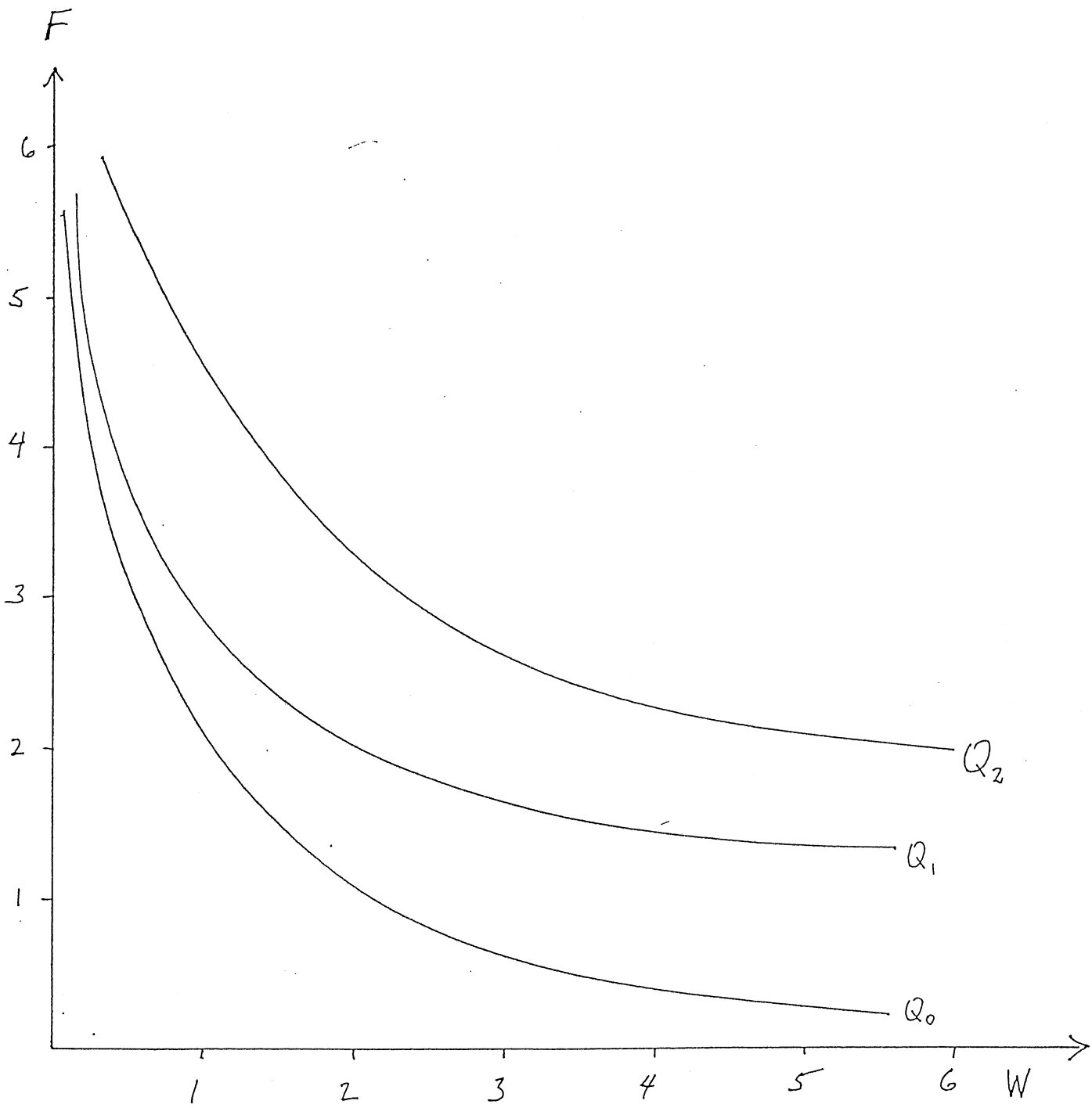
Question 3's Figures 2a, 2b, 3a, and 3b

Fig. 5



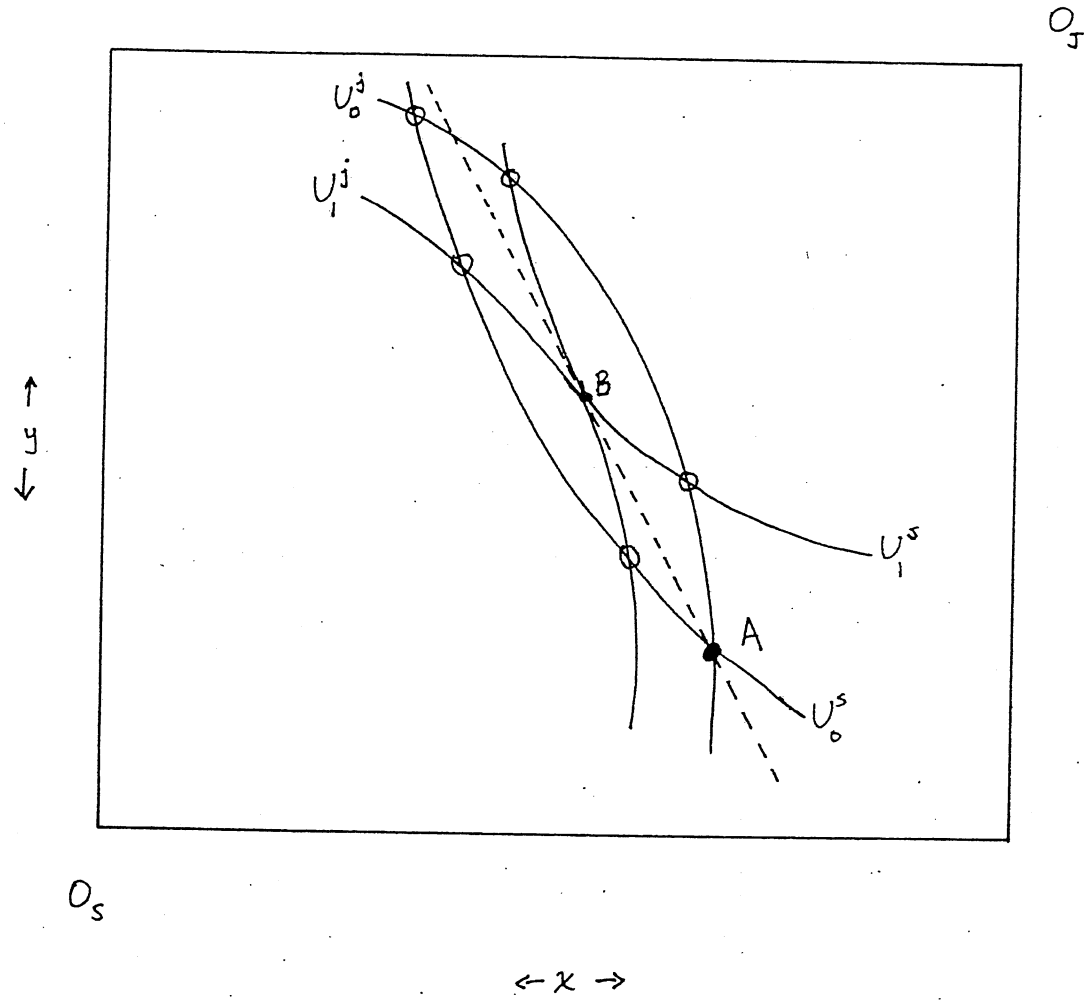
Question 6's Fig 5

Fig. 6



Question 6's Fig 6

Figure 1



S: Smith

J: Jones

O: origin

x, y: commodities

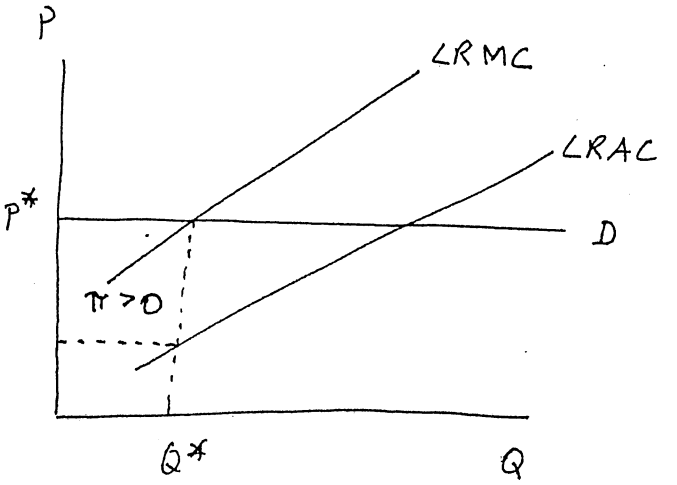
A: initial allocation

Question 10's Fig. 1

Answers

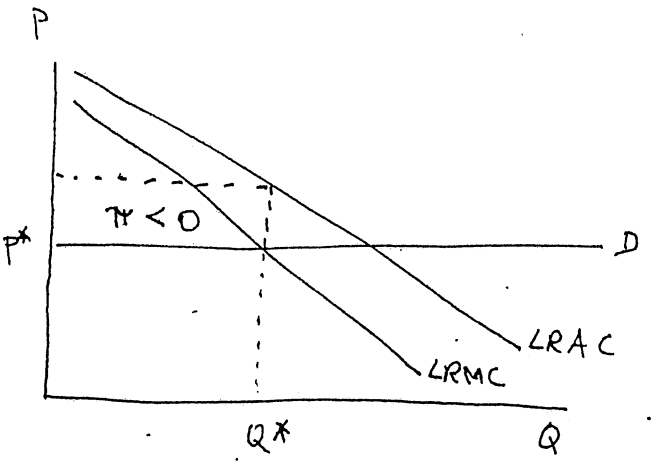
(1)

a.



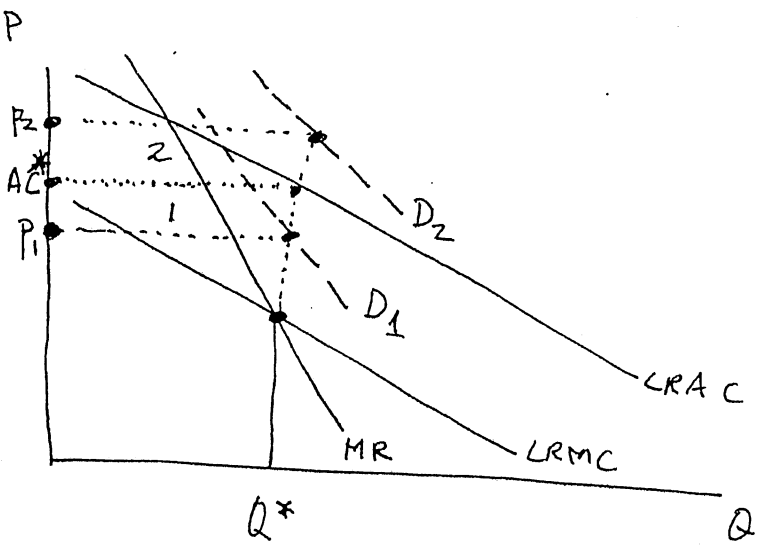
Competitive long-run equilibrium is not possible in this case because it requires $\pi = 0$; here, $\pi > 0$ always.

b.



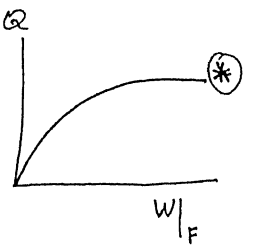
Here, competitive long-run equilibrium is not possible because $\pi < 0$ always.

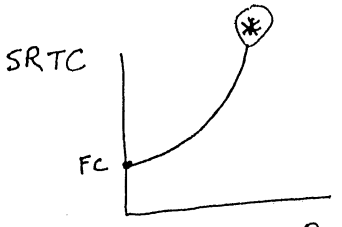
c.

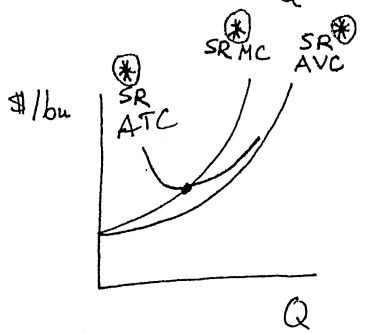


If demand is D_1, profits are negative since $AC^* > P_1$.
If demand is D_2, profits are positive since $P_2 > AC^*$.
(The amount of profit is given by the rectangles marked "1" and "2" respectively.) So, a monopolist may make either positive or negative profits.

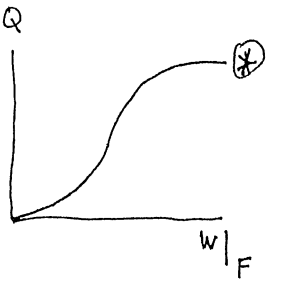
② a) Case I:

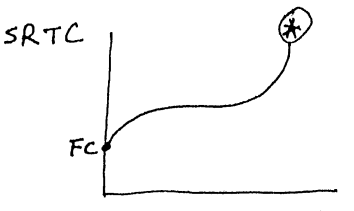


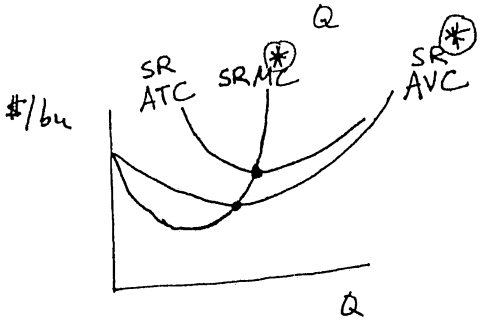




Case II:







(*) Diminishing Returns begins immediately

Diminishing Returns begins only after some point (*)

Top Graph: cross-section of the production function ← same description

Q: Corn, in bushels

W: water, in gallons

F: fertilizer, in pounds

$W|_F$: water holding F fixed

TC: total cost, in $

FC: fixed cost, in $

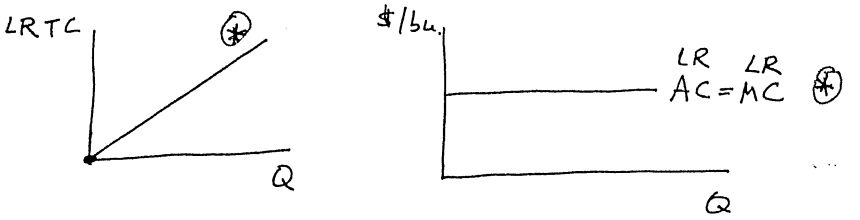
MC: marginal cost

AVC: average variable cost } in $/bu.

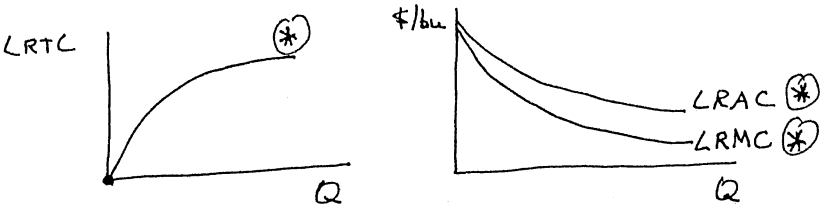
ATC: average total cost

1 point for everything marked with *

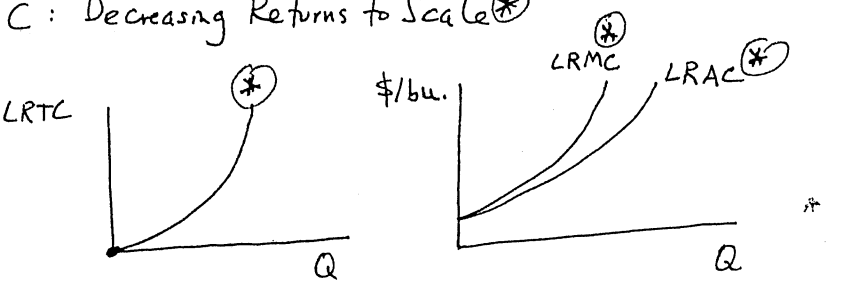
b) Case A: Constant Returns to Scale (*)



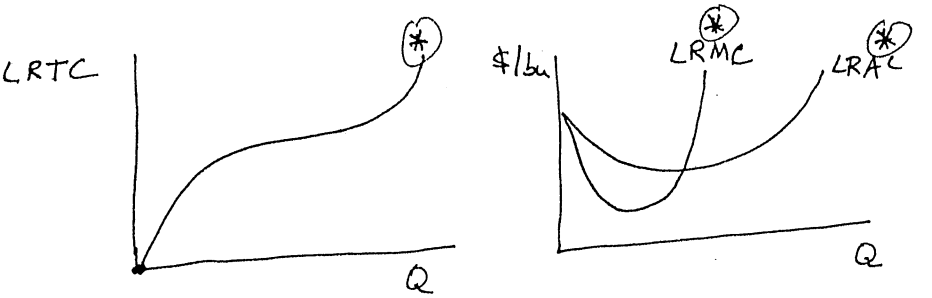
Case B: Increasing Returns to Scale (*)



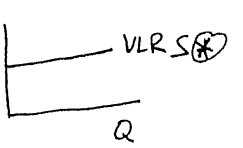
Case C: Decreasing Returns to Scale (*)



Case D: First Increasing, then Decreasing Returns to Scale (*)



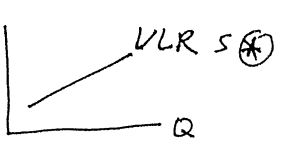
c) Case α: Constant Cost Industry (*)



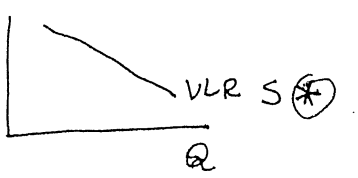
P: price, $/bu.

VLR S: very long run supply curve

Case β: Increasing Cost Industry (*)

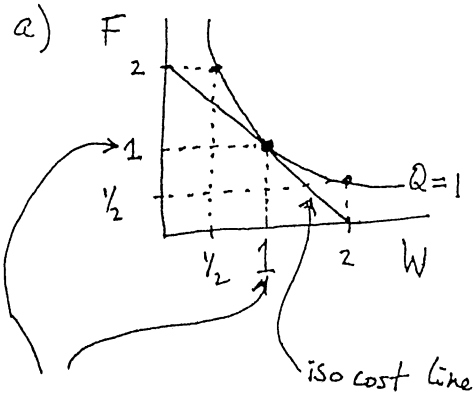


Case γ: Decreasing Cost Industry (*)



③. $Q = W \cdot F$

a)



optimal input choices are $W=1$ and $F=1$ ← (7 pts)

5 pts. just for the general form of the isoquant & tangency w/ isocost line

$W=1$, $F=1$ $\Rightarrow Q=1$. The Q=1 isoquant has the form $Q = 1 = W \cdot F \Rightarrow F = 1/W$.

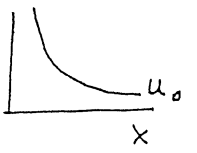
5 pts for isoquant details: Q=1, F=1/W, exact graph

Isocost line has slope $= \frac{-p_W}{p_F} = \frac{-1/2}{1/2} = -1$ ← (9 pts)

b) Figure 3a shows a monopsony buyer of water. Such a buyer does not take the price of water as given. So p_W is not a constant; instead, it is a function of W. (That function is given by the supply curve.) (8 pts)

Fig. 3b shows that p_F is not a constant either.

So the cost equation now is $\text{cost} = p_W(W) \cdot W + p_F(F) \cdot F$. This is no longer a linear function of W and F, so the isocost (contour) "line" is no longer straight.

④ a. 

Diminishing Marginal Rate of Substitution: If a consumer gets utility from two goods X and Y, the Marginal Rate of Substitution of X for Y is $-\frac{\Delta Y}{\Delta X}$ holding U constant. (So it's minus the slope of the indifference curve.) Note that $-\frac{\Delta Y}{\Delta X} > 0$. As X increases, $\frac{-\Delta Y}{\Delta X}$ decreases; this is "diminishing Marginal Rate of Substitution."

Similarly, as Y increases, $\frac{-\Delta X}{\Delta Y}$ = MRS of Y for X diminishes.

b. Diminishing Returns: the additional output obtained by increasing (5 pts) a single input (and leaving all others fixed) eventually decreases: $\frac{\Delta q}{\Delta w} \downarrow$ as $q \uparrow$ for sufficiently large q (where "w" is an input)

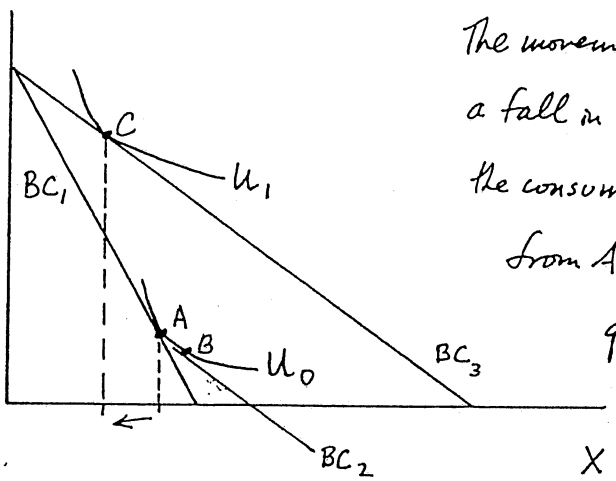
c. Diminishing Marginal Rate of Technical Substitution: Suppose a production (5 pts) process uses two inputs, W and F, to produce output Q. Then as F increases, $\left.\frac{\Delta W}{\Delta F}\right|_{Q \text{ constant}}$ decreases (and the same is true for F and W interchanged: as W increases, $\left.\frac{\Delta F}{\Delta W}\right|_Q$ decreases). Another way of saying this is that as F decreases, $\left.\frac{\Delta W}{\Delta F}\right|_Q$ increases, which means that as F decreases, it takes increasingly

more ΔW to compensate for losses in ΔF.

d. Decreasing Returns to Scale: if <u>all</u> inputs to a production process are increased by x%, output increases by less than x% (5pts)

(5pts) e Decreasing Cost Industry: as the number of firms in the industry increases, the cost curves for each firm drop

⑤ a)

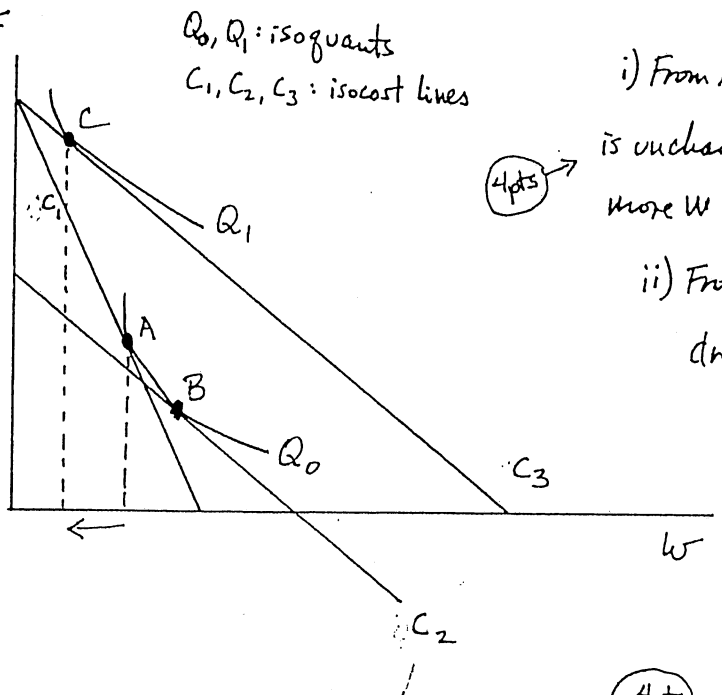


pts
4 income effect
4 substitution effect
4 Giffen good

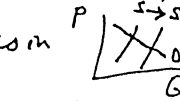
The movement from BC_1 to BC_3 corresponds to a fall in the price of X. In response to this, the consumer's optimal bundle of goods changes from A to C, resulting in a fall in the quantity demanded of X. This means that X is a Giffen good: a fall in its price causes the quantity demanded to fall.

BC_2 is parallel to BC_3. A → B is the substitution effect, and B → C is the income effect.

b)



(4pts) → i) From A to B is the substitution effect. Output is unchanged, but the input mix changes to more W and less F.

(4pts) ii) From B to C is the output effect. If the drop in P_W causes marginal cost to fall, then the supply curve shifts out, as in 

, causing equilibrium quantity to rise. This is why a larger isoquant may be chosen.

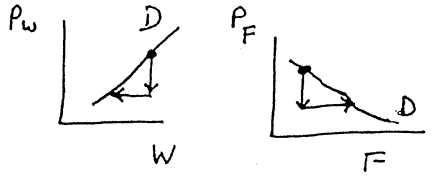
(4pts) →

iii) W is an inferior input because as output increases (B→C), the use of W by the firm decreases. F is not an inferior input because its use by the firm goes up as Q goes up.

pts
3 definition of inferior input
1 W inferior
1 F not inferior

iv) Going from a slope of an isocost line such as C_1 to a slope such as C_2 or C_3 implies a fall in P_W or a rise in P_F. The response was a fall in the quantity demanded of W and a rise in the quantity demanded of F. Hence the demand curve for W is upward-sloping and the demand curve for F is downward-sloping.

pts
2 W
2 F



(6) a) $P_X = 1$ $P_Y = 2$ Since x is on the horizontal axis and y is on the vertical axis, the slope of the budget constraint is $\frac{-P_X}{P_Y} = \frac{-1}{2}$. If the consumer spends his entire income on X, he can buy $6 \div 1 = 6$ units of X. This is one end of the budget constraint. If the consumer spends all his income on Y, he can buy $6 \div 2 = 3$ units of Y, which is the other end of the budget constraint. Utility is then maximized at point A (see Fig. 5), with x^* approximately 2 and y^* approximately 2.

b) $P_W = 1$ $P_F = 2$ Since W is on the horizontal axis and F is on the vertical axis, the slope of isocost lines is $\frac{-P_W}{P_F} = \frac{-1}{2}$. So, for example,

over→

one isocost line goes from (0,1) to (2,0), another from (0,2) to (4,0), and another from (0,3) to (6,0) (see Fig. 6). The lowest isocost line which still touches Q_1 is the one from (0,3) to (6,0), which touches the Q_1 isoquant at point B (coordinates approximately (2,2)). So W^* is approximately 2 and F^* is approximately 2.

c) Knowing p_w, p_f, and the isoquants, for any given Q you can find the cost-minimizing $W(Q)$ and $F(Q)$ as shown in part (b). Then the cost function would be $C(Q) = p_w W(Q) + p_f F(Q)$.

Knowing p and that the firm is competitive, you can find the total revenue function $TR(Q) = pQ$ (a straight line going through the origin).

So you could graph $C(Q)$ and $TR(Q)$ on the same graph and produce the Q which maximizes $\pi = TR(Q) - C(Q)$. Or, the profit-maximizing point could be found analytically instead of graphically (by using calculus).

a) 2 pts
b) 2 pts
c) 1 pt (it is not necessary to state $C(Q) = p_w W(Q) + p_f F(Q)$, or to explicitly write $W(Q)$ and $F(Q)$; a more verbal sketch of the procedure is OK)

Fig. 5

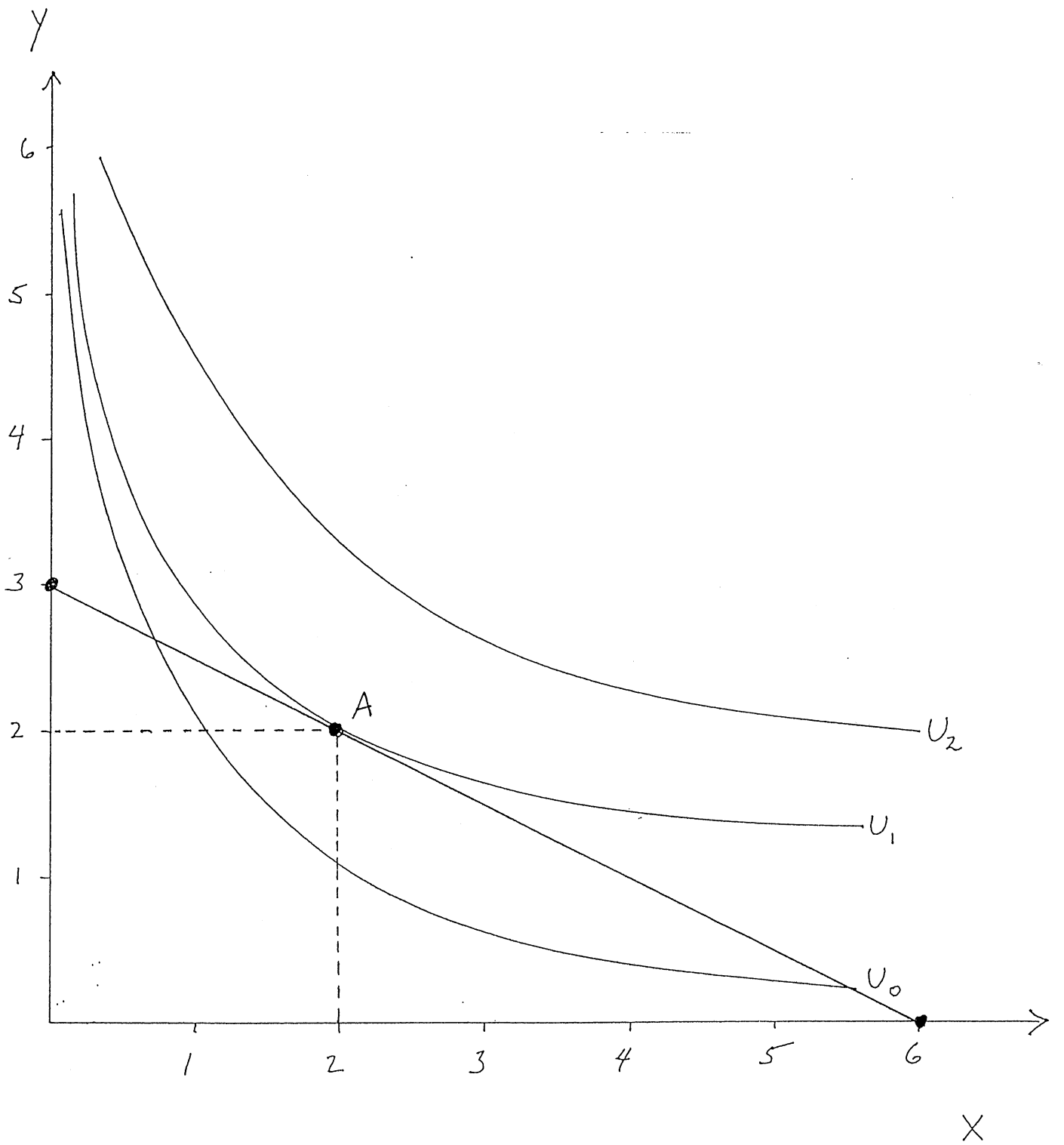
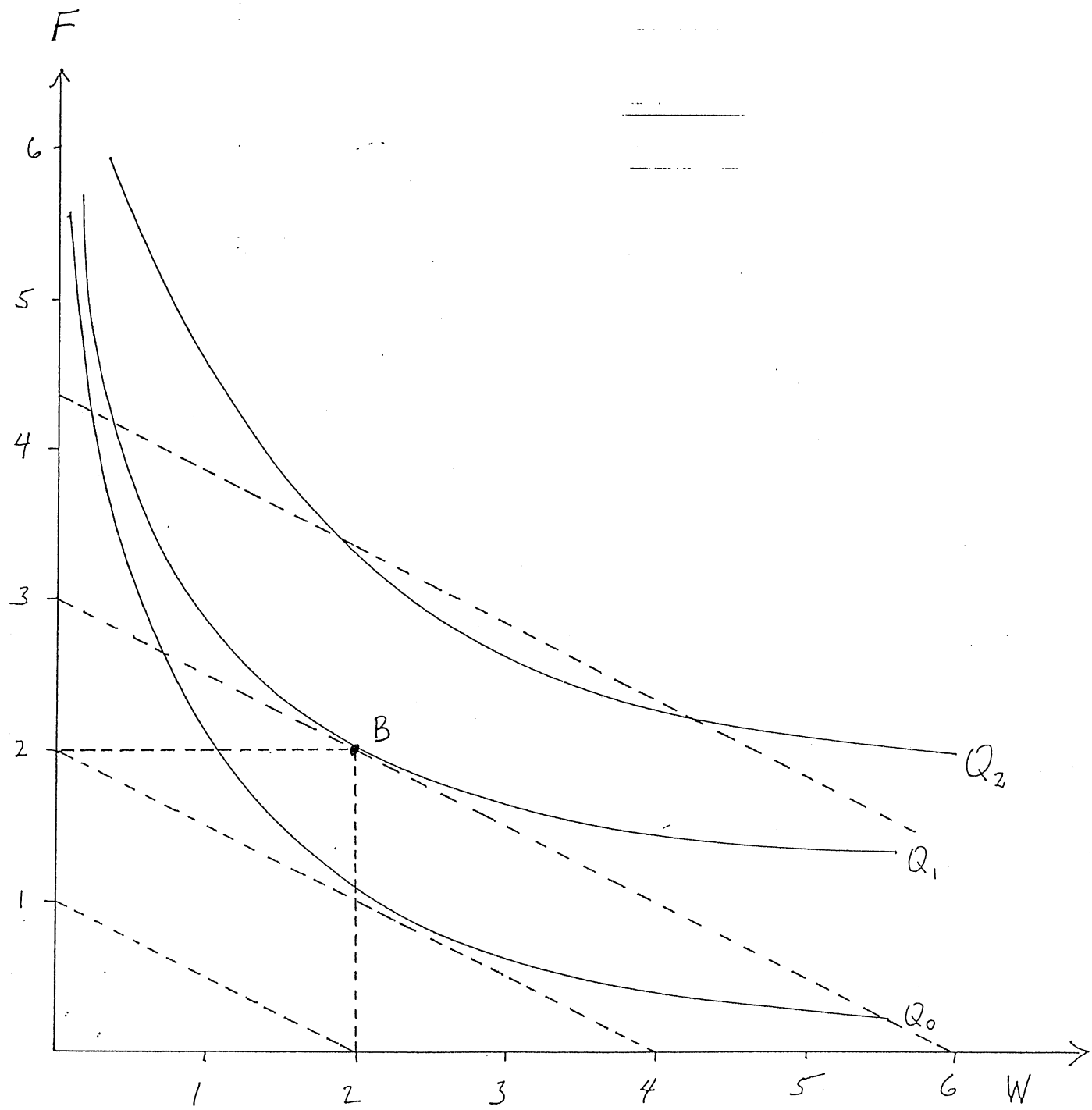
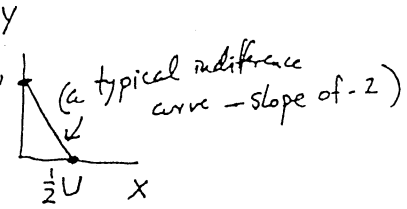


Fig. 6



⑦ a. $U = 2X + Y \Rightarrow Y = U - 2X$. This looks like



$P_X = \$1$. If $P_Y < \$0.50$, then the budget constraint, which looks like

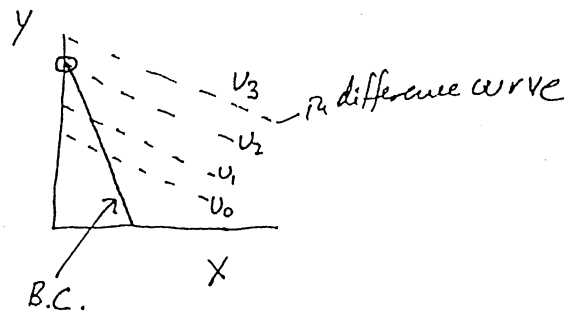
$$I = P_X X + P_Y Y \Rightarrow$$

$$Y = \left(\frac{-P_X}{P_Y}\right) X + I/P_Y$$

$$= -\left(\frac{1}{P_Y}\right) X + I/P_Y,$$

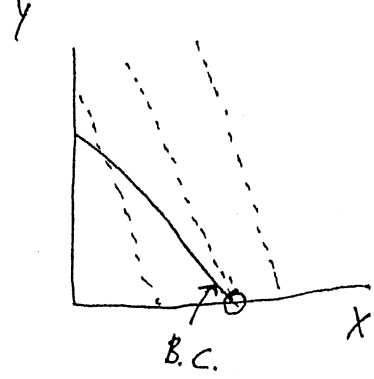
has a slope which is steeper than -2. A picture is

6 pts. for graph
3 pts. for each of 3 answers



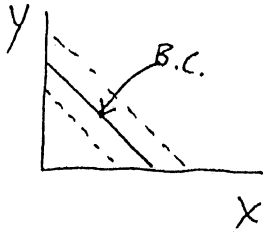
So, if $P_Y < \$0.50$, the consumer spends all his income (100%) on Y.

If $P_Y > \$.50$, the budget constraint will be flatter than the indifference curves. This yields

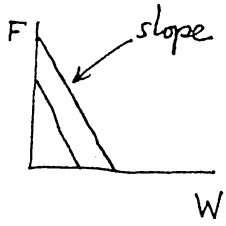


100% of income goes to X
0% " " " " Y

If $P_Y = \$0.50$, the entire Budget constraint lies on an indifference curve



and Mr. D is indifferent to how much of his income goes to X or Y.

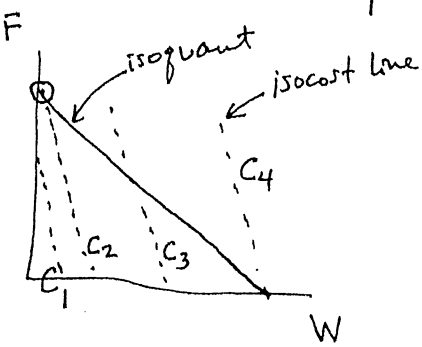
b. Isoquants: 

Iso-cost lines: $C = P_W W + P_F F \Rightarrow F = -\left(\frac{P_W}{P_F}\right) W + \frac{C}{P_F}$

$= -\left(\frac{2}{P_F}\right) W + \frac{C}{P_F}$.

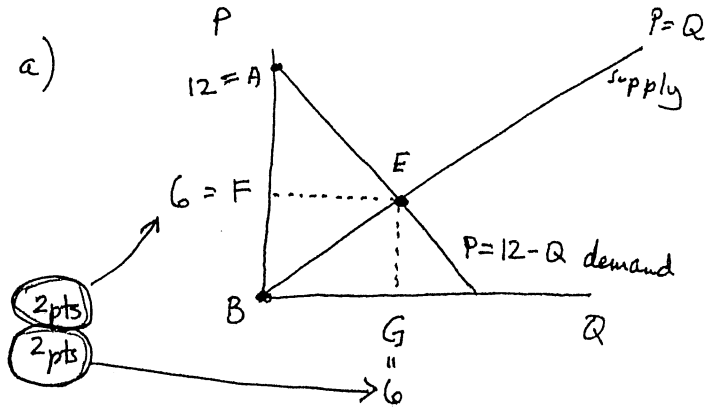
6 pts. for a graph
3 pts. for each of 3 answers

If $P_F < \$1$, the slope of the isocost lines is steeper than the slope of an isoquant:



So, if $P_F < \$1$, the firm will buy only F. Similarly, if $P_F > \$1$, the firm will buy only W, and if $P_F = \$1$, the firm is indifferent about its input mix.

(8) a)



(i) AEB

This is the entire social surplus until G. Beyond G, the price the consumers are willing to pay is less than the marginal cost of production, so those units won't be produced.

Equilibrium has $Q^{supply} = Q^{demand}$

$P = 12 - P$

$2P = 12$

$P = 6$

$Q^{supply} = 6$

$Q^{demand} = 12 - 6 = 6$ so $F = \$6$ (P)

$G = 6$ bushels (or 6 whatever)

$\text{area}(AEB) = \frac{1}{2}(\text{base})(\text{height})$

$= \frac{1}{2}(AB)(FE) = \frac{1}{2}(12)(6) = \boxed{36}$.

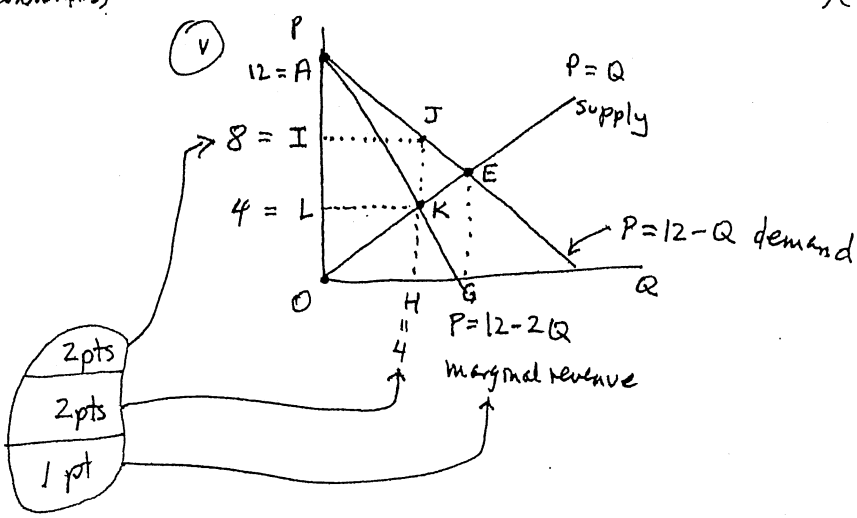
pts
i) 1
ii) 1
iii) 1
iv) 2 (1 for cons. surplus)

(ii) AEB = $\boxed{36}$

(iii) $FEB = \frac{1}{2}(\text{base})(\text{height}) = \frac{1}{2}(FB)(FE) = \frac{1}{2}(6)(6) = \boxed{18}$

(iv) $AEF = \frac{1}{2}(\text{base})(\text{height}) = \frac{1}{2}(AF)(FE) = \frac{1}{2}(6)(6) = \boxed{18}$ [consumer surplus]

(v)



Marginal revenue is $P = 12 - 2P$ because it has the same intercept but twice the slope of the demand curve $P = 12 - Q$.

over →

$MR = MC$

$12 - 2Q = Q$

$12 = 3Q$

$4 = Q$ so "H" is 4. Then "I" is $P = 12 - 4 = 8$. Also, "L" is $P = 4$.

Firms get $OKJI = OKL + LIJK$

$= \frac{1}{2}(4)(4) + (4)(4) = 8 + 16 = \boxed{24}$ (1pt)

(vi) $AIJ = \frac{1}{2}(12-8)(4) = \boxed{8}$ (1pt)

Note: total social suplus here is only $24 + 8 = 32$, compared with 36 without monopoly. The loss is $EKJ = \frac{1}{2}(JK)(HG) = \frac{1}{2}(8-4)(6-4) = \frac{1}{2}(4)(2) = 4$.

b) (i) See part (a)(i) on the previous page. ← Equ. Q: pts 2; Equ. P: 2

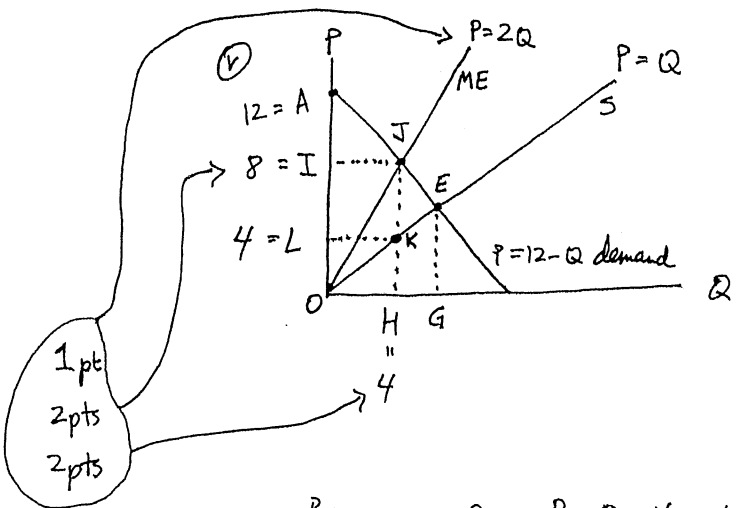
$AEB = \boxed{36}$

(ii) $AEB = \boxed{36}$

(iii) $AEF = \boxed{18}$

(iv) $FEB = \boxed{18}$ [rent]

i) 1
ii) 1
iii) 1
iv) 2 (1 for rent)



ME has the same intercept as S but twice the slope, so ME is $P = 2Q$.

ME = Demand at

$2Q = 12 - Q$

$3Q = 12$

$Q = 4$ = "H". Then $ME(Q=4) = 2Q = 8$ = "

Price comes from $P = Q = 4$ = "L".

over →

	pts
v)	1
vi)	1

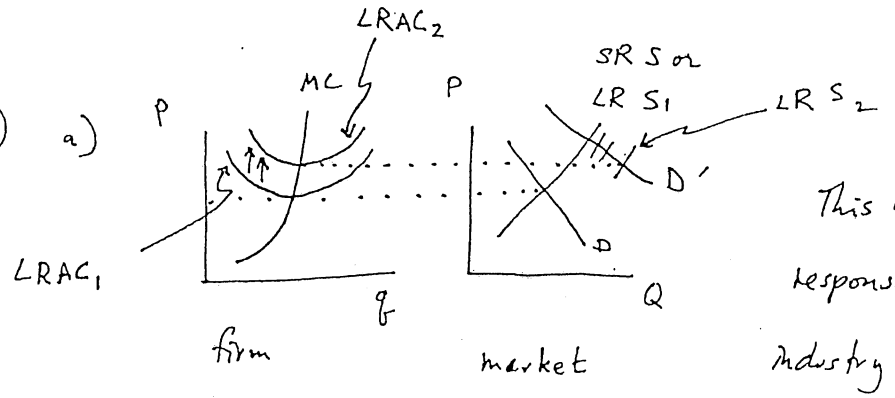
The monopsonist receives $AJKL = AJI + JKLI$

$= \frac{1}{2}(4)(4) + (4)(4) = 8 + 16 = \boxed{24}$

(vi) Workers get $OKJ = \frac{1}{2}(4)(4) = \boxed{8}$

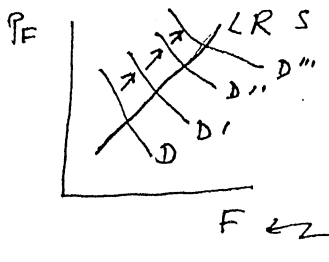
Optimal: Since $24+8 = 32$, whereas total social surplus without monopsony was 36, the dead weight loss to monopsony is $36 - 32 = 4 = JEK$.

(9) a)



This is a sketch of the response of an increasing-cost industry (say, the corn industry) to an increase in demand. The story in brief is that the increase in demand drives price up, attracting new firms, which: i) shifts the LR S curve out; and ii) shifts each firm's LRAC up (since it's an increasing-cost industry). Finally, a new VLR equilibrium is reached, in which zero profit is restored. (over →)

The problem is that the price of inputs (water and fertilizer) have risen (this is why LRAC has risen). Looking at, say, the fertilizer market, each successive entry of corn firms is a new demand shock:



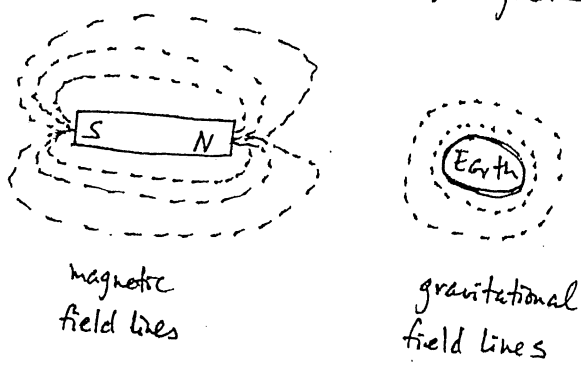
Once firms finish entering the corn market, demand shocks stop in the F market. Now, however, there are presumably positive profits earned by F and W (water) firms. So the corn market is in VLR equilibrium but the F and W markets aren't. New firms enter the F and W markets, attracted by the positive profits. This causes the LR supply curves there to shift out, decreasing P_F and P_W. This is a natural part of getting the W and F markets back into VLR equilibrium, but, by changing P_F and P_W, it pushes the corn firms out of their just-acquired VLR equilibrium.

So, the process of re-establishing VLR equilibrium in the corn market disturbs the VLR equilibrium in the W and F markets, and re-establishing VLR equilibrium in the W and F markets disturbs the new VLR equilibrium in the corn market. Whether the economy ever gets back to VLR equilibrium in <u>all</u> markets <u>simultaneously</u> is an open question. ↖ (20pts)

If all industries are constant cost, then, for example, re-establishing

VLR equilibrium in the corn market will end up not affecting P_F or P_W, and hence will end up not affecting VLR equilibrium in the W or F markets.

b) Indifference curves and isoquants are like the field lines (lines of constant potential) of the electric, magnetic, or gravitational fields. These field lines are unaffected by the temporary presence of smaller electric, magnetic, or gravitational fields (or bodies generating those fields); in fact, even in the presence of such bodies, to a first approximation the larger fields are unaffected. This is like indifference curves and isoquants, which never touch and which are unaffected by history (there's no learning). For example, as a consumer's income changes and the prices he faces change, the consumer may sample many different commodity bundles in (x, y) space (where x and y are commodities), but throughout these experiences the indifference curves stay absolutely fixed.



magnetic field lines

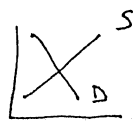
gravitational field lines

Mirowski argues that the founders of neoclassical economics were trying to imitate the (then) new theories in physics when they came up with indifference curves and isoquants.

14 pts

(10)

(9 pts) a. These assumptions imply that the consumers know how much utility they would get from any consumption bundle including those they have never consumed before, and they assume that firms know how much output they would get from any bundle of inputs including those they have never used before. (These facts follow from the assumption that the isoquants and indifference curves fill the entire input space or commodity space $\begin{matrix} Y \\ \vert \\ \vert\_\_\_ \\ \quad X \end{matrix}$, so each point — either an input bundle or a consumption bundle — is known to lie on one particular isoquant or indifference curve.) It follows that consumers are assumed to know their preferences completely and firms are assumed to know their technology (actual and potential) completely; no learning ever needs to be done.

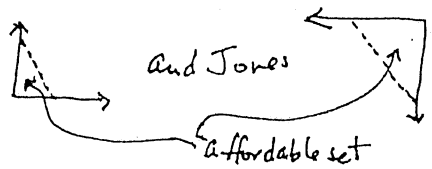
(8 pts) b. 

The supply and demand curves for a competitive equilibrium assume that each consumer and each firm take price as given. Hence they never change the price. Hence firms can never "lower the price," nor can consumers "bid up the price."

(8 pts) c. The average product of labor is Q/L <u>holding F fixed</u>. In the data as presented, there is no reason to assume that F is being held fixed to calculate the Q/L column. So the answer is no.

(9pts) → d. The outcome of face-to-face negotiation will be an allocation better than A for Smith – hence above and to the right of U_0^S – and better than A for Jones – hence below and to the left of U_0^J. This results in a lens-shaped area (see Fig. 1).

The outcome of a price system with relative prices $-P_X/P_Y$ equal to the slope of the dotted line in Fig. 1 would be at "B." This is because the dotted line would serve as the budget constraint for both Smith and Jones.



So a price system would lead to an improvement for both parties, just like negotiation would. Furthermore, the price system leads to a Pareto Optimal point (since at B, there exist no additional trades which make both Smith and Jones better off), just like face-to-face negotiation eventually would (presuming Smith and Jones negotiate until all gains from trade are exhausted).