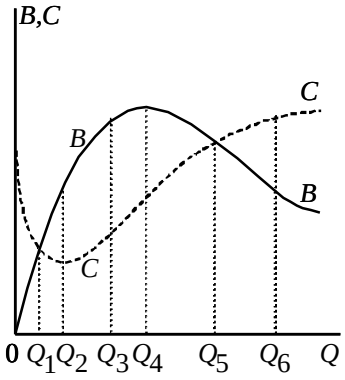
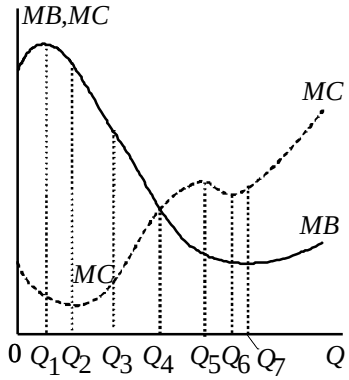
Midterm Exam #1 - Answers
October 1, 1997

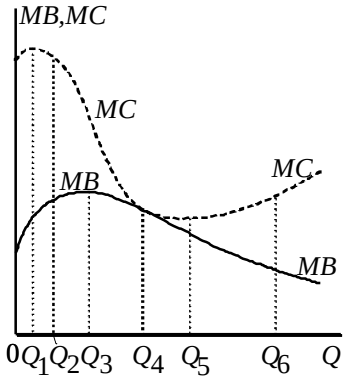
1. [12 Points (2 each)] The figures below show either total benefits (*B*) and total costs (*C*), or marginal benefits (*MB*) and marginal costs (*MC*), as functions of the level (quantity, *Q*) of some activity. In the blanks provided and using the labels in the diagrams, indicate the level of each activity that maximizes net benefits from it. You should assume that there are no fixed costs in any of these cases. If the optimum appears to be different from any that are labeled, use the one that is closest to the optimum.



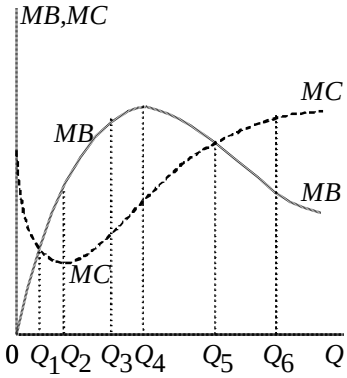
a) Q_3



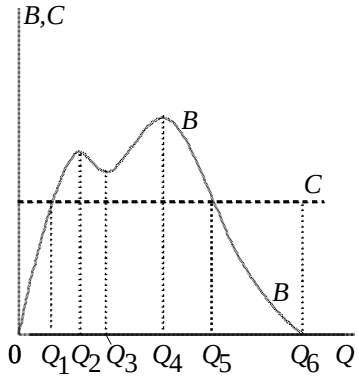
b) Q_4



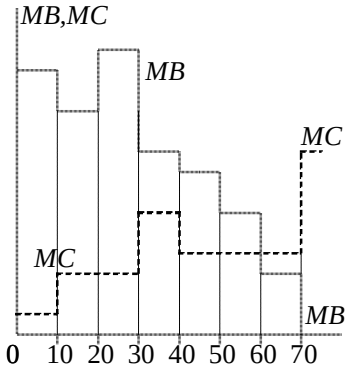
c) 0
(Note *MC*>*MB*)



d) Q_5

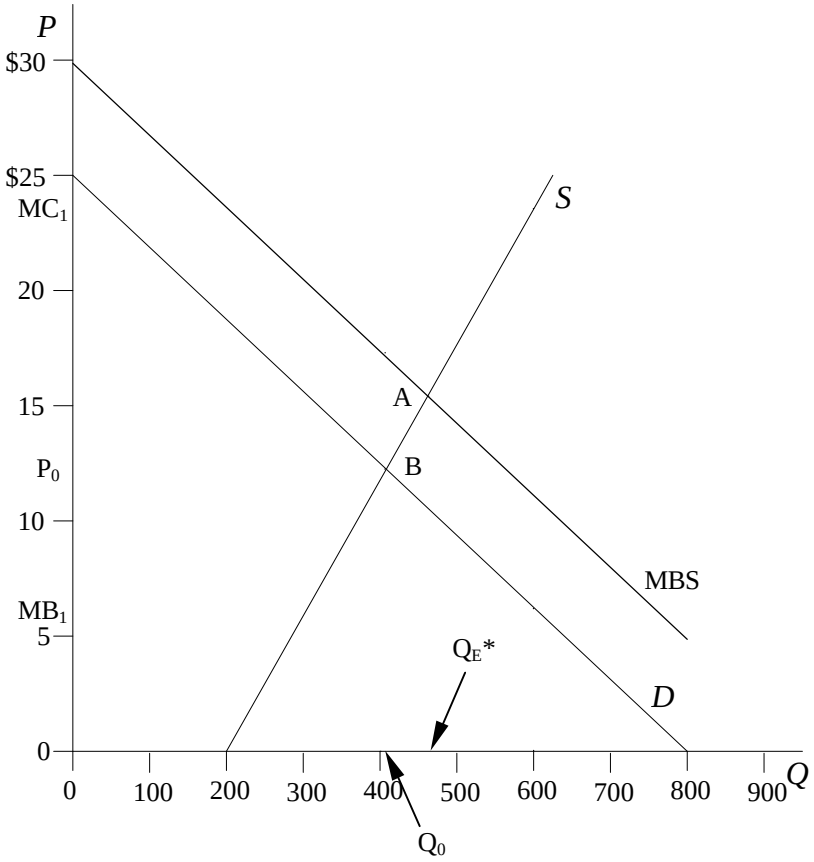


e) Q_4



f) 60

2. [22 points] In the diagram below are drawn a supply curve, *S*, and a demand curve, *D*, for a market.



a) (4 points) Find the market equilibrium price and quantity in the diagram and label them P_0 and Q_0.

b) (4 points) Suppose that output in the market were at the level Q_1=600. Find the marginal (private) cost of additional output when Q_1=600, and label it MC_1. Find the marginal (private) benefit of additional output when Q_1=600, and label it MB_1.

c) (2 points) Suppose that consumption in this industry causes pleasure to other people who are nearby to those consuming (perfume, perhaps), the external benefit of which to society is $5 per unit of output. Draw a curve in the diagram representing the marginal benefit to society as a whole of various levels of consumption in the industry, and label it MBS.

d) (2 points) Identify the socially optimal level of output in the diagram in the presence of the externality introduced in part (c), and label it Q_E*. (Finding it in the diagram is enough. You don't need to read the number.)

e) (4 points) Describe, in the space below, a policy that would move consumption in this industry to this socially optimal level. Why would this work?

A $5 subsidy to either production or consumption. This would work by causing either producers or consumers to internalize the externality.

f) (6 points) Find in the diagram an area or areas that measure both of the following effects of the optimal policy from part (e). Add labels to the diagram, so that you can describe them with those labels in the blanks below.

The increased benefit from the externality: A+B

The net benefit to society: A

3. [24 points] Supply and demand for potato chips in Fort Wayne, Indiana, are given by the following two equations:

$$P = 2 + 0.005Q$$
$$Q = 335 - 100P$$

where P is price in \$ per 24 oz. bag and Q is quantity in thousands of 24 oz. bags per week. Be careful, as you answer the following, that you specify completely your units of measurement.

a) (2 points) Verify, in the space below, that competitive equilibrium price and quantity are \$2.45 per bag and 90,000 bags per week. (You will need to use the equations above, either to solve them for these equilibrium values or to confirm that the market clears at these values. Show enough of your work for us to see what you have done.)

Solving for equilibrium, combine the above equations:

$$Q = 335 - 100(2 + 0.005Q) = 335 - 200 - 0.5Q = 135 - 0.5Q$$
$$1.5Q = 135$$
$$Q = 135 / 1.5 = 90$$
$$P = 2 + 0.005(90) = 2 + .45 = 2.45$$

Alternatively, to confirm that the market clears at these values, just plug them into the above equations to see that these values satisfy them:

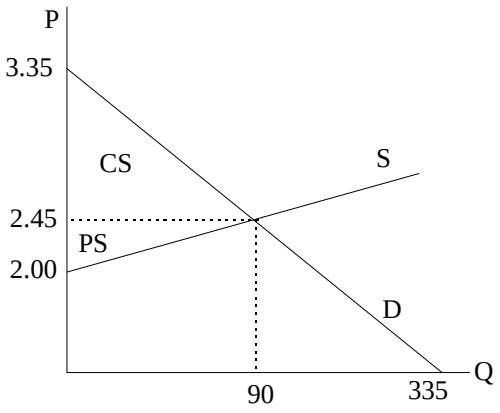
$$P = 2 + 0.005Q = 2 + 0.005(90) = 2 + 0.450 = 2.45$$

and

$$Q = 335 - 100P = 335 - 100(2.45) = 335 - 245 = 90$$

b) (4 points) Calculate the total consumer and producer surplus in this market in that competitive equilibrium (you may assume that firms have no fixed costs).

$$Q = 335 - 100P$$
$$\Rightarrow \quad 100P = 335 - Q$$
$$\Rightarrow \quad P = 3.35 - 0.01Q$$
$$CS = (3.35 - 2.45)(90{,}000) / 2 = 40{,}500$$
$$PS = (2.45 - 2)(90{,}000) / 2 = 20{,}250$$



Total Consumer surplus: \$40,500 per week

Total Producer surplus: \$20,250 per week

a) (4 points) Suppose now that a production tax, of \$0.15 per 24 oz. bag, is levied on producers of potato chips. Verify, in the space below, that the new equilibrium quantity is 80,000 bags per week and the new equilibrium price paid by demanders is \$2.55 per bag. (See part (a) for what you need to do to verify an equilibrium.)

Solving for equilibrium, start with the equilibrium condition:

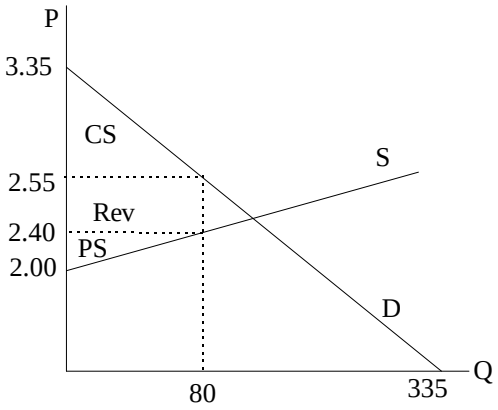
$$P_D = P_S + 0.15$$
$$(3.35 - 0.01Q) = (2 + 0.005Q) + 0.15$$
$$3.35 - 0.01Q = 2.15 + 0.005Q$$
$$1.20 = 0.015Q$$
$$Q = 1.20 / 0.015 = 80$$
$$P_D = 3.35 - 0.01Q = 3.35 - 0.01(80) = 3.35 - 0.80 = 2.55$$

Alternatively, to confirm that the markets clear at these values, first note that if demanders pay \$2.55, then suppliers receive this minus the tax: 2.55-0.15=2.40. Then check that the quantity supplied at this price equals the quantity demanded at \$2.55:

$$P_S = 2 + 0.005Q_S$$
$$\Rightarrow \quad Q_S = -400 + 200P_S = -400 + 200(2.40) = -400 + 480 = 80$$
$$Q_D = 335 - 100P = 335 - 100(2.55) = 335 - 255 = 80$$

d) (6 points) In the new equilibrium, including the production tax from part (c), what are the new levels of total consumer and producer surplus, and how much revenue is the government collecting?

$$CS = (3.35 - 2.55)(80{,}000) / 2 = .80(80{,}000) / 2 = 32{,}000$$
$$PS = (2.40 - 2.00)(80{,}000) / 2 - .40(80{,}000) / 2 = 16{,}000$$
$$\text{Rev} = (0.15)(80{,}000) = 12{,}000$$



New Total Consumer Surplus: \$32,000 per week

New Total Producer Surplus: \$16,000 per week

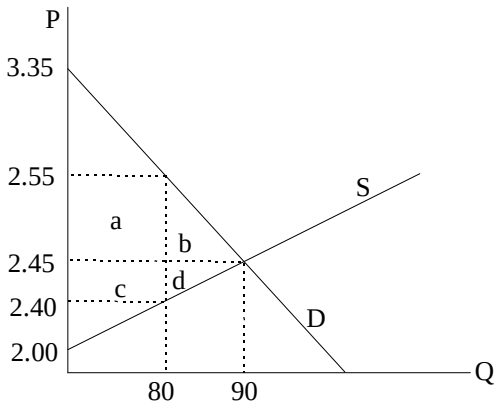
Government Tax Revenue: \$12,000 per week

e) (8 points) What are the welfare effects of the tax? Be careful to distinguish gains and losses.

Using the results of parts (b) and (d):

$$\Delta CS = 32{,}000 - 40{,}500 = -8{,}500$$
$$\Delta PS = 16{,}000 - 20{,}250 = -4{,}250$$
$$\Delta \text{Re}v = \text{Re}v = 12{,}000$$
$$Net = -8{,}500 - 4{,}250 + 12{,}000 = -750$$

You could also do this by calculating the changes only, using the diagram at the right, although having already calculated both the old and new levels of consumer and producer surplus, the above calculation is easier.



$$\Delta CS = a + b = (2.55 - 2.45)(80 + 90)/2$$
$$= 0.10 \times 85 = 8.5$$
$$\Delta PS = c + d = (2.45 - 2.40)(80 + 90)/2$$
$$= 0.05 \times 85 = 4.25$$
$$\Delta \text{Re}v = a + c = (2.55 - 2.40)(80)$$
$$= 0.15 \times 80 = 12$$
$$Net = b + d = (2.55 - 2.40)(90 - 80)/2$$
$$= 0.15 \times 5 = 0.75$$

where these calculations are in thousands of dollars per week.

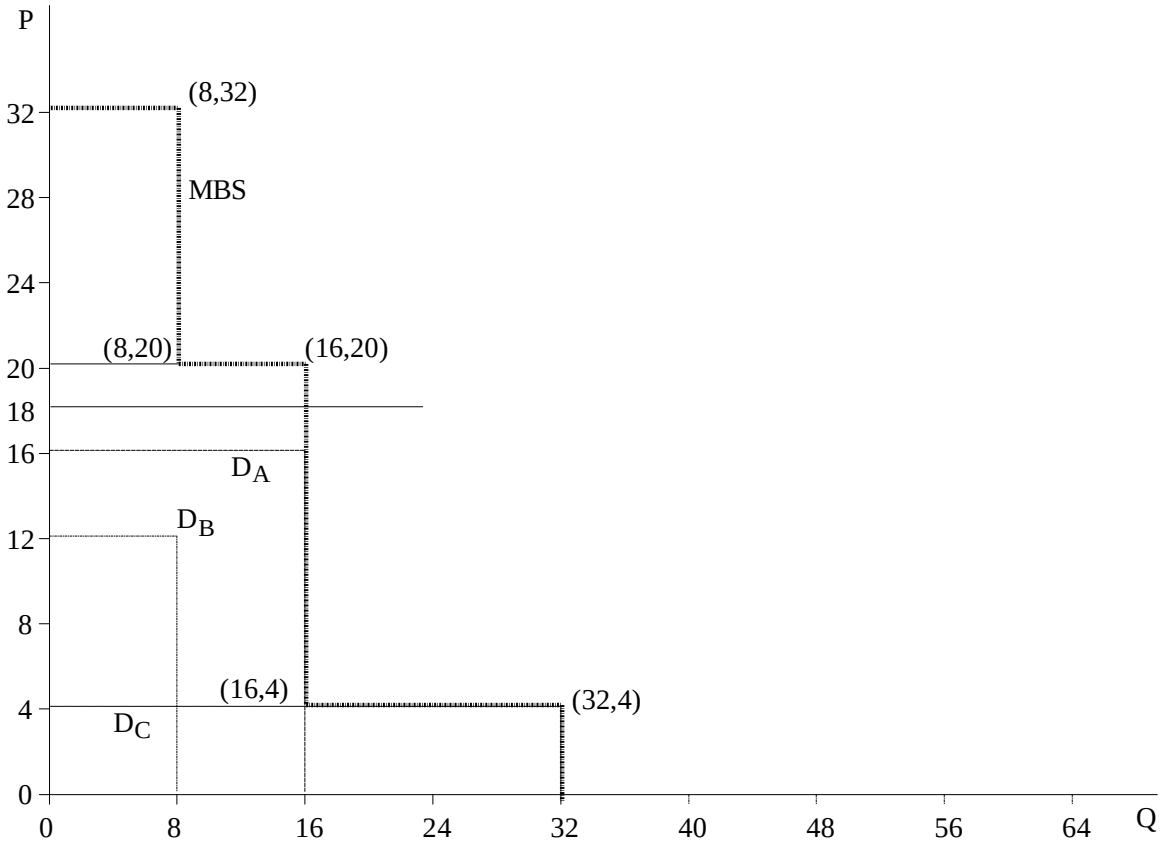
Change in Consumer Surplus: –$8,500 per week

Change in Producer Surplus: –$4,250 per week

Change in Government Revenue: +$12,000 per week

Net Social Benefit from Tax: –$750 per week

4. [24 points] In the figure below are drawn the demand curves for three households, D_A, D_B, and D_C, for a non-excludable public good. Each household is willing to pay the constant marginal amount indicated for the public good for any quantity up to a maximum, as shown, but both the willingness to pay per unit and the maximum are different across households.



a) (4 points) In the figure above, draw the social marginal benefit curve for this public good, taking account of the demands by all three households. Be sure to make clear the locations of the intercepts of this curve as well as any kinks. Label it MBS.

b) (6 points) If there were no government or other possibility of collective action, what quantities of the public good would you expect to see produced in this economy if the marginal cost of the public good were constant and equal to each of the following? Briefly explain your answers.

i) 18 None, because no household has a willingness to pay this high.

ii) 14 16 units, because household A is willing to pay more than this cost, and knows that no other household will pay this much.

iii) 8 None, because while households A and B both are willing to pay more than this, both would prefer to let the other do it and free ride.

c) (4 points) If this were a private good instead of a public good (for this part of the question only), how much would be produced at constant marginal costs equal to the following?

i) 8 24

ii) 2 56

d) (10 points) Suppose that the marginal cost of the public good were constant and equal to 18. Suppose also that the total cost is to be divided equally among the three households.

i) What quantity of the public good would be socially optimal? Indicate how you get your answer.

16, from the graph, where marginal benefit to society (MBS, the vertical sum of the demand curves) equals 18.

ii) If the social optimum of part (d-i) were selected, what is the total amount each household would have to pay for it?

Each household would pay 96. They each pay 1/3 of the marginal cost of 18, or 6 per unit. This times the number of units, 16, is $6 \times 16 = 96$.

iii) Which of the three households, if any, would be worse off than if the public good were not provided at all?

Household C, only, would be worse off, since it would be paying 6 per unit but its willingness to pay is only 4.

iv) If the number of households were to double, adding one household of each type with the same demand curves D_A, D_B, and D_C, how would the socially optimal quantity change?

It would not change. The MBS curve drawn above would expand upward, doubling in height, since there would be twice as many households of each type to add together. However, the vertical portion at quantity 16, which previously extended from 4 to 20, will now extend form 8 to 40. Since this still includes the cost of 18, the optimal quantity continues to be 16.

v) How many of these six households would now be worse off? (This is still assuming that the optimal quantity is provided and that its cost is divided equally among all households.)

None. The 18 cost is now divided 6 ways, so each household pays only 3. At this price, households like C now benefit, since their willingness to pay is 4.

5. [12 points] Each of the figures below show average and marginal cost curves for monopolist firms, together with the demand curves that they face. Note that in figure (c) the average and marginal cost curves coincide, both being constant up to a capacity constraint and rising vertically at capacity. There is also a capacity constraint in figure (d), though here the marginal and average costs are not the same below capacity, but both become vertical at capacity.

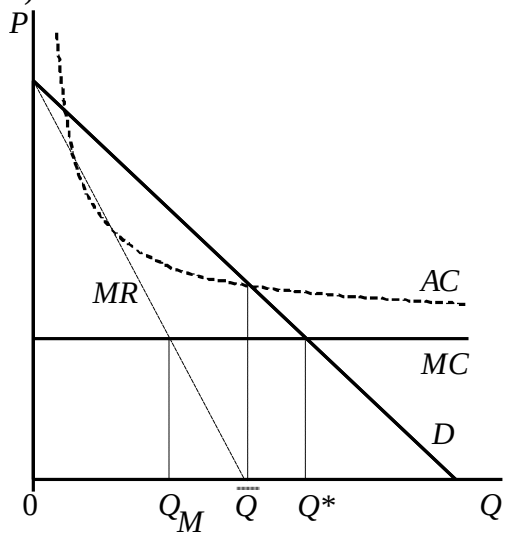
In each of the figures, find the following levels of output and label them as indicated:

Q_M: The monopolist's profit maximizing output.

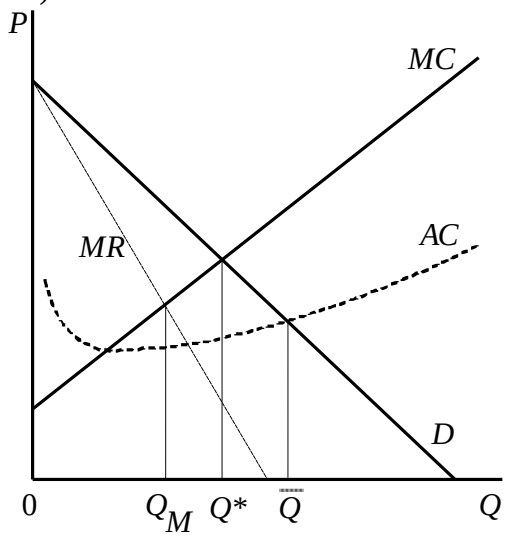
Q^*: The socially efficient output.

$\overline{Q}$: The largest output the firm could produce without running at a loss.

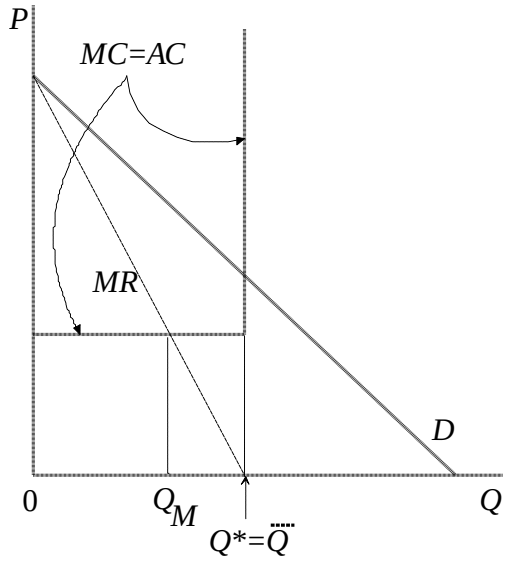
a)



b)



c)



d)