Practice Problem Solutions for Quiz 1

1. Use a supply and demand diagram to analyze each of the following scenarios. Explain briefly. Be sure to show how both the equilibrium price and quantity change in each case.

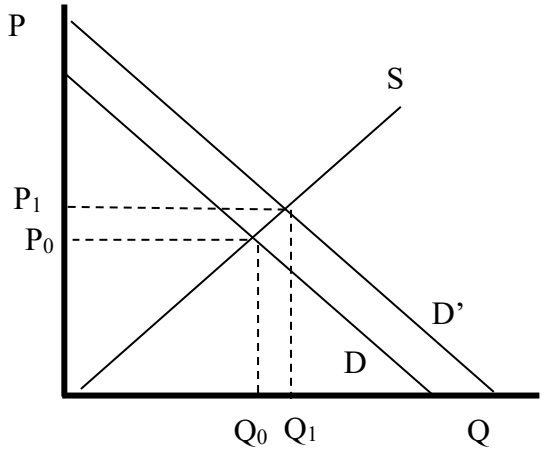
a) The economic downturn has led to more people staying home to watch movies, rather than go to a movie theater. Show how this change in behavior affects the market for microwave popcorn.

b) Suppose that drought conditions in agricultural regions increase the costs of irrigation. How would this affect the market for fruits and vegetables?

c) The *New York Times* recently reported on technological advances leading to an increase in the number of female cows. Female cows are valuable to farmers because they can be used to produce milk. However, while farmers now have more female cows available to produce milk, they are not happy. Use a supply and demand diagram for the milk market to explain why.

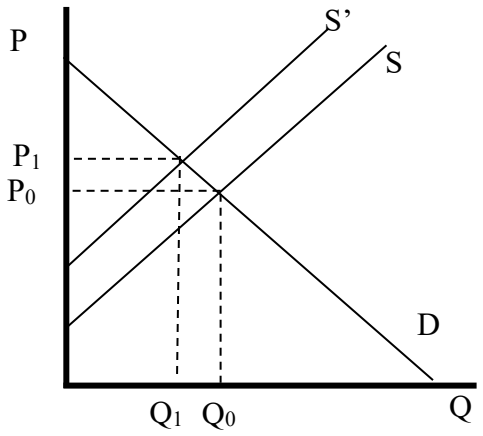
The purpose of this problem is to get you thinking about how demand and supply curves are affected by outside influences, and to help you distinguish between shifts of a curve versus a movement along a curve.

a)



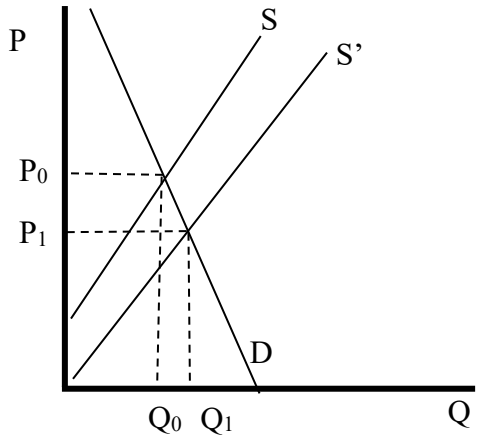
Microwave popcorn is a *compliment* to watching movies at home. Thus, demand for microwave popcorn increases, shifting up and to the right. The equilibrium quantity and price both increase.

b)



Drought conditions reduce the supply of fruits and vegetables, shifting the curve up and to the left. The equilibrium price rises, and the equilibrium quantity falls.

c)



This technological advance increases milk production. As a result, supply increases, shifting down and to the right. Although the equilibrium quantity rises, the equilibrium price falls, explaining why farmers are not happy. Note, in particular, that the demand for milk is usually inelastic. Thus, the drop in price is likely to be larger than the increase in quantity demanded, so that the farmers' revenue likely falls.

2. Suppose that the market for milk can be represented by the following equations:

$$\text{Demand: } P = 12 - 0.5Q_D$$
$$\text{Supply: } P = 0.1Q_S$$

where P is the price per gallon, and Q represents quantity of milk, represented in millions of gallons of milk consumed per day.

a) Calculate the equilibrium price and quantity of milk.
b) To help dairy farmers, the government sets a minimum price of $2.50 per gallon of milk. What is the new quantity of milk sold in the marketplace?
c) Illustrate your answers to (a) and (b) on a graph. Using this graph, calculate how the consumer surplus and producer surplus change after the price supports are enacted. Also calculate any deadweight loss that results.
d) Suppose that the government supports the $2.50 per gallon price by purchasing any excess milk suppliers make available but are unable to sell to consumers. How much milk must the government buy?

a) The equilibrium occurs where supply equals demand:

$$12 - 0.5Q = 0.1Q$$
$$0.6Q = 12$$
$$Q = 12/0.6$$
$$\mathbf{Q = 20 \text{ million gallons}}$$

To find the price, we substitute the equilibrium quantity into either the demand or supply equation:

Either:

$$P = 0.1(20) = \mathbf{\$2}$$

Or:

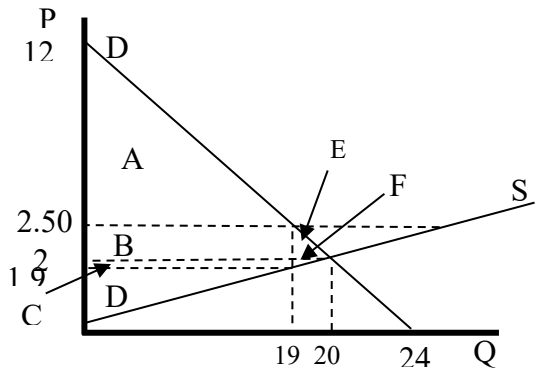
$$P = 12 - 0.5(20) = \mathbf{\$2}$$

b) The minimum price is above the equilibrium price. Thus, there will be an excess supply of milk – more people will want to sell milk than will be willing to buy milk. The new quantity sold will be limited by the number of people willing to purchase milk at this higher price. We find this by substituting \$2.50 for P in the demand equation, and then solving for Q:

$$2.50 = 12 - 0.5Q$$
$$9.50 = 0.5Q$$
$$Q = 9.50/0.5$$
Q = 19 million gallons

c) To draw the graph, we begin by drawing the supply and demand curves. Note that the equations are already solved for P. Thus, we know that the y-intercept (on the price axis) for demand is \$12. Similarly, by setting P = 0, we find that Q = 24 when P = 0 (because 12 – 0.5(24) = 0).

For supply, we know the line goes through the origin (y-intercept = 0), and intersects demand at a quantity of 20 and a price of \$2.



With a price floor of \$2.50, note that there will be excess supply, so the quantity demanded at \$2.50 determines the quantity sold. As we found in part (b), this is 19 million gallons of milk.

Consumer surplus is everything above the price and below the demand curve. Before the price supports are enacted, this is areas **A, B and E** above. This is a triangle with a base of 20 and a height of 10 (=12-2). Thus, the area of this triangle, and thus the consumer surplus, equals 0.5(20)(10) = **\$100 (or \$100 million, since quantity is in millions)**.

After the price supports are in place, consumer surplus falls to just area **A**. This is a triangle with a base of 19 and a height of 9.5 (=12-2.5). Thus, the area of this triangle = 0.5(19)(9.5) = **\$90.25 (or \$90.25 million, since quantity is in millions)**..

Producer surplus is everything below the price and above the supply curve. Without price supports, this is areas **C, D, and F**. The area of this triangle = 0.5(20)(2) = **\$20 (e.g. \$20 million)**.

With price supports, producer surplus is areas **B, C, and D**. Thus, producers lose F, but gain B. Area B is a rectangle with a height of 0.5 (=2.50 – 2) and a base of 19. Its area = (0.5)(19) = 9.5. To find the areas for C and D, we need to know where the line between these areas hits the supply curve at the quantity of 19. We get this by substituting 19 for Q in the supply equation: P = 0.1(19) = 1.9. Given this, we can now calculate that rectangle C has an area of 1.9 (=0.1x19), and triangle D has an area of 18.05 (=0.5x19x1.9). Thus, the total producer surplus = 9.5 + 1.9 + 18.05 = **$29.45 (e.g. $29.45 million)**. As expected, producer surplus increases, and consumer surplus decreases, after price supports are enacted.

There is a deadweight loss with the price supports, because some milk that was sold before is now not sold. This is areas **E and F**. Note that these two areas are part of consumer or producer surplus before the price supports are in place, but not afterwards. These areas represent lost opportunities because less milk is sold. To calculate the value, note that this is a triangle with a height of 0.6 (= 2.5 – 1.9) and base of 1 (= 20 – 19). The area is (0.5)(0.6)(1) = **$0.30 (e.g. $300,000, since quantity is in millions)**.

Finally, to see the intuition of deadweight loss, compare the sum of consumer and producer surplus before and after the policy. Before the policy, the total surplus is $120. After the policy, the total of consumer and producer surplus is $119.70. The difference between these is $0.30. That is, $0.30 of potential surplus is lost because of the minimum price.

d) The excess supply is the difference between the quantity supplied at a price of $2.50 and quantity demanded at a price of $2.50. We know from part (b) that 19 million gallons are demanded at this price. Thus, we just need to find the quantity supplied at this price:

$$2.50 = 0.1Q_S$$
$$Q_S = 2.50/0.1$$
$$Q_S = 25 \text{ million gallons}$$

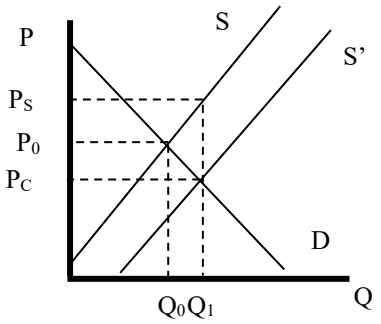
Since 25 million gallons of milk are available for sale, but consumers only purchase 19 million gallons, the government must purchase the **6 million gallons** that are not purchased by consumers.

3. From an analytic standpoint, a subsidy is simply a negative excise tax that confers a benefit to certain groups rather than imposing a burden on them. For decades, the federal government has given fairly large subsidies to farmers for producing everything from grain to honey.

a) Under what conditions of supply and demand would farmers enjoy all the benefits of these subsidies?

b) Under what conditions of supply and demand would farmers enjoy none of the benefits of these subsidies? Who does benefit from the subsidy in this case?

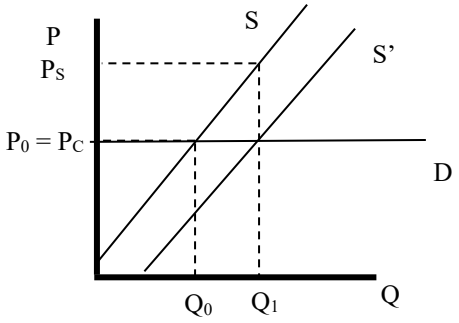
a) This problem is simply a tax incidence problem in reverse. Consider how the subsidy affects the agricultural market:



Just like a tax on farmers would shift the supply curve in, a subsidy for farmers shifts the supply curve out. The equilibrium quantity increases from Q_0 to Q_1.

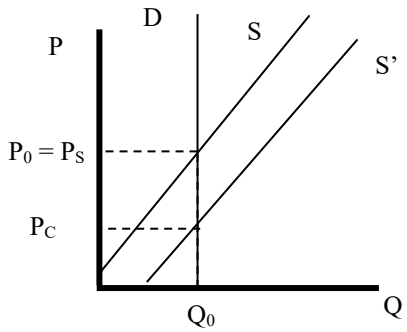
To see what happens to prices, remember that we get the price consumers pay off of the demand curve. This is P_C. Consumers pay less as a result of the subsidy, since there is more food available. However, farmers earn more money, since they get both the price consumers pay and the subsidy. The total amount received by farmers is P_S.

Now, consider what must be true for farmers to enjoy all the benefits. That can only be true if the price consumers pay does not change. When might that occur? There are two possibilities. One is when demand is perfectly elastic, consumers will continue to pay the same price. Thus, suppliers receive the entire benefit of the subsidy. This is illustrated below:



Alternatively, if supply was perfectly inelastic, the quantity sold would not change, so consumers would continue to pay the original price. Again, in this case, suppliers would receive the entire benefit of the subsidy.

b) Farmers enjoy none of the benefits when the price paid by consumers falls by the entire amount of the tax. An example of when this would occur is when demand is perfectly inelastic. In this case, there is no demand for extra agricultural products, so the price falls to discourage additional production. This is illustrated below:



Alternatively, this could occur if supply were perfectly elastic. In that case, the subsidy would simply induce more and more farmers to grow crops, so that the price farmers receive always remains the same.

4. You are the manager of a store that carries generic soft drinks. Due to a local economic boom, your customers' incomes are forecasted to rise by five percent during the next month. The income elasticity of demand for these products is estimated to be –2.0. Estimate the change in the quantity of your soft drink orders required to accommodate the new demand without a surplus or shortage of inventory (that is, how much will demand for the generic soft drinks change due to the increased income?).

Income elasticity is the percentage change in quantity demanded due to a one percent change in income. In this case, a one percent increase in income leads to a two percent decrease in quantity demanded. Since income is rising by 5 percent, quantity demanded will decrease by 10 percent (5% X –2%).

To see this, begin with the formula for income elasticity:

$$\frac{\%\Delta Q}{\%\Delta I} = -2$$

Now, plug in the income elasticity from above and solve for the percentage change in quantity:

$$\frac{\%\Delta Q}{5} = -2$$
$$\%\Delta Q = -10$$

5. Concerned about the behavior of his own teenage children, the governor of a large Southern state is considering policy to help reduce consumption of alcoholic beverages. His advisors have suggested a new tax, the Tax Against Beer (TAB). While beer is currently taxed, this tax would increase the overall tax on beer. It would have the effect of raising the price of beer (and thus the tax revenue raised per unit of beer sold) by 10%.

You are given the following information, and asked to calculate the effect of the tax on both consumption of alcoholic beverages and on government revenue.

Price elasticity of demand for alcoholic beverage: -0.4
Number of alcoholic beverages currently consumed per year: l,000,000

a) By how much will consumption of alcoholic beverages fall after the tax is imposed?
b) Will government revenue increase or decrease after the tax is imposed? How do you know this?
c) How might your answers to (a) and (b) vary if looking at the long-run, rather than the immediate effect?

a) For this problem, we simply use the elasticity formula:

$$\varepsilon = \frac{\%\Delta Q}{\%\Delta P}$$

We are given the percent change in price (10%) and the elasticity. Thus, we can calculate the change in quantity:

$$-0.4 = \frac{\%\Delta Q}{0.1}$$
$$\%\Delta Q = (-0.4)(0.1) = -0.04$$

Quantity will fall by 4%.

To find the reduction in terms of number of beverages consumed, simply multiply this by the total number currently consumed (1,000,000). Thus, we find that consumption of alcoholic beverages falls by 40,000.

b) Government revenue will increase. Demand is inelastic. Thus, the decrease in quantity demanded will be small relative to the increase in price resulting from the tax.

c) One reason that alcoholic beverages have an inelastic demand is because they are addictive. Those who are addicted will purchase alcohol at nearly any price. However, higher prices may discourage new users from consuming alcohol and becoming addicted. Thus, in the long run, demand is likely to be more elastic. The fall in quantity consumed should be greater. The increase in revenue will be smaller, and revenue may decrease if demand becomes elastic.

6. Suppose that demand and supply of apples are described by the following equations:

$$P = 100 - 3Q \quad \text{(demand)}$$
$$P = 20 + Q \quad \text{(supply)}$$

a) Calculate the equilibrium price and quantity. Illustrate.
b) Suppose a $4 tax is placed on apples. What is the new equilibrium quantity? How much do consumers pay to get this quantity? How much do suppliers receive for selling this quantity? Show your results on a supply & demand diagram.

a) The supply and demand of apples is:

$$P = 100 - 3Q \quad \text{(demand)}$$
$$P = 20 + Q \quad \text{(supply)}$$

In equilibrium, the quantity supplied by sellers must be the same as the quantity demanded by consumers. If not, there will be either an excess demand or excess supply, and the price will be bid up or down accordingly. Thus, to find equilibrium, we find the intersection of supply and demand:

$$100 - 3Q = 2Q + 20$$
$$80 = 4Q$$
$$\mathbf{Q = 20}$$

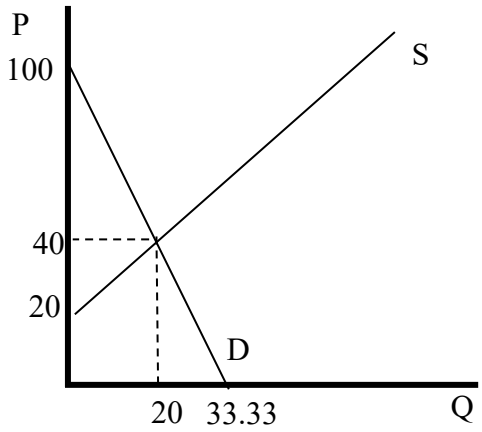
Having found the quantity, we now plug this answer into either the supply or demand equation to find the equilibrium price:

$P = 100 - (3)(20)$
$= 100 - 60$
$\mathbf{= 40}$

or

$P = 20 + 20$
$\mathbf{P = 40}$

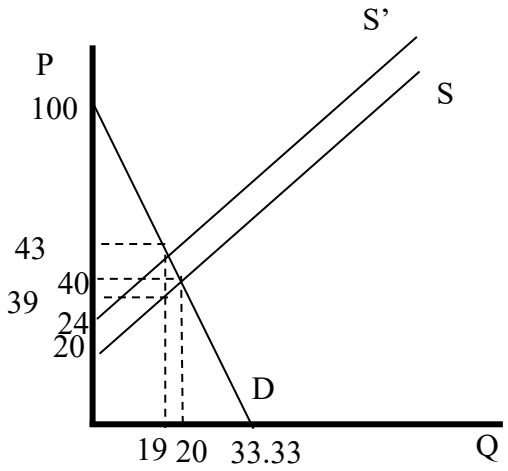
The graph for this market is:



To draw each line, we need two points. We can use the following information to draw the graph. First, the demand curve has a y-intercept of 100. Second, we can solve for Q when P = 0 to find that the demand curve must cross the x-axis at 33.33. For the supply curve, we know that the y-intercept is 20. Starting from there, we proceed to draw a curve with a slope of 1 – that is, for each 1 unit increase in Q, the price must also increase by 1.

b) Recall from class that a tax requires us to shift either the supply curve or demand curve in. Note that your results will be the same no matter which one you choose. For example, let's shift the supply curve.

The supply curve shifts in by the amount of the tax. That is because at any given price, suppliers now receive $4 less, with the remainder going to the government. This is the supply curve faced by consumers. Algebraically, P - 4 = 20 + Q $\Rightarrow$ P = 24 + Q. We subtract $4 because P is the price consumers pay. Suppliers get to keep this price less the four dollar tax. Graphically, note that the y-intercept of the graph has shifted up by the amount of the tax.



We begin by finding the new equilibrium. Equate the new supply curve with the old demand curve.

$$24 + Q = 100 - 3Q$$
$$4Q = 76$$
$$\mathbf{Q = 19}$$

With a quantity of 19, consumers pay:

$$P_C = 100 - 3(19) \text{ (from the demand curve)}$$
$$\mathbf{P_C = 43}$$

However, $4 goes to the government, leaving **$39** for suppliers. Note that we can also get this off the *old* supply curve (39 = 20 + 19). We use the old supply curve because what we are interested in is what suppliers are willing to supply *after the tax has been paid*.

7. Suppose the market for cameras has a supply curve of P = 30 + Q, and a demand curve of P = 240 – 2Q. Assume that the market is perfectly competitive.

a) What will the equilibrium price and quantity of cameras be?
b) Calculate the producer and consumer surplus associated with the equilibrium found in part (a). Illustrate on a graph.
c) Suppose the government levies a tax of $18 per camera sold. What is the new quantity of cameras sold? What price do consumers pay? What price do producers receive? Illustrate on a graph.
d) Find the new producer and consumer surplus associated with your answer to part (c).
e) How much revenue does the government raise from the tax?
f) How does the sum of consumer surplus, producer surplus, and revenue after the tax (your answers to (d) and (e)) compare to the sum of producer and consumer surplus found before the tax (your answer to (b))? What does the difference between the two represent?

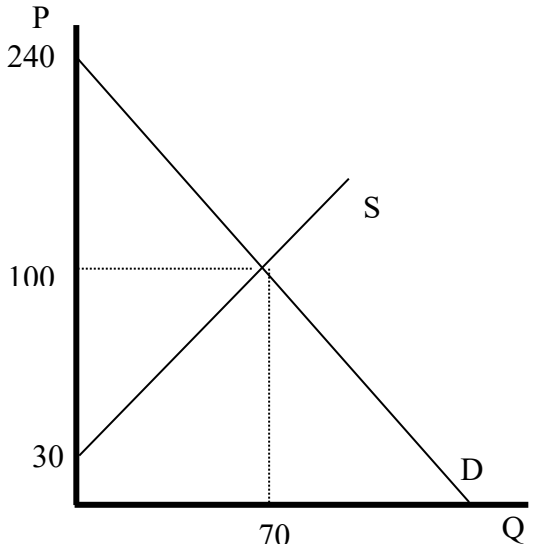
a) The equilibrium price and quantity are:

$$30 + Q = 240 - 2Q$$
$$3Q = 210$$
$$Q = 210/3$$
$$\mathbf{Q = 70}$$

Substitute this into either supply or demand to get:

$$\mathbf{P = 100}$$

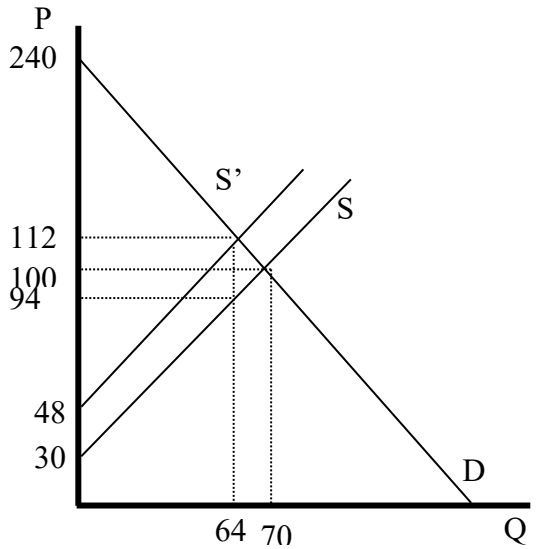
b)



Consumer surplus is the triangle above the price and below demand. It has a height of 140 (= 240 – 100) and a base of 70. Its area = 0.5(140)(70) = **$4,900**.

Producer surplus is the triangle below price and above supply. It has a height of 70 (= 100 – 30) and a base of 70. Its area = 0.5(70)(70) = **$2,450**.

c) The result of the tax is to shift either the supply curve or demand curve in. Note that your results will be the same no matter which one you choose. In this example, I'll shift the supply curve. The supply curve shifts up by the amount of the tax. The new supply curve represents the supply curve faced by consumers. If P is the price consumers pay, suppliers get P - 18, with $18 going to the government. Algebraically, P = 30 + Q becomes P = 48 + Q. Graphically, note that the y-intercept of the graph has shifted up by the amount of the tax.



We begin by finding the new equilibrium. Equate the new supply curve with the old demand curve.

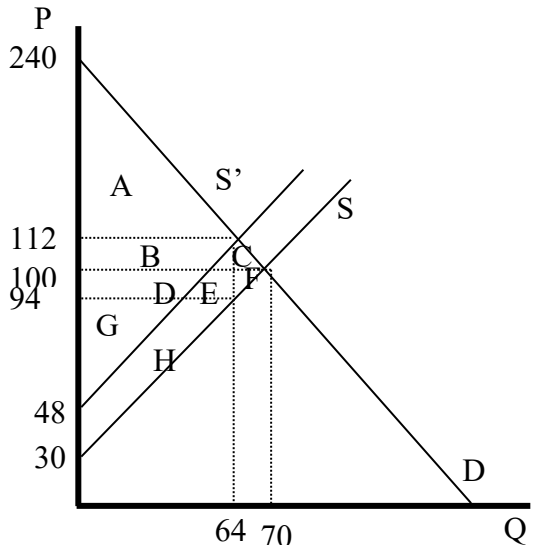
$$48 + Q = 240 - 2Q$$
$$192 = 3Q$$
$$Q = 192/3$$
$$\mathbf{Q = 64}$$

We plug this quantity into the *original* supply and demand curves to get the post-tax prices. With a quantity of 64, suppliers receive:

$P_S = 30 + 64 =$ **$94** (from the original supply curve)

Consumers must pay $18 more than this, or **$112**. Note that we can verify this using the demand curve, where we get $P_C = 240 - 2(64) = 240 - 128 = \$112$.

d)



Note that we use the original supply and demand, at the new prices and quantities, to find consumer and producer surplus.

Area A in the above graph represents consumer surplus. This is a triangle with a height of 128 (= 240-112) and a base of 64. Its area = 0.5(128)(64) = **$4,096**.

Areas G and H in the above graph represents producer surplus. This is a triangle with a height of 64 (= 94 - 30) and a base of 64. Its area = 0.5(64)(64) = **$2,048**.

e) Revenue is simply the tax times the quantity sold.

$$\$18 \times 64 = \$1152.$$

On the above graph, revenue is the rectangle represented by areas BDE.

f) Before the tax, the sum of consumer and producer surplus was $7,350. Afterwards, the sum of consumer surplus, producer surplus, and revenue is $7,296. The difference is $54. Graphically, this is the area of triangles C & F.

This difference is the deadweight loss. It is the value of lost opportunities, because some potentially beneficial transactions do not occur after the tax. For the quantities between 64 and 70, demand is above supply. This tells us that consumers are willing to pay more than the marginal cost of producing the good. However, because of the tax, these units are not sold. The potential producer or consumer lost because of this is the deadweight loss.

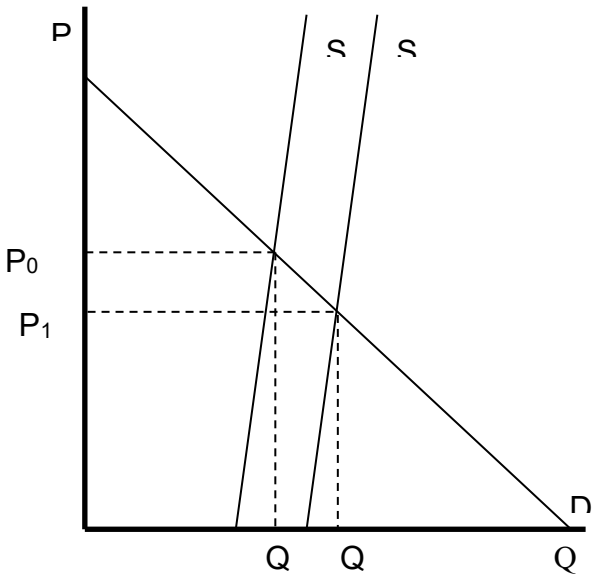
8. Concerned about the high cost of housing in their city, officials in Busytown solicited ideas to help residents afford new homes. Note that Busytown is a densely populated urban city. It is surrounded by a lake on one side, and mountains on the other, so there is little room to expand. The following suggestions were received:

- Councilman Humperdink notes that the lack of space is a problem. He proposes easing zoning restrictions, so that lots can be subdivided to allow more housing units on existing lots.
- Sergeant Murphy argues that Humperdink's plan will benefit developers, rather than homebuyers. He suggests providing a $10,000 housing subsidy to all Busytown residents, arguing that this extra cash will help them cope with the high cost of housing.

You have been asked by city leaders to evaluate these two proposals.

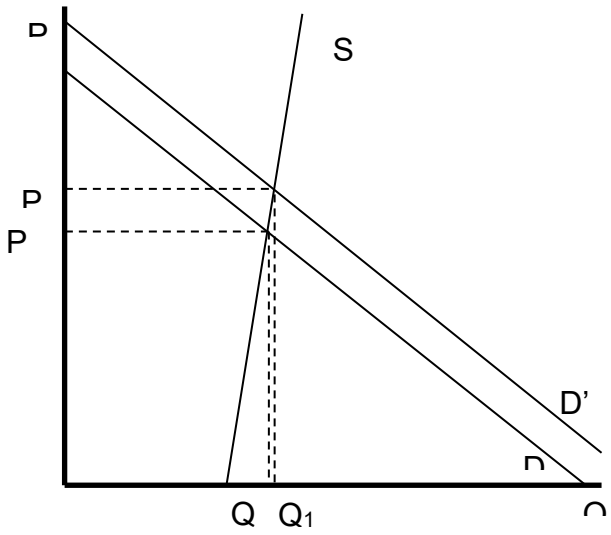
a) Using a supply and demand diagram, illustrate the effect of Councilman Humperdink's plan to ease zoning restrictions. Be sure to show both the initial equilibrium and what changes occur after the law is changed. Briefly explain why you have drawn the curves as you did.
b) Using a second supply and demand diagram, illustrate the effect of Sergeant Murphy's proposed subsidy. Again, be sure to show both the initial equilibrium and what changes occur after the law is changed. Briefly explain why you have drawn the curves as you did.
c) Based on your analysis, which policy would you recommend? Why?

a)



Because there is little room to expand, supply is inelastic. Thus, we use a nearly vertical supply curve. Easing zoning restrictions makes it possible to build more housing. This shifts supply to the right. The equilibrium price falls, and the equilibrium quantity rises.

b)



The subsidy to homeowners affects demand. By giving them more income, they can afford to spend more on homes. This leads to an increase in demand, shown by shifting demand up and to the right. Because of this, the quantity of homes does increase, but not by much, since supply is inelastic. Instead, the bigger impact of this plan is higher housing prices.

c) Because of the inelastic supply of housing, only the plan to ease zoning restrictions has the intended effect of lowering prices and increasing quantity. In contrast, because the subsidy increases demand, it increases both quantity and price. As such, I would recommend the plan to ease zoning restrictions