Chapter 5

N1. Total cost as a function of output is $TC(x) = x^2 \rightarrow MC(x) = dTC(x) / dx = 2x$. Note that the approximation that we used in class $MC(x)=TC(x)-TC(x-1) = x^2 - (x-1)^2 = 2x-1$ is not quite accurate (see below).

N2. The cost of producing y centiliters (y/100 liters) is $y^2/10^4$ dollars. In this case, the approximation employed in class for marginal cost (dollars per liter) becomes MC(y) = 2y - 0.01.

N5. The cost of producing z milliliters ($z/10^3$ liters) is $z^2/10^6$ dollars; in this case, the approximation employed in class for marginal cost (dollars per liter) is MC(z) = 2z – 0.001. As you measure output in finer and finer measurement units, marginal cost (measured in dollars per liter, but corresponding to smaller and smaller output increments) approaches 2z. E.g., in the case of nano (10^{-12}) liters, marginal cost is 2z - 0.0000000000001 dollars per liter – pretty close to 2z, eh?

Prob 5.12

a) The marginal revenue and marginal cost schedules are as follows:

Q	Marginal revenue	Marginal cost
1	20	5
2	16	10
3	9	15
4	3	20
5	-8	25

You need MC = MR; since we don't see equality in the table above, we choose the point where MC is just above MC, therefore the firm produces at Q = 2 and P = \$18 (you should compute profits at the `candidate' optimal quantities 2 and 3 and compare them).

b) The \$5 excise tax will increase marginal cost by \$5 at all levels of output; marginal revenue is unchanged. Now marginal revenue and marginal cost are as follows:

Q	Marginal revenue	Marginal cost
1	20	10
2	16	15
3	9	20
4	3	25
5	-8	30.

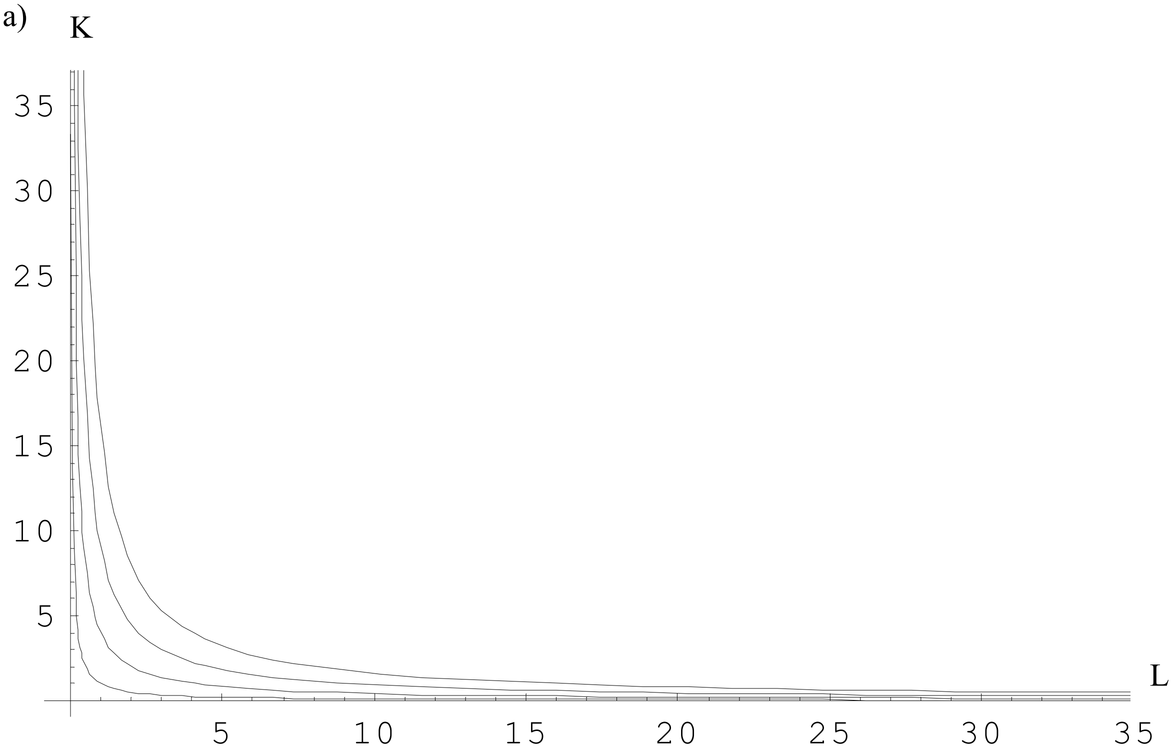
The optimal quantity choice is still Q=2.

c) A lump-sum tax does not affect the firm's marginal revenue or cost, therefore the firm will continue to produce at Q=2, as in point (a), and will have a profit of $1.
d) If the lump-sum tax is $25, the firm does best by producing Q=2, as above, but it incurs a loss. If it could exit the industry it would; if not, it would produce Q=2.

Chapter 6

N1.

a)



The isoquants correspond to Q=1,2,3,4 (increasing to the NE).

b) $MPL = \partial(\sqrt{KL}) / \partial L = \sqrt{K / L} / 2; MPK = \partial(\sqrt{KL}) / \partial K = \sqrt{L / K} / 2; MRTS_{LK} = K / L$
When K=20 and L=5, $MRTS_{LK}$ = 20/5 = 4, MPL = $(20/5)^{1/2}/2$ = 1 and MPK = ¼. If you don't know how to partially differentiate, use MPL = change in output/change in labor input, and consider changes in labor input that are `small' (along the lines of problems N1-3 in the previous chapter). In any event, if you see a problem like this in your exam, you may assume that the functional form of the MRTS will be given to you.

d) If the firm uses 20 units of capital in the short run, the required short-run level of labor input is 5 units ($10=(20L)^{1/2}$, so L=5). The short term total cost = 1 * 20 + 1 * 5 = $25 (price of capital times the amount of capital plus the price of labor times the amount of labor).

e) In the long run the firm will produce at the point where $MRTS_{LK}$ is equal to the ratio of factor prices P_L/P_K. Since the ratio of prices is 1, it follows that K = L; hence, to produce 10 units at minimum cost the firm will employ 10 units of each input; total cost is $20, less than the corresponding short-run cost (as expected!)

Prob 9.

MRTS = MPL / MPK > P_L / P_K, which implies MPL /P_L > MPK /P_K. This means that the marginal product of labor relative to its price (bang-per-buck) is higher than the marginal product of capital relative to its price. By employing less capital (suppose you employ capital at the level at which the firm's outlay on capital is one dollar less) and using the proceeds ($1) to hire additional labor, the total cost won't change, but the output will increase. Therefore, to minimize its cost for a given level of output (or, conversely, to maximize output for a given level of cost), a firm will choose its capital and labor inputs to satisfy MPL /P_L = MPK /P_K.

Prob 11.

a) at (3,1) output is 193, if we reduce the labor input by one unit to 2, we need k = 3 to sustain 193, so the capital input needs to be increased by 2 units , therefore the MRTS is 2. MPL = 193 – 152 = 41, MPK = 193
b) In short run the amount of capital is fixed, so with 2 units of capital we need 4 units of labor, therefore the total short-run cost = 4*10 + 2 * 4 = 48
In the long run we need to set MPK /PK = MPL /PL, therefore MPK /MPL = 4/10, look on the table where total output = 263 and satisfying the ratio we find K = 2, L = 4 approximately satisfies the requirement.
c) Same as in b K = 3, L = 3 approximately satisfies the requirement.
d) At (2,1) the output level is 152; doubling both inputs the output level becomes 263; since 263/152 < 2 (output increases by a factor less than 2), the technology exhibits decreasing returns to scale, and consequently the long-run average cost curve slopes upward (see page 171 of textbook).

Chapter 7

N1. MC = MR = P = 10 → Each firm will produce 10 units.
Total cost = fixed cost + variable cost = 6 + (2 + 4 + 6 + 8 + 10) = 36 → Profit = TR – TC = 10* 5 – 36 = $14

The industry is not in a long-run equilibrium, since the firm is making profit and it attracts other firms to enter.

As in a) there will be entry into this industry. In the long run the each firm will produce at the minimum of average cost, we can calculate
AC(1) = (6+ 2) /1 = $8, AC(2) = (6+ 2 + 4) /2 = $6, AC(3) = (6 + 2 + 4 + 6) /4 = $ 6, AC(4) = $ 7, ….., therefore price will be $6 and each firm will produce 3 widgets.

N2. (a) and (b) : In the long-run equilibrium, each firm produces at the minimum average cost and since it makes zero profit , the price equals the minimum AC, therefore AC(1) = (15 + 5) /1 = 20, AC(2) = (15 + 5 + 10) /2 = 15, same AC(3) = 15, AC(4) = 16 ¼, … → each firm produces 3 units and set price at $15, at $15 price the demand is 450, therefore the total number of firms is 450 / 3 = 150 c): for each firm the short-run supply curve is just the marginal cost curve, therefore for the price = \$10 each firm produces 2 units, and since there are 150 firms in the industry the corresponding quantity in the industry is 150 * 2 = 300

N6.

a) In the long-run equilibrium each firm will produce at the lowest average cost , therefore taking derivative of Q on AC and setting it to zero: d(AC) /dQ = 1 – 100/(Q*Q) = 0 $\rightarrow$ Q = 10, which is the number of kites each firm will produce. The long run supply curve is just the marginal cost curve P = 2Q.

b) P = MC = AC = 2*10 = \$ 20 for each firm, therefore the price is \$20 and the total number of kites to be sold is Q = 8000 – 50*20 = 7000 and since each firm will produce 10 kites, the total number of firms in the industry is 7000/10 = 700

c) In the short run Q = 7000, therefore 7000 = 9000 – 50 P $\rightarrow$ P = \$40 in the short-run. Since average cost per unit for each firm is still \$20 and each firm still makes 10 kites, the profit for each firm is (40-20)*10 = \$200

d) In the long run the price of kites is still \$20 since each firm still makes zero profits, since now the total demand is 9000 – 50*20 = 8000, then the total number of firms in the industry is 8000/10 = 800 and 800-700 = 100 new firms enter the industry.

N7

a) Since each firm requires one fire extinguisher

$P_F = Q = F$

For each firm

$$TC = Q^2 + 100 + F \Rightarrow AC = Q + \frac{100}{Q} + \frac{F}{Q}$$

MC is same as before: MC=2Q, since F is a fixed cost

(2 points)

b) the firm wants to produce at the lowest AC: either take the derivative, or set AC = MC, you get that the quantity produced by a firm is equal to $Q = \sqrt{100+F}$; the total industry produces

$$Q_{Tot} = Q * F = F * \sqrt{100+F}$$

$$P = 2Q = 2\sqrt{100+F}$$

(2 points)

c) since $P = 2\sqrt{100+F} \Rightarrow F = \frac{P^2}{4} - 100$

$\Rightarrow$ total industry produces

$$Q_{Tot} = F\sqrt{100+F} = (\frac{P^2}{4} - 100) * \frac{P}{2} = \frac{P^3}{8} - 50P$$

$\Rightarrow$ the total supply curve

$$Q = \frac{P^3}{8} - 50P$$

d) set supply= demand

$$\Rightarrow \frac{P^3}{8} - 50P = 8000 - 50P$$

$$\Rightarrow P^3 = 8000 * 8 = 64000$$

$$\Rightarrow P = 40$$

$$Q = 8000 - 50P = 6000 \text{ } \textit{kites will be produced}$$

$$\textit{there are } F = \frac{1600}{4} - 100 = 300 \text{ } \textit{firms}$$

$$\textit{each firm makes } \frac{6000}{300} = 20 \text{ } \textit{kites}$$

$$AC = 2\sqrt{100 + 300} = 40$$

$$\Rightarrow \textit{each firms makes profit} = 0.$$

Chapter 8

Prob 4

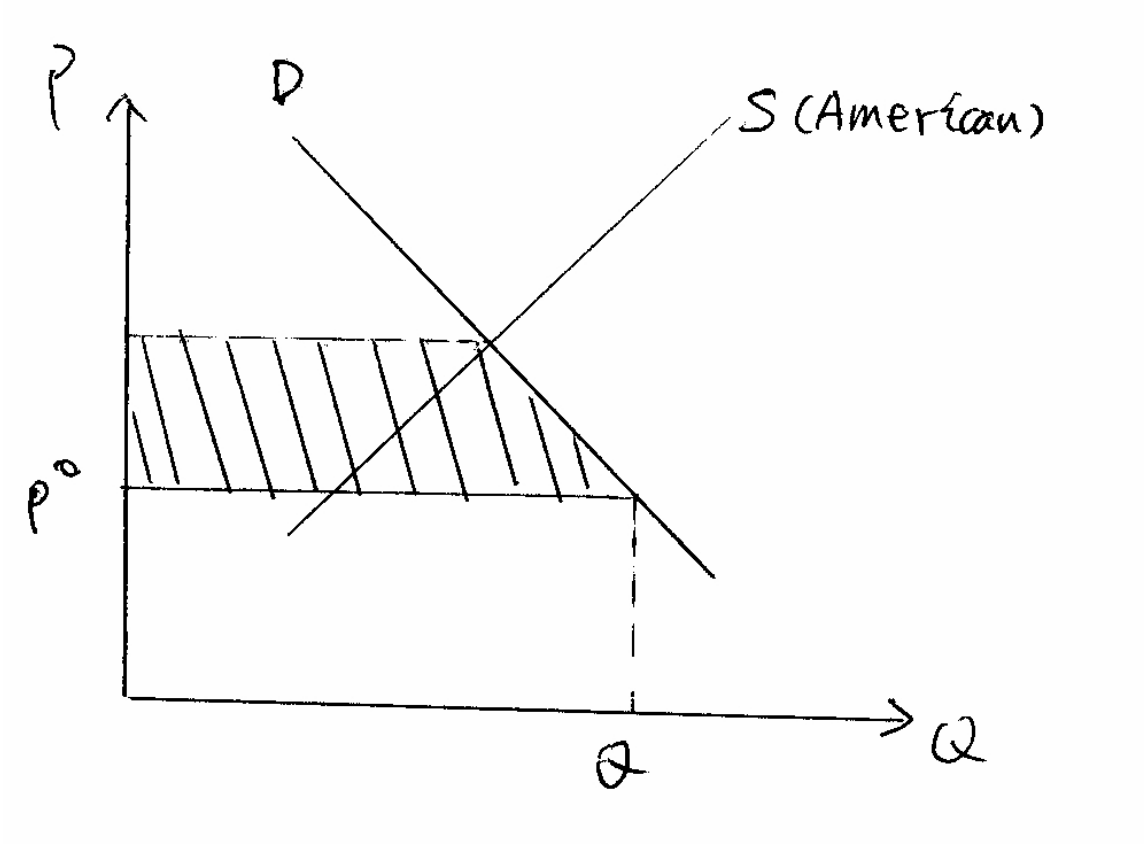
a) According to the Pareto criterion, c is preferred to e, since from e to c both Adam and Eve increase the number of apples they have, so they both fare better. We can't compare other pairs of allocations since allocating in other ways there will be one fare worse.

b) According to the efficiency criterion, a , b, c, d are at the same level since all allocations add up to 12 and changing between them doesn't make a difference in the total gains to all members of the society. On the other hand, e adds up to 10, therefore all a, b, c, d are preferred to e.

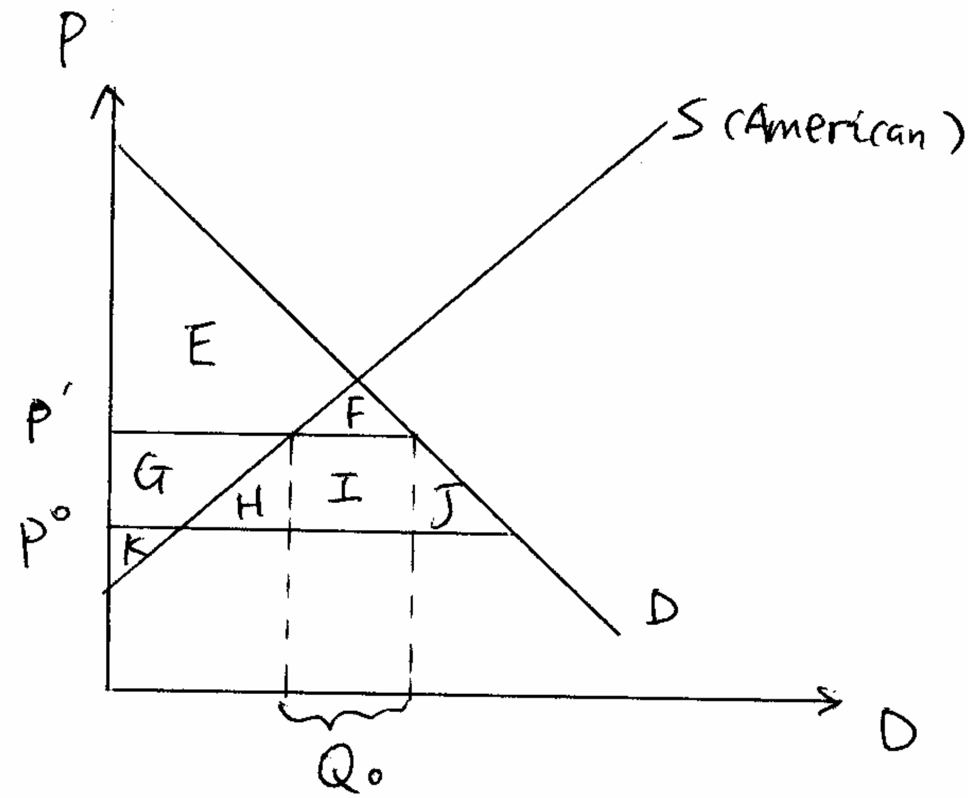
Prob 7

For example, give consumers F+G+ 1/3 E and give the producer C + D + 1/3 E , the loss to taxpayer is now –(C+D+F+G + 2/3 E).

Prob 16.



a) The American birdcages must sell at P0. The gain of the consumers is the shaded area. (2 points)



b) the price now changes to P', which is the price that makes the difference between the total quantity demanded and the supply of American suppliers equal to Q_0.
c) American consumers will lose and American suppliers will gain. The deadweight loss is H+J+I (I is the surplus of the foreign producer, but this doesn't count in the American balance of welfare).
d) The tariff must be preferred, because I is the tariff collected by government and the deadweight loss now is only H+J.

Chapter 10

N1 Since Q = a – b*P → P = (a – Q) / b → TR = P*Q = (a* Q – Q*Q) / b
Therefore d(TR) / d(Q) = (a – 2Q)/b

N2

a) since MR = P * (1 – 1/ |η|) ,
for A: MR = 10 – 0.2Q and P = 10 – 0.1Q → 10 – 0.2Q = (10 – 0.1Q) * (1 – 1 / |η|) → |η| = 100 / Q – 1
for B : MR = 4 – Q and P = 4 – 0.5Q → 4 – Q = (4 – 0.5Q)*(1 – 1/|η|) → |η| = 8 /Q – 1. Therefore, for same Q, demand for A is always more elastic than demand for B.

b) MC = 0

For A: MR = 10 – 0.2Q = MC = 0 → Q = 50, P = 5

For B: MR = 4 – Q = MC = 0 → Q = 4, P = 2

c) For A: MR = 10 – 0.2Q_A

For B: MR = 4 – Q_B

And… MC = (Q_A+Q_B) /21

So set 10-.2Q_A = 4-Q_B = (Q_A+Q_B)/21 to find Q_A = 40, Q_B = 2. Plug into the demand equations to find P_A = 6, P_B = 3.

d) The results of (b) and (c) seem to contradict (a), but note that in (a) we compare the two elasticities at the same quantity, while in (b) and (c) we work with different quantities. If you compute the elasticities that correspond to (c), you will find that the inverse elasticity rule holds.

e) It is impossible to make marginal revenue equal in both markets and equal to marginal cost. The monopolist will sell only in market A, at the point where Q_A = 18.75.

N3.

a) Because the monopolist always sells on the elastic portion of demand to maximize profit. (Strictly speaking, elasticities are weakly greater than 1 in absolute value: if MC = 0, elasticities are both equal to -1.)

b) MC = MR in both markets, since the monopolist has the same MC, MR(A) = MR(C) → 30 *(1 – 1/ |ηA|) = 10 * (1 – 1/ |ηC|)→

$|\eta_A| = 3|\eta_C| /(1 + 2 |\eta_C|)$

c) Largest value of $|\eta_A|$ is 1.5. The function f(x) = 3x/(1+2x) is increasing for x>=1, and as x->infinity, f(x) goes to 3/2.

Prob 14

Because these two markets are identifiable and have different demand curves, the monopolist can charge different prices on the two markets, for men's market: MC(QM+QW) = MR-men = MR-women → QM = 4, P = 7, and for women QW = 3 and P = 12.

Prob 24

False, the monopoly pricing schedule causes deadweight loss to consumer's surplus, which can't be recovered from the redistribution of monopolist's profit.

Chapter 11

N1.

a) For the car maker, $TR = 100*Q\_car – Q\_car * Q\_car \rightarrow$ Profit $= TR – P\_steel * Q = 100*Q - Q^2 – p\_steel*Q \rightarrow$ Q is maximized at $(100- P\_steel)/2$

b) From (a) we know the inverse demand curve for steel is $P\_steel = 100 – 2Qsteel$. $Qsteel = 50 – Psteel/2$ is the direct demand curve. Either one is fine.

c) Since the steel maker faces the demand curve in b) , $MR = 100 – 4Q = MC = 0 \rightarrow$ $Q\_steel = 25$ ton and $Q\_car = 25$ since one ton steel makes a car, and $P\_steel = 50$, $P\_car = 100 – Q = 75$

d) If the car maker acquires the steel maker, since steel producing is of zero marginal cost and there's no other costs, the marginal cost of making car is also zero, from the demand curve for car we know $MR = 100 – 2*Q\_car$, therefore setting $MR = MC = 0 \rightarrow Q = 50$ and $P = 50$

N2.

a) for Microsoft: $MR\_m = 100 – 2Q – P\_n = MC = 0$, where P_n is the price charged by Netscape
for Netscape: $MR\_n = 100 – 2Q – P\_m = MC = 0$, where P_m is the price charged by Microsoft
therefore $P\_n = P\_m$ and $P\_n + P\_m = P$, $\rightarrow$ $P\_n = P\_m = P/2$
by the demand curve: $Q = 100 – P$ we get $Q = 100 – 2*P\_n$,$\rightarrow$ $P\_n = 50 – 0.5Q$,
then since $MR\_m = 100 – 2Q – P\_n = 0$ we get
$100 – 2Q – (50-0.5Q) = 0 \rightarrow Q = 50/1.5 = 100/3$, $P\_m = P\_n = 100/3$

You can set the problem up to choose prices so that profit is maximized.

b) suppose P_m given, then for Netscape its $MR = 100 – 2Q – P\_m$, set $MR=MC = 0 \rightarrow Q = (100-P\_m)/2$, For Microsoft, it wants to maximize the profit which equals to $Q*P\_m – C = P\_m (100-P\_m)/2 – 0 = 50P\_m – 0.5*P\_m*P\_m$, by the maximization condition we get $P\_m = 50$, therefore $Q = 25$, $\rightarrow P = 100 –25 = 75$ $\rightarrow P\_n = P-P\_m = 25$

c) Now the problem is just a standard monopoly problem, $MR = 100 – 2Q = MC=0$, $\rightarrow Q= 50$ and $P = 50$

d) Now for Microsoft $MR\_m = 100 – 2Q$, R is the royalty, then setting $MC = R = MR$ we get $Q = (100-R)/2$, therefore the total royalty Netscape can get is $Q*R = (100R – R*R)/2$, maximizing it we get $R = 50$, therefore $Q = 25$, $P = 100 – Q = 75$.

Chapter 12

Prob1

I: (Right, Down)
II (Left, Down)
III (Right, Up)

IV None
V None
VI (Left, Up) and (Right, Down)
VII (Left , Up) and (Right, Down)
VIII ((Left, Up)

Prob2

I (left, down), (right, up), (right, down)
II (left, down), (right, up), (right, down)
III (right, up)
IV (right, up), (left, down), (right, down)
V (left, down), (right, down)
VI (right, down)
VII (left, up), (right, down)

Prob5

I Down
II Up
III Up
IV Down
V Down
VI Down
VII Up
VII Down

Prob 9

NO. If an outcome is not Pareto optimal, then there's at least one other outcome which makes one player better and the other unhurt. We move to that outcome and check if there's another outcome that can improve one player without hurting the other, by this way we can always find a Pareto optimum as long as the number of outcomes is finite.