Name:

Group members:

ARE 336 – Problem set 1 – Microeconomics review

Due **September 5**

This problem set has 3 questions, for a total of 100 points (with the possibility to earn up to 20 bonus points).

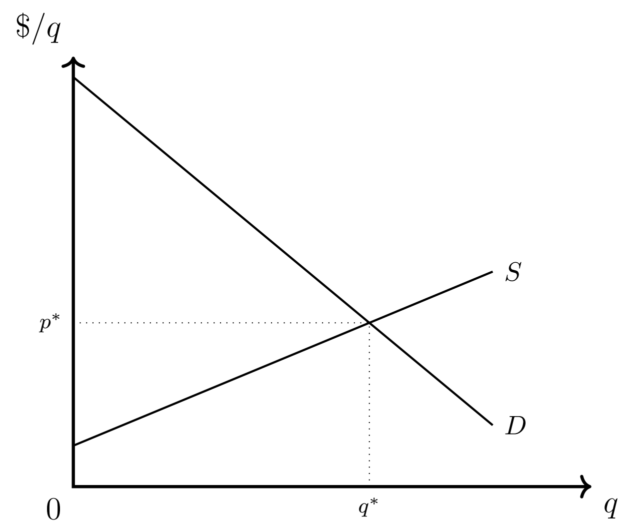
1. Consider the demand functions $D_1(p) = 10 - \frac{p}{250}$ and $D_2(p) = 15 - \frac{p}{100}$.
   (a) [3 points] Find the inverse demand functions.
   (b) [1 ½ points] Calculate the "choke price."
      i. [1 ½ points] State, in words, what the choke price is.
   (c) [3 points] Calculate the maximum quantity demanded for both demands.
   (**Hint:** The maximum quantity demanded occurs when the good is given away for free; when a good is free, it means $p = 0$.)
   (d) Do the following for the prices $p = \$100, \$500, \$1000, \$1500, \$2000, \$2500$:
      i. [4 points] Calculate quantity demanded. What do you notice about the relationship between quantities demanded for the two demand functions?
      ii. [4 points] Calculate consumer surplus. What do you notice about the relationship between consumer surplus for the two demand functions?
   (**Hint:** Consumer surplus is the "whole triangle.")
   (e) [3 points] Graph these demand functions on a figure with "Price" on the vertical axis and "Quantity" on the horizontal axis.

Question 1: 20 points

2. Some policymakers promote taxes as a way to dis-incentivize undesireable behavior. In 2015, the city of Berkeley, CA imposed a tax on all sugar-sweetened beverages. In this exercise, you will work through the impacts of a buyer-side sales tax. Suppose we are given the inverse demand and supply functions for soda in Berkeley *before* the tax is implemented:

$$P(q) = 20 - q$$
$$S(q) = 2 + \frac{1}{2}q$$

where q is cans of soda. The market is shown graphically below:



The original equilibrium price is p^*. At this price, q^* cans of soda are in the market.

Now assume that a tax of $2 is placed on the purchasers. We will use intuition and logic to work through the impacts of this tax on the market.

(a) [2 points] Use the equilibrium condition $S(q^*) = P(q^*)$ to find the equilibrium quantity. Calculate the inverse demand at this quantity to get the equilibrium price. (that is, $p^* = P(q^*)$).

(b) [2 points] Calculate the choke price of the pre-tax inverse demand function.

(c) [4 points] Note that, with the tax in place, the market price of soda will have to decrease by $2 in order for the equilibrium quantity to be demanded. In order to continue consuming the equilibrium quantity, what would the market price need to be? Mark this point on your graph, labeled a.

(**Hint:** The market price is the price *not including* the tax. So if the consumers face a market price of $3, they will pay $4 in total).

(d) [4 points] By similar reasoning, the choke price for the inverse demand function with the tax should be decreased by $2 as well. Mark this point on your graph, labeled b.

(e) [2 points] Connect points a and b to create the hypothetical tax-inclusive demand curve. Label this demand curve D_{tax}.

(f) [4 points] Find the new equilibrium *quantity*, q^{**}, at the intersection of the hypothetical demand and supply.
(**Hint:** i.e., find q^{**} using the equilibrium condition $D_{\text{tax}}(q^{**}) = S(q^{**})$).

(g) [4 points] Now we need to determine what the true market price is, and what the effective price for the buyers is. We know that the new equilibrium quantity is q^{**}. Calculate the price that supplies this amount using the supply function. Label this price p_m^{**}.
(**Hint:** i.e., $p_m^{**} = S(q^{**})$).

(h) [4 points] You just calculated the market price, p_m^{**}. This price reflects the "sticker price" of the soda. The suppliers are selling their good for this price, so their profit is the triangle between p_m^{**} and S. Label this triangle PS on your graph. What is the value of the producer surplus?

(i) [4 points] To calculate consumer surplus, we need to understand what consumers are willing to pay at the new equilibrium quantity. Use the original inverse demand curve to find this price, and label it p_b^{**}.
(**Hint:** i.e., $p_b^{**} = P(q^{**})$).

(j) [4 points] The consumer surplus is the area below D and above p_b^{**}. Label this triangle CS on your graph. What is the value of the consumer surplus?

(k) [3 points] The "tax wedge" is the rectangle beteween p_b^{**} and p_m^{**} on the vertical axis and between 0 and q^{**} on the horizontal axis. Label this rectangle Tax on your graph. What is the value of total tax revenue?

(l) [3 points] The deadweight loss is the total surplus that was being enjoyed in the pre-tax equilibrium, but is neither collected as tax revenue nor enjoyed as surplus after the tax goes into effect. Label this triangle DWL on your graph. What is the value of the deadweight loss?

Question 2: 40 points

3. Consider the case of free-to-visit parks. Because they are free, there is no price component of the supply function, just a fixed quantity supplied for all prices. Hence, the supply function is a vertical line that intercepts the horizontal axis at the quantity supplied.

   Suppose we are given the following willingness-to-pay function for free parks:

   $$WTP(q) = 15 - \frac{3}{4}q$$

   where q is the number of people that the park can accomodate. Consider that q is very closely related to park size, so that when the town chooses q, it is in essence choosing the number of acres to dedicate to its free park.

   (**Note:** Throughout this exercise, treat q as fixed at the quantity you determine in part (c). Once you choose this q, it cannot be changed.)

   (a) [2 points] The willingness-to-pay function is equivalent to the inverse demand function. What does this mean, in your own words?

   (b) [5 points] Calculate the choke price and the quantity demanded when the price is zero. Call these $\overline{p}$ and $\overline{q}$, respectively.

   (c) [8 points] Draw the willingness-to-pay function on a graph with quantity (q) on the horizontal axis and price ($\$/q$) on the vertical axis.

   The town's mayor asks you how many people the park should accomodate. You know that the park will be free to visit and you know the willingness-to-pay function for the parks. How many visitors should the *efficient* park accomodate?

   (**Hint:** Remember that the efficient quantity maximizes *total surplus*).

   (d) The mayor proposes to enact an entrance fee of \$3. The town will reinvest the revenues into the park. These investments improve the *quality* of the existing park, but they will not make the park any bigger. Hence, they will not affect the *supply* function.

   The mayor claims that by making such improvements, the park becomes a more desireable point of interest, garnering a higher willingness-to-pay. Therefore, while the once-free park will no longer be free, there will ultimately be welfare gains from this plan. The following steps will allow you to analyze his argument.

   i. [2 ½ points] What are some examples of investments that the town could make?

   ii. [5 points] Re-draw your graph from part 1, but now include the \$3 entry price. Assuming the willingness-to-pay function doesn't change, how many visitors will there be?

   (**Hint:** You may want to turn the WTP function into a quantity demanded function as a first step).

   iii. [5 points] There will be some amount of consumer surplus that is "transferred" to the parks in terms of revenue, and some amount of consumer surplus that is lost alltogether. How much consumer surplus is transferred, and how much consumer surplus is lost? Illustrate the lost consumer surplus on your figure and calculate the total lost consumer surplus.

iv. [2 ½ points] The mayor's intuition that reinvesting in the parks will cause an increase in demand turns out to be correct. The willingness-to-pay has increased, and the new willingness-to-pay is represented by the function

$$WTP_2(q) = 30 - \frac{3}{4}q.$$

Draw this new willingness-to-pay curve on your graph.

v. [5 points] Remembering that the quantity supplied is fixed, calculate the total consumer surplus and total fee revenue under the new willingness-to-pay curve.

vi. [5 points] Is it welfare-enhancing to charge an entrance fee of $3 and reinvest that revenue into the parks? Provide a short analysis of the policy using your insights from the previous parts of this problem. To answer this question, tell me (i) what is the net change in consumer surplus, (ii) how much fee revenue is generated?

vii. [10 bonus points] If you had to choose an optimal number of visitors for this new park to accomodate, how many would you choose? In other words, what would be q^{**}?

viii. [10 bonus points] How much more fee revenue and consumer surplus would be gained by using this new optimal accomodaiton level?

Question 3: 40 points