Problem Set #1
Due September 21, 1998
Answers

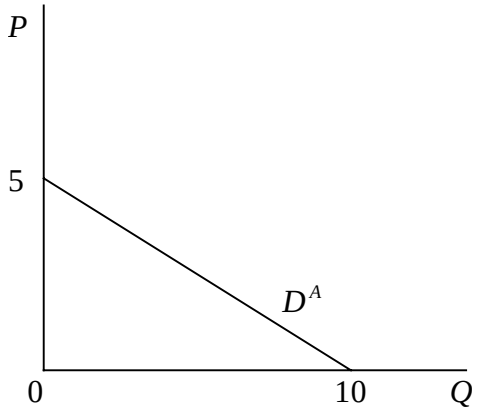
1. a) Graph demand curves for the following consumers. Be sure to label them with numbers to indicate important points on the graphs, including where they cross the axes and any kinks.

   i) Consumer A whose demand is given by $Q = 10 - 2P$.

   $Q = 10 - 2P, \quad P = 0 \Rightarrow Q = 10$

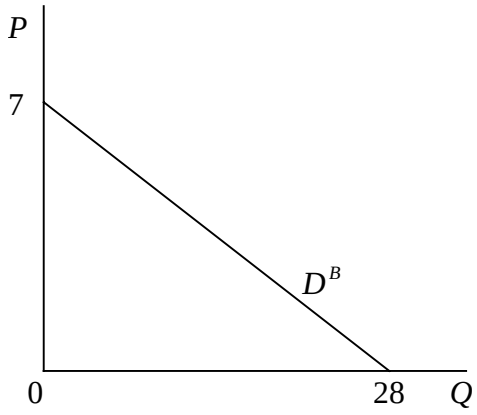
   $2P = 10 - Q$

   $P = 5 - 0.5Q, \quad Q = 0 \Rightarrow P = 5$



   ii) Consumer B whose willingness to pay is given by $P = 7 - 0.25Q$.

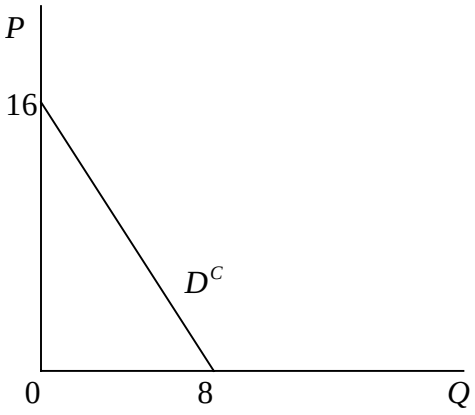
   $Q = 28 - 4P$



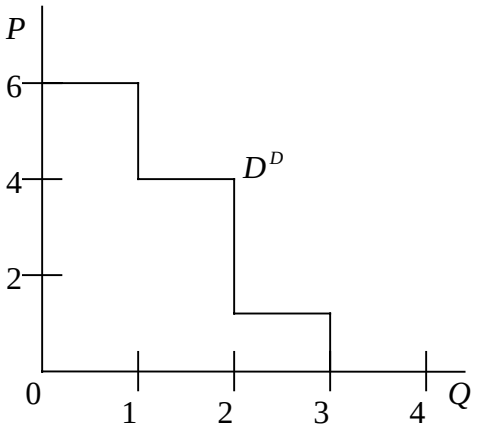
iii) Consumer C who is willing to spend a total of $T = 16Q - 2Q^2$, where Q is the quantity bought.

$T = PQ = 16Q - 2Q^2$

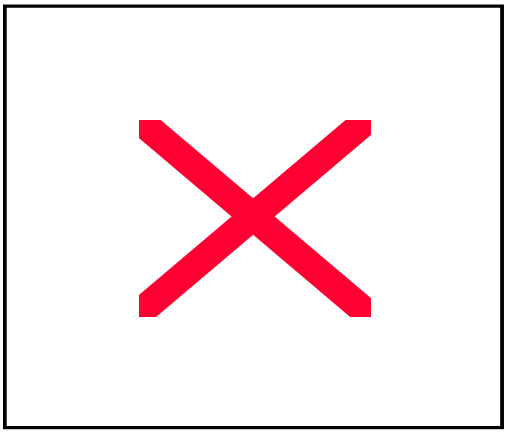
$T / Q = P = 16 - 2Q$



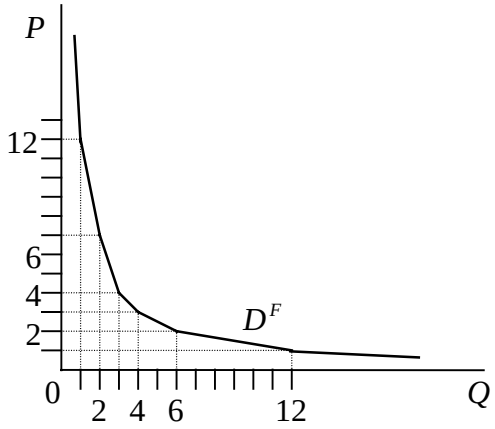
iv) Consumer D who is willing to pay \$6 per unit for up to one unit, \$4 for up to a second unit, \$1 for up to a third, and won't buy more than three at any price.



v) Consumer E who will pay no more than \$2 per unit of the good, will buy up to 4 units at that price, and will buy no more than 4 units at any price.



vi) Consumer F who will spend \$12 on whatever amount of the good that will buy, regardless of price.



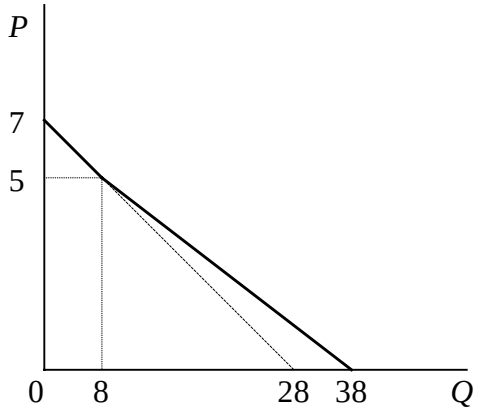
b) Graph the market demand curves for markets composed only of the following consumers from part (a):

i) Consumers A and B

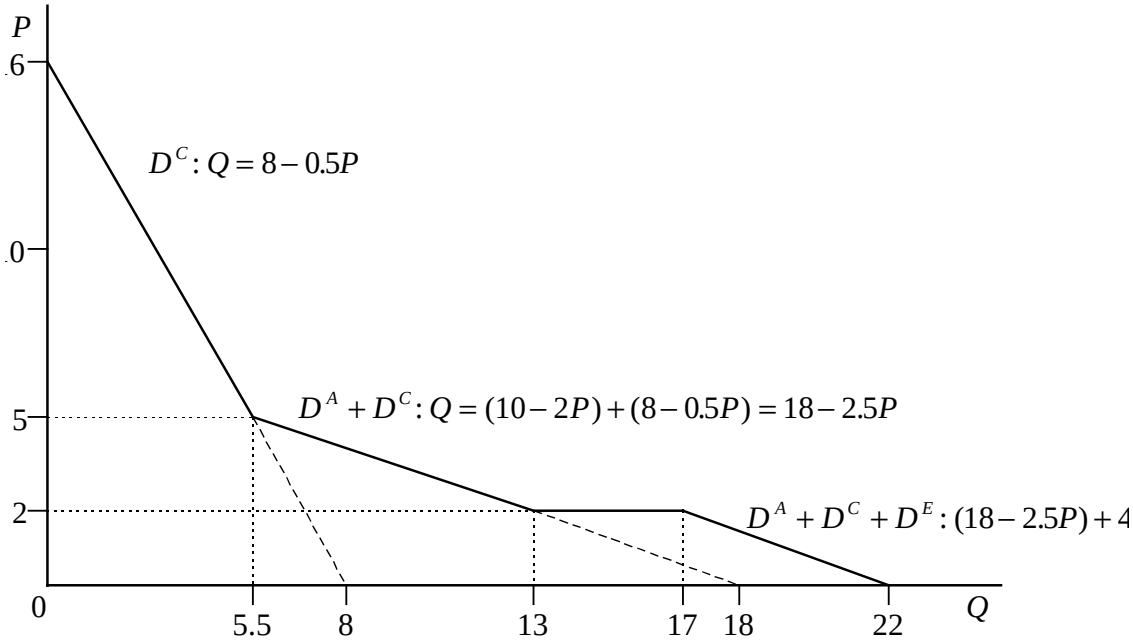
$P > 7 \Rightarrow Q = 0$ (nobody)

$7 > P > 5 \Rightarrow Q = 28 - 4P$ (B only)

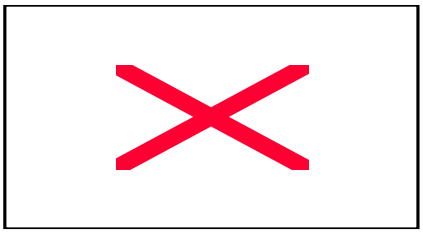
$5 > P \Rightarrow Q = (28 - 4P) + (10 - 2P)$
$= 38 - 6P$
(A and B)



ii) Consumers A, C, and E



2. Four firms each have constant but different marginal costs as shown in the table at the right. They also have capacity constraints that prevent them from producing more than the maximum amount indicated. Government, the only demander in this industry, wants 24 units of the good.



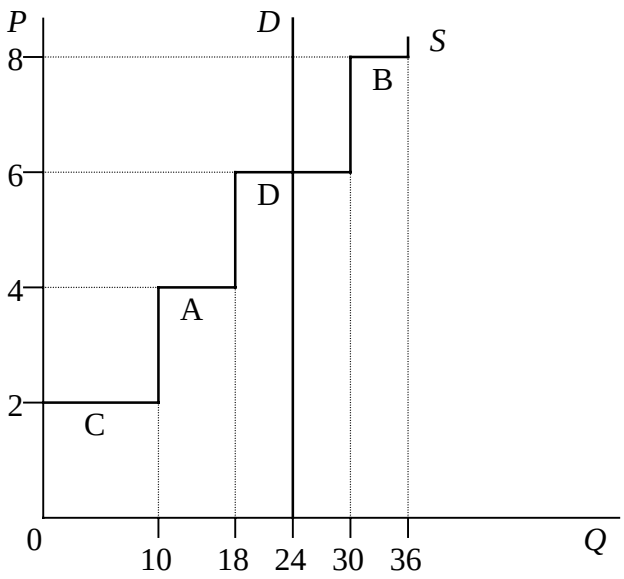
a) If each firm charges a price equal to its own marginal cost, how much will the government spend if it buys an equal number of units from each firm?

Government buys 6 units from each firm, which charge 4, 8, 2, and 6 respectively. It therefore spends 4×6=24 at Firm A, 8×6=48 at Firm B, 2×6=12 at Firm C, and 6×6=36 at Firm D, for a total of 120.

b) Under the pricing assumption of part (a), could the government save money by buying different amounts from the different firms? Why? How?

Yes. If it were to buy as much as possible from the cheapest firms until it fills its order, it would save money. That is, it would buy 10 from C, spending 20, 8 from A spending 32, and 6 (=24-10-8) from D spending 36. It's total expenditure would then be 20+32+36=88, which is less than the 120 in part (a).

c) Graph the supply and demand curves for this market and find the competitive market equilibrium price.



Demand is vertical at 24. Supply is horizontal at each firm's cost up to its capacity, where it rises vertically to the next firm's cost.

$P^e = 6$

d) How much does the government spend in the market equilibrium you just found, and how much does it buy from each firm? How does this outcome compare to the others that you have looked at above?

It spends the market price, 6, for all 24 units, or 6x24=144. It buys the same quantities as in part (b): 10 from C, 8 from A, and 6 from D. The cost to the government is more than in either (a) or (b).

Optional:

Note that profits are zero in both (a) and (b), but here they are 56: C: (6-2)10 = 40 A: (6-4)8 = 16 D: (6-6)6 = 0

Total costs and benefits are therefore:

	(a)	(b)	(c)
Govt Exp.	-120	-88	-144
Firm Profit	0	0	56
Net	-120	-88	-88

Therefore, even though the government spends more in option (c), society is better off there than in option (a).

3. The demand for noodles in Hong Kong per day is given by

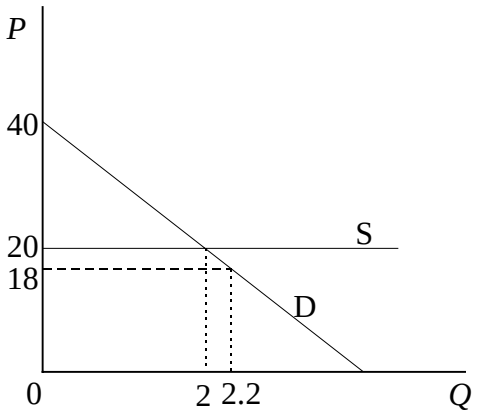
$$P = 40 - 10Q$$

where Q is the quantity of noodles sold per day, in millions of bowls, and P is the price in HK$ per bowl. Suppliers of noodles make them available at a constant cost of HK$20 per bowl. Recognizing the unique health benefits of noodles, the Hong Kong government is considering providing a subsidy to their production of HK$2 per bowl.

a) Without the subsidy, calculate the market equilibrium quantity and price of noodles in Hong Kong.

$P = 40 - 10Q \quad \Rightarrow \quad Q = 4 - 0.1P$

and thus the demand curve is as drawn:



Supply is horizontal at a price of 20, since that is the constant (marginal) cost. Thus equilibrium price equals that marginal cost, or HK$20 per bowl. Equilibrium quantity is found by substituting that price in the equation above.
$Q^e = 4 - 0.1(20) = 4 - 2 = 2$. Thus

P^e = HK$20 per bowl

Q^e = 2 million bowls per day

b) Hong Kong's GDP is in the neighborhood of US$100 billion. (Note this is US$, not HK$.) Approximately what percentage of Hong Kong's GDP is noodles, if

the above information is correct? (Make explicit any additional assumptions that you make.)

Value of noodles produced and sold in US$ per year is

$$20(HK\$/bowl)\times 2(mil.bowls/day)\times 365(days/yr)\times(1/8)(US\$/HK\$) = 1825(mil.US\$/yr)$$
$$= 1.825(bil.US\$/yr)$$

which is 1.8% of Hong Kong GDP. (This assumes Hong Kong GDP=US$100 bil. per year, 365 days per year, and an exchange rate of 8HK$=1US$.)

c) If the proposed subsidy is provided, what will be the new quantity of noodles produced and consumed, how much will consumers pay per bowl and how much will suppliers receive?

New quantity = 2.2 mil. Bowls produced and consumed per day. Consumers pay HK$18 per bowl, while producers still receive HK$20 per bowl.

d) Calculate the changes in consumer surplus and producer surplus due to the subsidy. How much will the subsidy cost the government?

Change in consumer surplus = $2\times\left(\frac{2.0+2.2}{2}\right) = 2\times 2.1 = 4.2$ HK$ mil. per day

Change in producer surplus = 0, since they still receive their (constant) marginal cost.

Cost to government = $2\times 2.2 = 4.4$ HK$ mil. per day

e) If consumers are unaware of these health benefits, how much would the benefits have to be worth in order for this subsidy to be a socially desirable policy? How would your answer to this change if the health benefits of noodles are correctly perceived by consumers?

Excluding any health benefits, the net social cost of this policy is the sum of the changes in consumer and producer surplus minus the cost to the government. This is 4.2 – 4.4 = HK$0.2 mil. per day.

If consumers are unaware of these health benefits, then they are not included in the marginal private benefits that they reflect in their demand curve, and therefore they constitute an additional benefit not included in the above. Thus if the health benefits are worth more than HK$0.2 mil. per day, then this policy is worth doing.

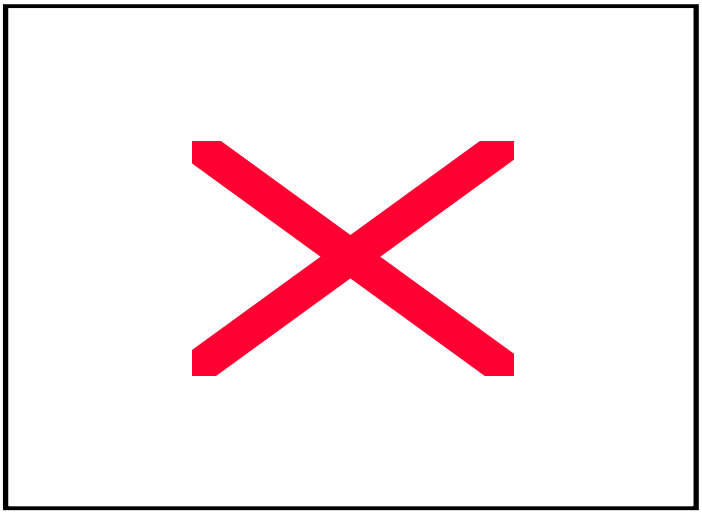
If, on the other hand, consumers *are* aware of the health benefits, then these are included in their private marginal benefit from consuming noodles, and they are already a part of the increase in consumer surplus that we have calculated. Therefore the fact that these health benefits exist does not provide any *additional* benefit above

what we have already calculated. Since the analysis above shows that the policy imposes a net social cost, the policy is *not* desirable regardless of how large the health benefits may be. (Of course, as a check on this assumption, one might want to estimate the health benefits, if possible, directly and compare them to the change in consumer surplus. If the health benefits are known to be larger than the HK$4.2 mil. per day change in consumer surplus, then something may be wrong. The health benefits in this case cannot be included in the demand curve, unless perhaps consumption of noodles is in fact unpleasant, and people eat them only for their health benefits.)

4. Suppose that the data for the sugar market used in Tarr and Morkre are all correct except that the world price of sugar, instead of being 15 cents per pound, is 10 cents per pound. Recalculate, under that assumption, the effects of an import quota that is used instead of a production subsidy to maintain sugar producers' revenues at 21.8 cents per pound. That is, recalculate the effects reported in Tarr and Morkre's Table 4.4. You need not be exact here, but do make clear how you get your results.

   The figure below reproduces Figure 4.2 from Tarr and Morkre, with some changes. The world price is now 10.0, which is exactly 5.0 below the original world price. Since the duty on sugar is still 2.8 cents, the domestic market price in the absence of any quota will now be 12.8 cents, as shown.

   We need to know the quantities supplied and demanded at this price. These can be inferred from the data in the original Figure 4.2, since the supply and demand curves are straight lines. For example, we observe that a 4.0 cent price increase, from 17.8 to 21.8, was associated with an increase in quantity supplied of 6.045–4.296=1.749. This is an increase of 1.749/4=0.43725 for each one cent. The drop in price of 5 cents to 12.8 will therefore cause a drop in supply of 5×0.44=2.186, so the supply at price 12.8 is 4.296–2.186=3.110. Similarly, a 4.0 cent price drop from 21.8 to 17.8 increases demand from 9.025 to 9.356, or 0.331, which is an increase of 0.08275 for each cent. With a further drop of 5.0 cents to 12.8, demand will increase by 5×0.08275=0.414, to 9.356+0.414=9.770. These quantities are shown in the figure below.

   We can now recalculate the results in Table 4.4. To simplify things, first note that every area we need includes multiplication by the price difference, 21.8–12.8=9.0 cents per pound. To make this commensurate with the

quantity measure in tons and also to give answers in dollars, convert it to dollars by ton by multiplying by 2000 pounds per ton and dividing by 100 cents per dollar. The price difference is then $180 per ton.

Cost to Consumers = PS+DP+QR+DC
= 180(9.025+0.5(9.770-9.025)) = $1691.55 m.

Cost to Consumers/Taxpayers
= QR+DC = 180((9.025-6.045)+0.5(9.770-9.025)) = $603.45 m.

Cost to U.S. Economy
Consumption Distortion = DC = 180(0.5(9.770-9.025)) = $67.05 m.
Quota Rents = QR = 180(9.025-6.045) = $536.4 m.
Total = QR+DC = $603.45 m.

Summarizing, and comparing to the original results,

	If World Price = 15 cents	If World Price = 10 cents
Cost to Consumers	735.2	1691.6
Cost to Consumers/Taxpayers	251.6	603.5
Cost to U.S. Economy		
Consumption Distortion	13.2	67.05
Quota Rents	238.4	536.4
Total	251.6	603.5