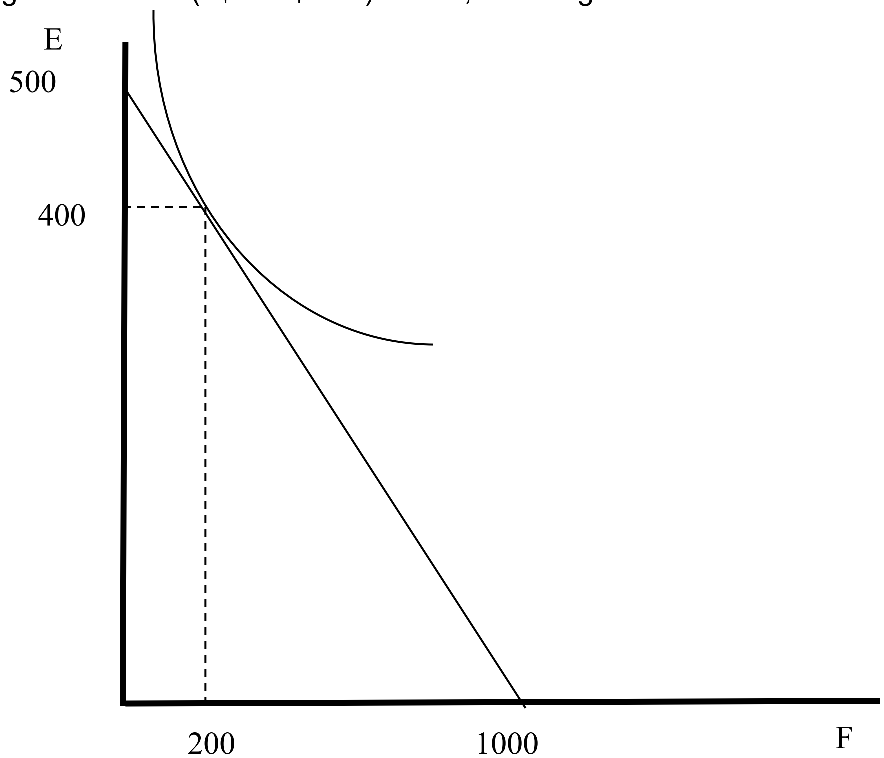
Solutions to Practice Problems for Quiz #2

1. Assume that there are only two goods: fuel (F) and everything else (E), where the price of the latter (E) is exactly $1.00.

a) Sketch the budget line for the typical low-income homeowner without either of the plans. Draw one indifferent curve that is tangent to the budget constraint at 200 gallons of oil.

The typical family has $500 to spend per month. If they spend all her income on everything else (E), they can get $500 worth of other goods. If they spend all is money on fuel (F), they get 1000 gallons of fuel (=$500/$0.50). Thus, the budget constraint is:



The indifference curve shows that the typical family currently maximizes utility by choosing 200 gallons of fuel. Thus, it is tangent to the budget constraint at 200 gallons. Since this costs $100 (=200 * $0.50), the family has $400 left to spend on other goods.

b) Briefly explain why this point of tangency maximizes the household's satisfaction.

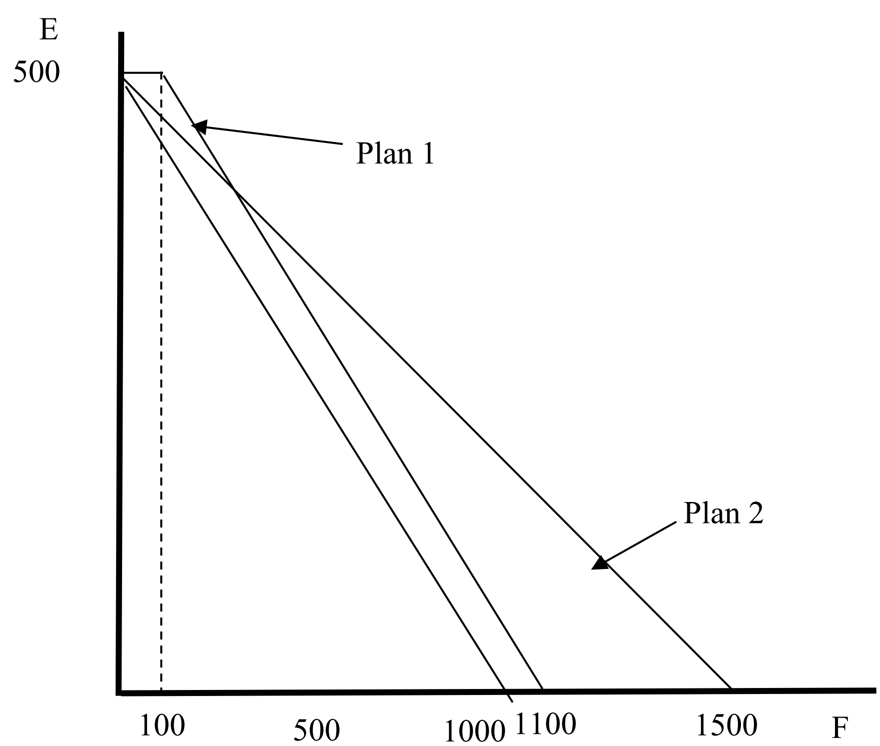
Graphically, we see that the point of tangency maximizes utility because this indifference curve is the highest indifference curve that contains a bundle that is affordable – that is, a bundle that is on the budget constraint. Intuitively, what is true at the point of tangency is that the marginal utility per dollar spent on fuel equals the marginal utility per dollar spent on everything else. Thus, there is no way that the family could swap some spending from one good to the other and increase utility.

c) On a separate diagram, reproduce the budget line from part a. and add the budget lines with Plan 1 and with Plan 2. Label each budget line.

To draw the budget lines for Plan 1 and Plan 2, we begin by figuring out what bundles we consume if we spent all our money on fuel or all our money on everything else. Let's begin with Plan 1. One problem that I've found students having is that they try to figure out what the person *would do* under each plan. The budget constraint does not tell us what people will do – it only tells us what they *can do*. Thus, all the points, including the ones where all our income is spent on one good, need to be considered.

In Plan 1, each family gets 100 gallons of free fuel oil. Thus, if they spend all their income on fuel, they get 1100 gallons of fuel, since they spend $500 on fuel, which buys 1000 gallons, plus they get the 100 free gallons. If they spend all of their money on everything else, they spend $500 on everything else, but still get 100 gallons of fuel. Thus, the budget constraint for Plan 1 looks like the budget constraint for the food stamp program that we drew in class.

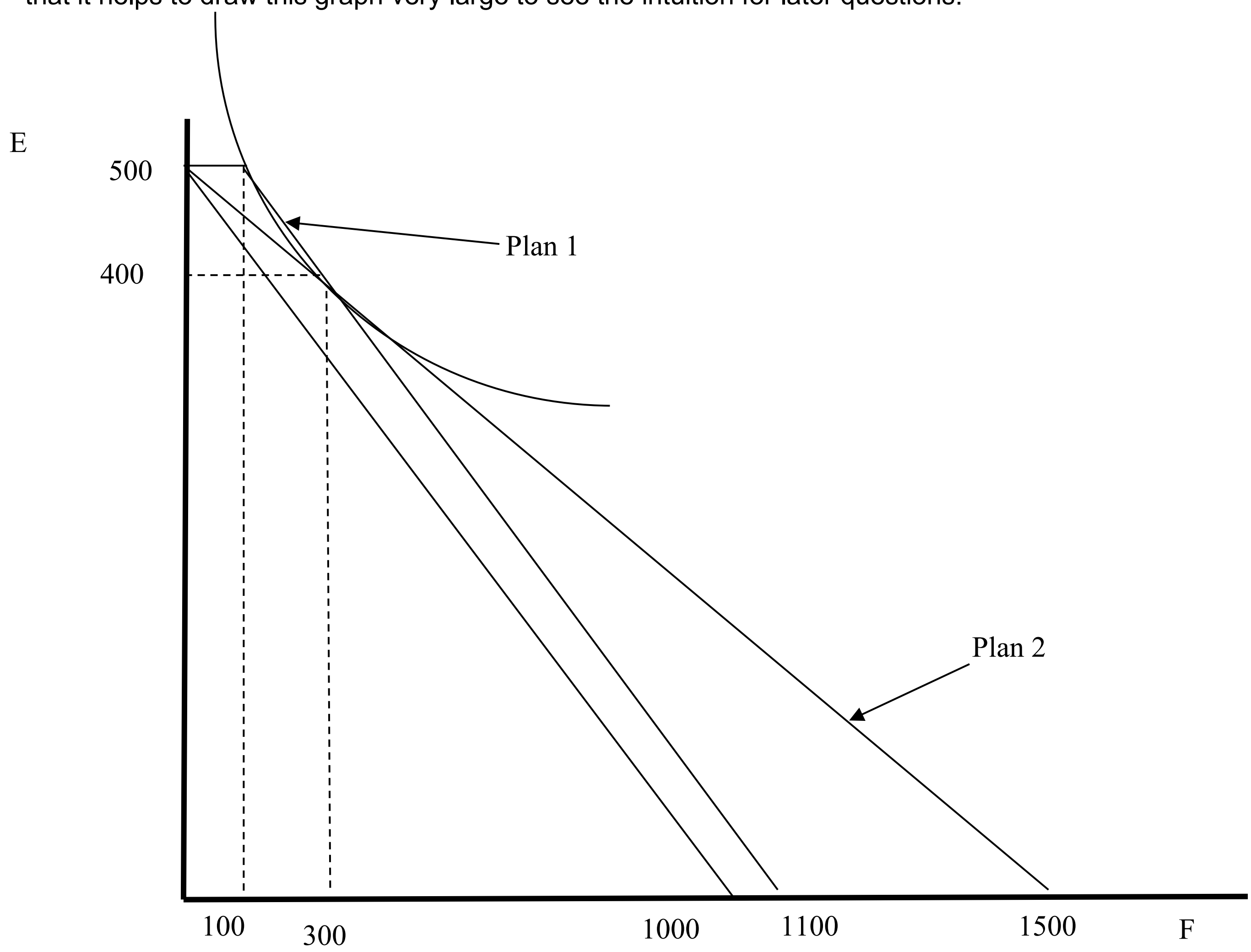
In Plan 2, the government subsidizes one-third of the cost of fuel. Thus, each family only pays two-thirds of the price, as the government pays the rest. The new price of fuel for each family is $0.33 1/3 (=0.5*2/3). Because Plan 2 is a change in price, we rotate the budget line. If a family spends all their money on everything else, they still get $500 worth. If they spend all their money on fuel, they now get 1500 gallons (= $500/0.333333)



2. After some careful analysis (not presented here), you discover that the typical low-income family would purchase exactly 300 gallons of oil under Plan 2. Given this finding, answer the following questions (on a separate page):

a) Redraw and label the three budget lines from question 3 part c. Show where the typical low-income family ends up under Plan 2.

I have reproduced the budget constraint below, as well as adding the indifference curve. Note that it helps to draw this graph very large to see the intuition for later questions.



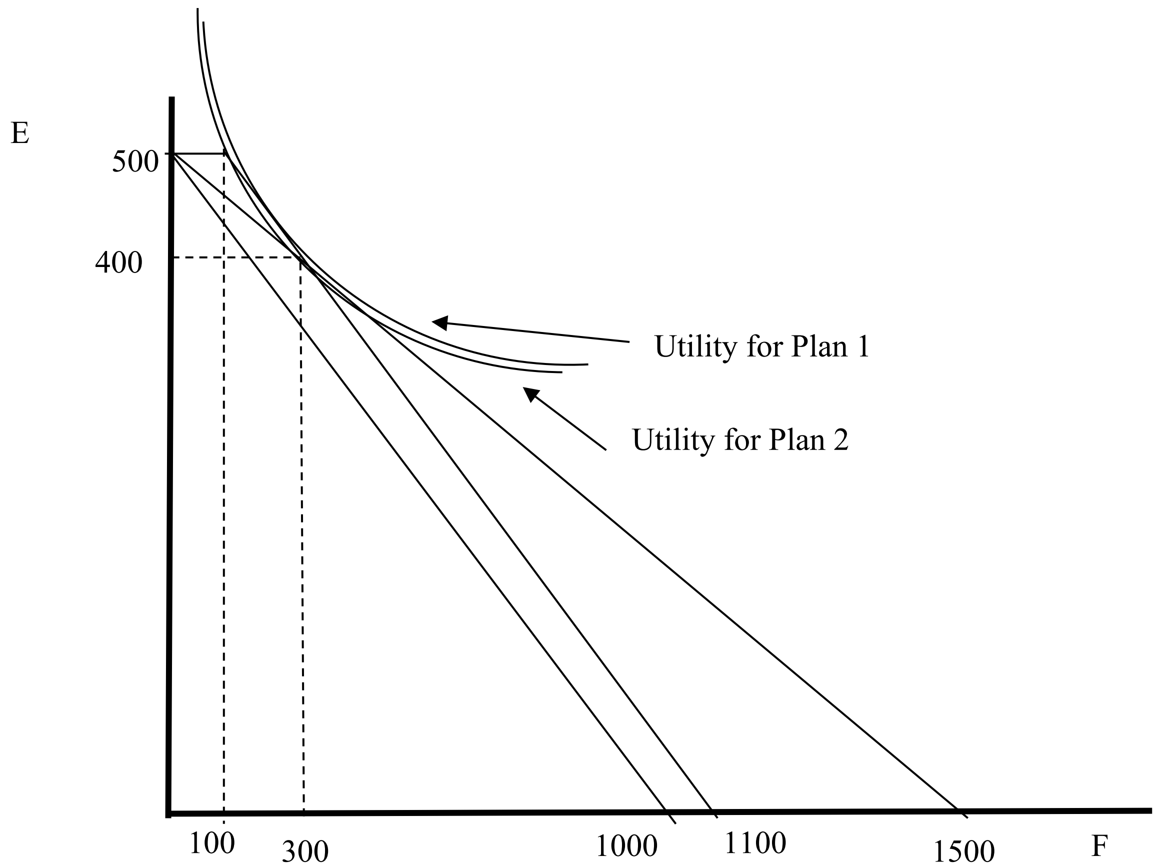
The indifference curve above is tangent to the budget line for Plan 2 at a quantity of 300 gallons of fuel oil. Since the price of fuel oil is now 0.33, 300 gallons cost the family $100. Thus, they can spend $400 on everything else.

b) Which plan costs the government more? (Hint: the budget lines for Plan 1 and Plan 2 intersect at 300 gallons of oil.)

Both plans cost the government the same amount. Under Plan 1, the government spends $50 per person, as they spend $0.50 on 100 gallons of fuel. Since the typical family chooses 300 gallons of fuel under Plan 2, the government also spends $50. The total cost of 300 gallons of fuel is $150. The government pays one third of that cost, or $50. Consumers pay the other two-thirds, or $100.

The result that the plans cost the same occurs because consumers choose exactly 300 gallons of fuel under Plan 2. The costs of Plan 1 always remain the same, since the government always buys 100 gallons of fuel. However, the cost of Plan 2 depends on how much fuel families buy under the Plan. If they chose to by less than 300 gallons of fuel under Plan 2, the cost of Plan 2 would be cheaper. If they chose to buy more than 300 gallons of fuel, the cost of Plan 2 would be higher. The key here is that the government always pays for one-third of the fuel. If one-third of the purchased fuel is greater than the 100 gallons given to each family in Plan 1, the costs would be greater.

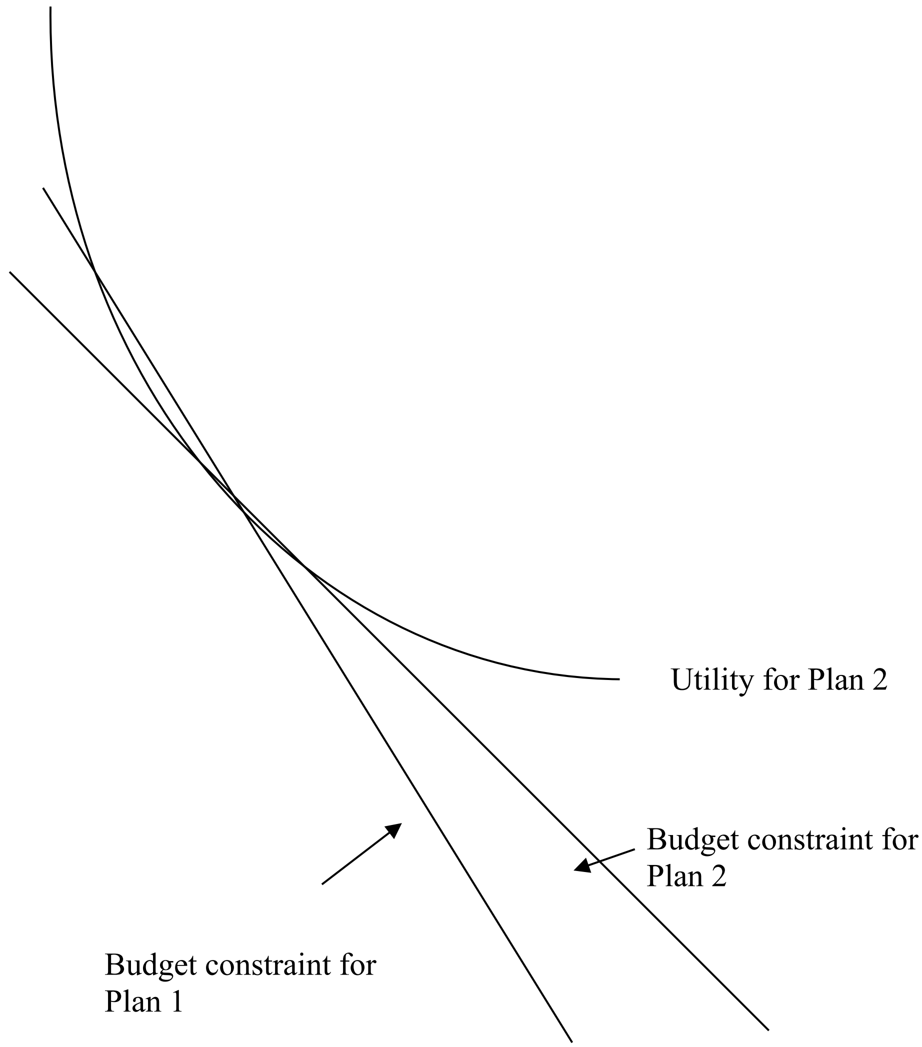
c) Draw an additional indifference curve showing (approximately) where families will choose to be under Plan 1. Explain intuitively why Plan 1 will lead to a higher level of satisfaction for recipient households than Plan 2.



The key point here is that the utility is higher under Plan 1. Plan 1 does not change prices – it just gives families some extra fuel, which in this case is similar to the income effects that we discussed in class. Since prices haven't changed, the families can then choose to buy what they want, with the knowledge that they already have 100 gallons of oil. Note that they do not buy 200 additional gallons of oil, but rather spend some more money on other goods. With Plan 2, prices have changed, so the consumers choices react. Because oil is relatively cheaper, they purchase 300 gallons, rather than 200 gallons at a price of $0.50.

An intuitive way to think of this is as follows: Plan 1 does not change the families' relative preferences between fuel and other goods, because *relative prices have not changed*. Plan 2 does change the families' relative preferences. Thus, Plan 1 affects both their decisions to buy fuel *and* their decisions to buy everything else. Plan 1 just gives them a "boost" of 100 gallons of oil and then lets them do what they want with their income.

We can see this graphically by enlarging the area where the indifference curves are:



The budget constraints for Plan 2 and Plan 1 intersect at 300 gallons of fuel oil, which is also where the indifference curve is tangent to the Plan 2 budget constraint. Since the slope of the Plan 1 budget constraint is steeper, the indifference curve cannot also be tangent to the Plan 1 line there. Instead, *the budget constraint for Plan 1 goes through the indifference curve*. As a result, it is possible to draw a higher indifference curve that is tangent to the Plan 1 budget constraint.

d) Explain why Plan 2 leads to a greater consumption of oil by recipient households than Plan 1.

Plan 2 leads to greater consumption of oil because it lowers the price of oil. Thus, it induces families to *substitute* oil for other goods. The key here is that, since Plan 2 changes prices, it has both an income effect and a substitution effect. Plan 1 does not have a substitution effect, as the prices do not change.

3. The country of Pangaea currently subsidizes gasoline. Concerned over both the environmental impact and the cost of these subsidies, the government is considering eliminating the subsidy. You have been asked to analyze the effect of eliminating the subsidy on both consumers and the government's budget. To begin, consider the following facts for a typical family in Pangaea.

- With the subsidy, gasoline costs $1.50 per gallon. The typical family purchases 100 gallons of gasoline at this price.
- The cost of gasoline without any subsidy would be $2.50 per gallon.
- The typical family has $750 of disposable income to spend on gasoline or other consumption goods.

a) Using an indifference curve and budget constraint, sketch the initial condition with the subsidy. Place other consumption on the *y*-axis and gallons of gasoline on the *x*-axis. Be sure to show the endpoints of the budget constraint, as well as the levels of gasoline and other consumption chosen by this family.

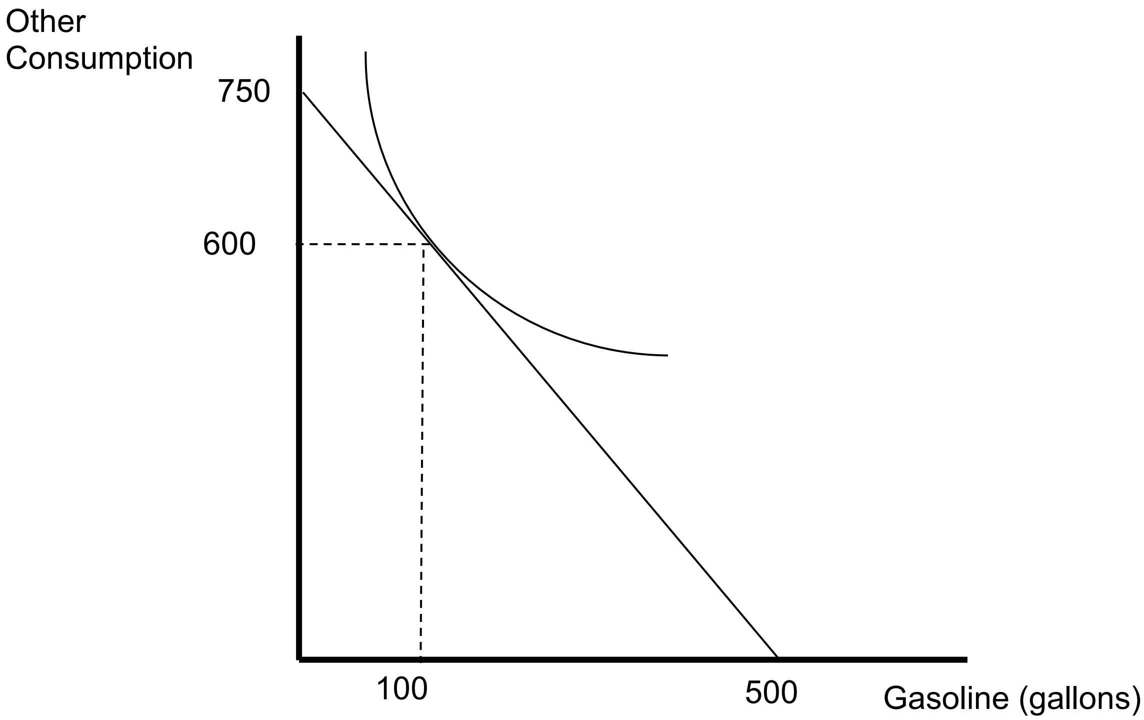
b) Reproduce your diagram from part (a). Now, consider what happens when the subsidy is removed and gasoline prices increase to $2.50 per gallon, Add the new budget constraint to the diagram, along with a new indifference curve showing approximately how much gasoline the family will consume when prices are higher.

c) Reproduce your answer to (b). To compensate families for higher prices, the government uses the money saved from eliminating the gasoline subsidy to lower income taxes. Suppose that the amount of extra income each family gets is just enough to return their utility to what it was when gasoline was subsidized. Add a budget constraint representing this policy to your diagram.

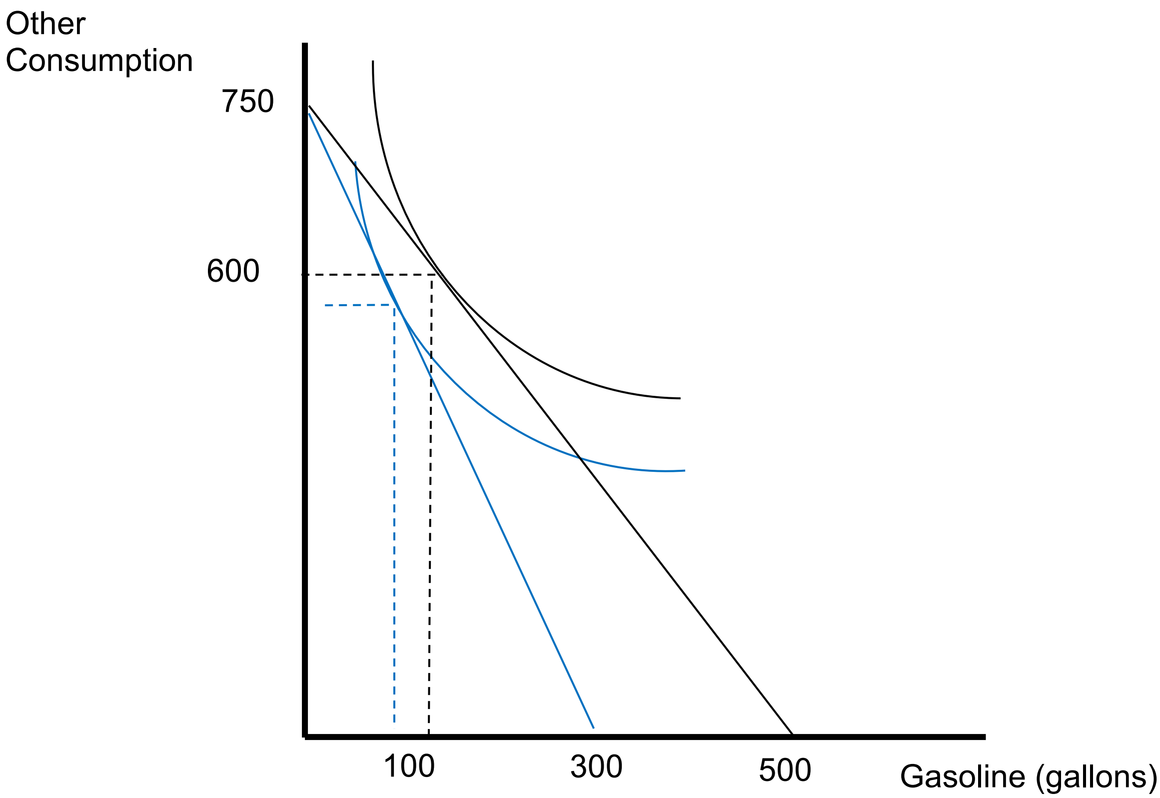
   After taxes are reduced, will families choose to purchase 100 gallons of gasoline, as they did under the subsidy? Explain briefly.

d) Finally, consider the effects of lowering taxes on government revenue. Compared to what they spent subsidizing gasoline, will the income tax cut cost the government more, less, or exactly the same amount? How do you know this?

a) To draw the budget constraint, note that consumers can buy up to 500 gallons of gasoline (= \$750/\$1.5) or \$750 worth of other goods. Note that these endpoints are what we need for the budget constraint – we want to show *what is possible*, not just what the consumers actually do. A typical family actually chooses 100 gallons of gas. Since each gallon costs \$1.5, this leaves them \$600 to spend on other consumption. This is shown by drawing an indifference curve tangent to the budget constraint at 100 gallons of gasoline. This is the highest possible indifference curve given the budget constraint.



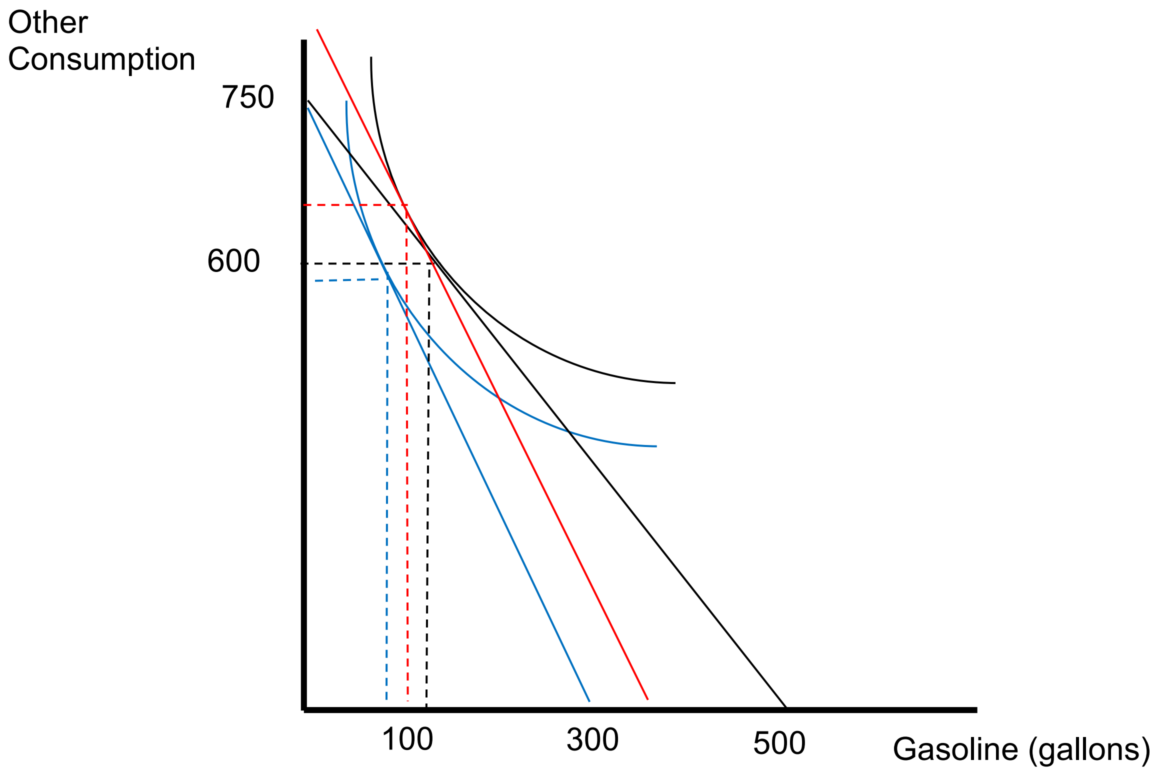
b) The price increase rotates the budget constraint in, as shown in blue below. If this family spent all their income on gasoline, they could only afford 300 gallons.



While we don't know exactly how much gasoline this family will now consume, we do know that the indifference curve must shift down to be tangent with the new blue budget constraint. Thus, we expect both consumption of gasoline and other goods to fall. This new indifference curve, tangent to the new budget constraint, is lower than the original indifference curve. Utility has fallen.

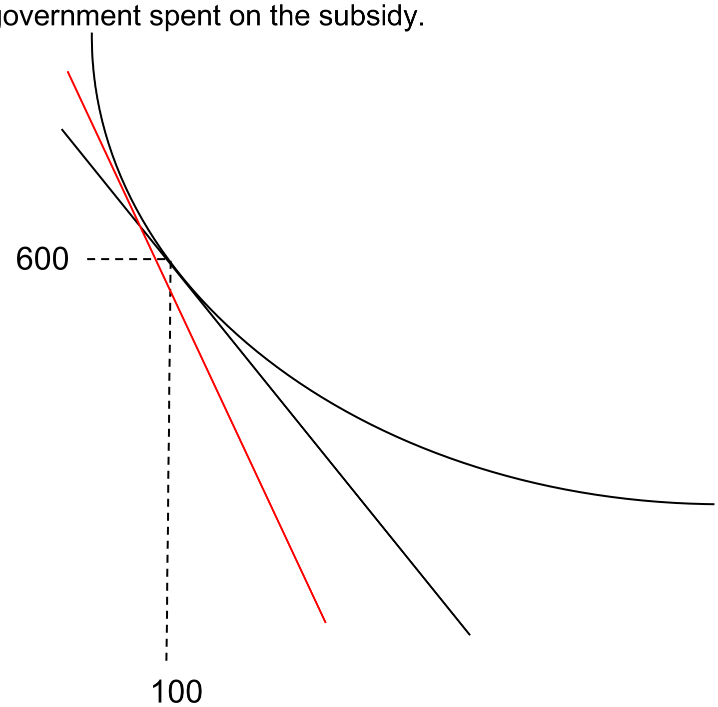
c) This budget constraint is shown in red above. The budget constraint is parallel to the blue constraint, since the price of gasoline remains $2.50, but shifts out until it is tangent to the original black indifference curve. Thus, consumers now have the same utility as before.

While we are not told exactly how much gasoline consumers choose at this point, note that it is less than 100 gallons. That is because of the *substitution effect*. Even though consumers have enough income to restore their original utility, they choose to buy less gasoline because it is more expensive. By giving the consumers enough income to restore their initial utility, we have removed the *income effect* of the price change, leaving only the substation effect remaining.



d) Note that the new budget constraint does not give this family enough income to purchase what they did before. While the family will spend some of the extra income on gasoline, they will spend more of it on other consumption than they would have had the cost of fuel been $1.50 per gallon. As a result, the government does not need to give this family enough income to get all the way back to their original consumption point. Thus, the amount of money given back in lower taxes must be *less* than the original cost of the subsidy.

The above intuition is all that was necessary to answer this question correctly. To see the response graphically, note that the red budget line is steeper than the original black budget line. Thus, it is tangent to the black indifference curve at a higher point on the indifference curve, as shown below. While the family will spend some of the extra income on gasoline, they will spend more of it on other consumption than they would have had the cost of fuel been $1.50 per gallon. Because it is below the original consumption point, this represents less income than the government spent on the subsidy.



A common mistake here is simply saying that the income tax cut cost more because not everyone consumes gas. The question asks you to analyze this policy for a typical family – the typical family does consume gasoline. I'm looking for you to compare the magnitude of two *comparable* policies. Adding extra information like that complicates the analysis unnecessarily. If families who don't buy gasoline receive a tax cut, they are clearly better off, which is not the goal of the policy in question (c). Realistically, if we want to consider multiple types of families, we can also adjust the tax cut amount so that the government doesn't end up spending more after removing the subsidy.

4. The Philadelphia Police Department has 500 police officers to allocate between West Philadelphia and Center City. The average product, total product, and marginal product in each of these two areas is given below, where output is measured as the number of arrests made. Currently, the police department allocates 200 police officers to Center City and 300 to West Philadelphia. If police can be redeployed only in groups of 100, how, if at all, should the police department reallocate its officers to achieve the maximum number of arrests?

West Philadelphia				*Center City*			
# Police	AP	TP	MP	# Police	AP	TP	MP
0	0	0	--	0	0	0	--
100	40	40	40	100	45	45	45
200	40	80	40	200	40	80	35
300	40	120	40	300	35	105	25
400	40	160	40	400	30	120	15
500	40	200	40	500	25	125	5

For this question, you need to compare the *marginal product* of police officers in each of the two districts. Although the average products are equal in each neighborhood, their marginal products are not. Currently, there are 200 officers in Center City, and their marginal product equals 35 arrests. There are 300 officers in West Philadelphia, and their marginal product equals 40 arrests. If we took 100 officers out of Center City, arrests in that neighborhood would fall by 35. If we redeploy those same officers in West Philadelphia, there will be 40 more arrests in West Philadelphia. The net increase in arrests is 5. Once this is done, no further improvements are possible, since the marginal product in West Philadelphia is still 40, but the marginal product in Center City is now 45.

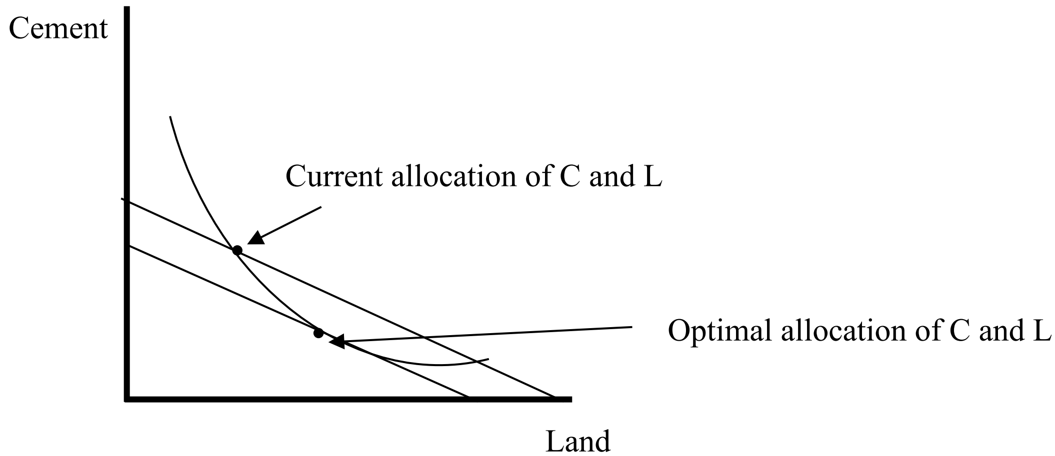
While it isn't necessary to answer the question (and, indeed, you should answer the question by looking at marginal product, rather than calculating the results for each possible combination), note that the total number of arrests from having 300 police in West Philadelphia and 200 police in Center City is 200 (=120+80). The total number of arrests from having 400 in West Philadelphia and 100 in Center City is 205 (=160+45). Thus, arrests go up by 5, as predicted above

5. Coldwell Banker is employing 10 acres of land and 50 tons of cement to produce 1,000 parking spaces. Land costs \$100 per acre and cement costs \$12 per ton. For the input quantities employed, $MP_L = 50$ and $MP_C = 4$.

a) Is Coldwell Banker producing parking spaces as cheaply as possible? If so, how do you know this? If not, say what Coldwell Banker could do to improve the situation.

To minimize costs, Coldwell Banker should operate where $MP_L/P_L = MP_C/P_C$. Intuitively, this says that the marginal product per dollar spent on each input is equal. Here, the $MP_L/P_L = 50/100 = 0.5$, and $MP_C/P_C = 4/12 = 0.33$. Thus, the marginal product per dollar spent on land is greater than the marginal product per dollar spent on cement. Coldwell Banker gets more output from a dollar spent on land than a dollar spent on cement. They should use more land and less cement.

b) Illustrate the above scenario using a diagram with an isoquant for 1,000 parking spaces and the appropriate isocost curve.



Since Coldwell Banker wants to produce 1000 parking spaces, all the points we consider should be on the same isoquant. The optimal combination is where the isocost line and the isoquant are tangent. Currently, they are using too much cement and not enough land. Thus, they are currently at a point to the left of the optimal point. Note that the isocost line here is not tangent, and it is higher than the optimal isocost line, since costs are not at the lowest possible level.

6. Explain why a firm's costs in the long-run will always be less than or equal to its costs in the short-run.

Firms have more flexibility in the long-run, as they are free from all their fixed commitments. This doesn't mean that the fixed costs disappear. It does mean, however, that they can adjust the level of the previously fixed inputs to a more desirable level. For example, if they previously were using too much labor, more capital could be added in the long-run, which would make labor more productive.

7. A rural electricity district owns two power plants – a hydroelectric plant that can generate power at 2¢/kWh, and a natural gas plant that can generate power at a cost of 4¢/kWh. Currently, the district generates two-thirds of its power using the hydro plant, and the remaining one-third using the natural gas plant. As a result, the natural gas plant is only operated at one-half of its capacity, while the hydroelectric plant is used at its full capacity. The mayor of Smallville, whose town is served by these power plants, argues that the natural gas plant should be used more, rather than the hydro plant. Because of the gas plant's large size, operating the plant at full capacity would allow the fixed costs of building the natural gas plant to be spread over a larger amount of generated electricity, thus lowering prices for consumers in the district. How would you respond to the mayor's argument?

The mayor's mistake is confusing fixed costs and marginal costs. The costs of building the power plants are sunk. Thus, they are not relevant to the decision making process. While increasing use of the natural gas plant would lower average costs, what matters is the marginal cost of generating power from each. Here, we see that the hydropower plant can generate power at 2¢/kWh, while it costs 4¢/kWh to generate power using the natural gas plant. Given that the marginal costs of hydropower are cheaper, it makes sense to use the hydropower plant first, and then use the more expensive natural gas plant to meet the remaining demand.

Note also that, even if you interpret the costs above as average costs, using the natural gas plant is not correct. In that case, while it may be true that using the gas plant more would lower the average cost of the natural gas plant, the hydro plant would be used less. Thus, the average cost of the hydro plant would go up.

8. Smarter Kids is an international NGO that provides schooling in underserved areas of low-income countries. Depending on the location, they can either send teachers to teach in classrooms in local buildings or deliver services on-line. Smarter Kids measures the effectiveness of their services based on observed increases in the test scores of local children on standardized tests. You are given the following information on the costs and effectiveness of each type of service provision:

On-line instruction: On-line instruction is less expensive, costing just $500 per student per year. However, on-line instruction is not as effective as services provided in person. Research shows that a year of on-line instruction raises test scores by just 5 points.

In-person instruction: Providing teachers to teach in local classrooms is more effective, as teachers are able to pay more attention to individual children. However, both the cost and effectiveness of doing so varies by location, depending on both the number of student in a classroom and the quality of the facilities available. On the next page are data on in-person services for four local communities:

Community	**Cost per student per year**	**Test score increase**
Apple Hill	$2,000	10 points
Baskerville	$5,000	60 points
Canterbury	$3,000	45 points
Denali	$6,000	50 points

Smarter Kids has sufficient funding to provide services in each of these four cities. However, they need to decide whether it is more effective to provide services in-person or on-line. Based on the data given above, in which communities should Smarter Kids provide services in-person, rather than on-line? Why?

Our choice for each community should depend on which type of service provision reduces test scores the most per dollar spent. For this, we need to consider both the costs and the potential test score increase. We compare MP/P for this evaluation.

The marginal product of a year of on-line instruction is 5 points. Each year of instruction costs $500. Thus, $MP_{on\text{-}line}/P_{on\text{-}line}$ = 5/00 = 0.01. We can then do the same calculation for in-person services in each community. If the marginal product per dollar for in-person services is greater than 0.01, we should use in-person services in that community. Here are the calculations:

Apple Hill: 10/2000 = 0.005
Baskerville: 60/5000 = 0.012
Canterbury: 45/3000 = 0.015
Denali: 50/6000 = 0.0083

Based on these figures, we should use in-person services in Baskerville and Canterbury, and on-line services in the remaining communities.

9. To maximize profits, the firm produces at an output level at which total revenue exceeds total costs by the greatest possible amount. At the same time, profits are maximized at the output level at which marginal cost equals marginal revenue. Can you reconcile these two statements?

Profits are maximized when total revenue exceeds total costs by the greatest amount. This occurs when marginal cost equals marginal revenue. The intuition is that the *marginal* costs and revenue tell us the cost and revenue from the *next* unit. If the marginal revenue is greater than the marginal cost, increasing output by one will bring in more money than it will cost to produce the unit. Thus, total profits will increase, and the additional output is worth producing. Similarly, if marginal revenue is less than marginal cost, the next unit will cost more to make than it will bring in. Thus, it is not worth producing. These changes can be made to total profits at any output level *except when marginal revenue and marginal cost are equal*. At that point, the additional revenue brought in by the next unit just covers the cost of producing the next unit, so that total profits remain the same.

10. Consider the following cost data for a perfectly competitive firm:

Q	AVC	MC
6	8.5	8
7	8.571	9
8	8.75	10
9	9	11
10	9.3	12

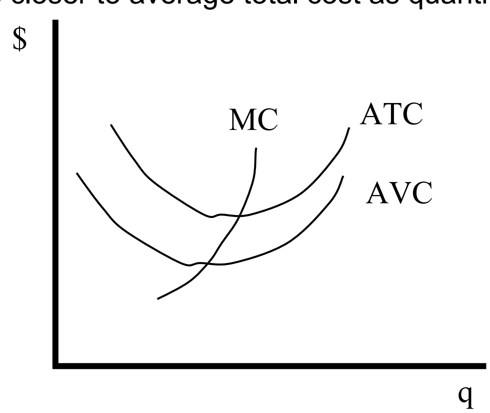
This company also has fixed costs of $10.

a) Graph this company's average variable cost, average total cost, and marginal cost.

The trick to this question is recognizing what to do with the fixed costs. You will need this information to observe profits, the shutdown point, and long-run equilibrium. You have total fixed costs, but only average variable costs. You can either multiply AVC by Q at each level to get total variable costs, and then add fixed costs to it to get total costs, or divide fixed costs by Q to get average fixed costs, and then sum AFC and AVC to get ATC. Since the AVC is used to find the shutdown point, and ATC is used to find the long run equilibrium, I will proceed this way.

Q	AVC	AFC = FC/Q	ATC=AVC + AFC	MC
6	8.5	1.667	10.167	8
7	8.571	1.429	10	9
8	8.75	1.25	10	10
9	9	1.111	10.111	11
10	9.3	1	10.3	12

We can now proceed to graph the average and marginal cost curves. The marginal cost curve should go through the bottom of both the average variable cost and average total cost curves. Because average fixed cost declines as quantity increases, average variable costs gets closer to average total cost as quantity increases.



b) For the following market prices, find the equilibrium quantity and profits. Be sure to explain how you arrived at your answers:
   i) \$12, ii) \$10, iii) \$9, iv) \$8.

Because this is a perfectly competitive market, the firm is a price taker. Thus, the firm produces as long as the price is greater than or equal to the marginal cost. If the price falls in between two marginal costs, choose the lower quantity, since the higher one will cost more money than it will make. In each case, profits are total revenue - total cost, which can be found as Q(AR - ATC), where AR = P.

i) With a price of \$12, output is 10. Profits are (10)(12 - 10.3) = \$17.
ii) With a price of \$10, output is 8. Profits are (8)(10-10) = \$0.
iii) With a price of \$9, output is 7. Profits are (7)(9 - 10) = -\$7. Note that there are losses here. However, since the losses are less than fixed costs, the business should remain open. Notice that the price is greater than the average variable cost at this point. Intuitively, the firm stays in business because they are covering fixed costs.
iv) At a price of \$8, the firm shuts down, because this price is lower than the average variable cost for all the quantities. If it did operate, it would be at a quantity of 6. However, at this point, profits would be (6)(8 - 10.167) = -\$13. The firm loses less money by shutting down and just paying the fixed costs.

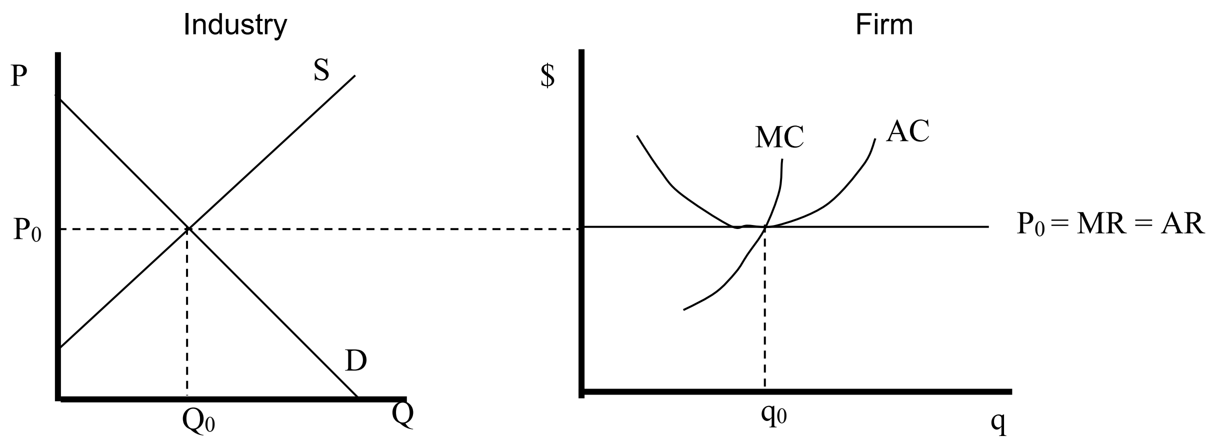
c) What will be the long-run equilibrium price for this product? Why?

In the long run equilibrium, all firms are making zero profits, and are thus at the minimum of their average total cost curves. In this case, this occurs at a quantity of 8 and a price of \$10. [Note that although the average total cost is also at 10 at a quantity of 7, this occurs because of rounding. If the firm operates at this point, it loses money. The zero profit point, as found in part a, is at 8 units of output.

11. Suppose that the market for artificial Christmas trees is initially in a long run equilibrium.

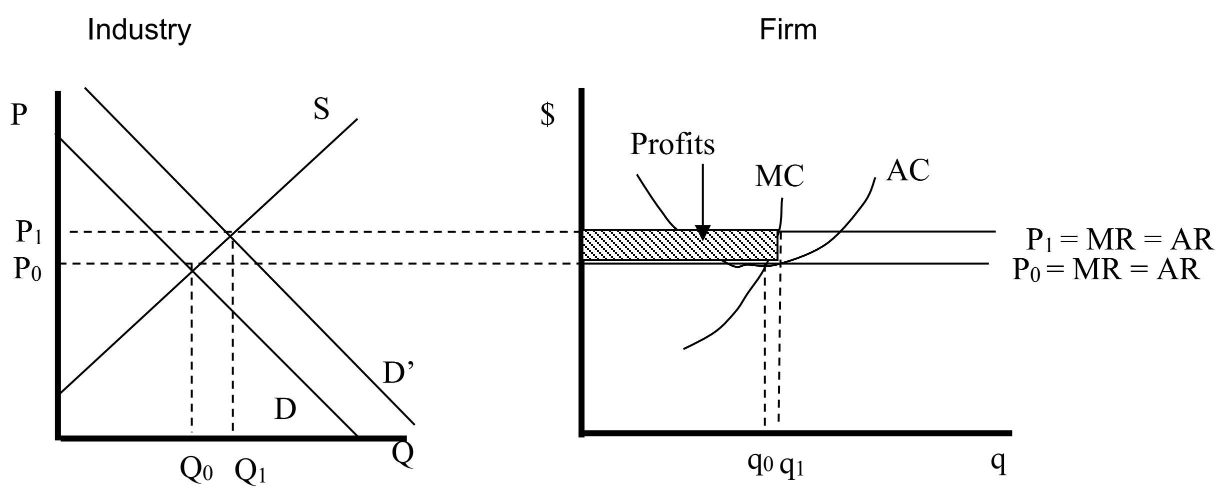
a) Draw a supply and demand curve showing the equilibrium price and quantity for artificial Christmas trees. On a second graph, depict a typical tree firm's average and marginal cost curves and depict their profits. Explain why you have drawn this as you did.

In long-run equilibrium, firms are making zero economic profits. The price must be equal to the marginal cost at the point where MC intersects the AC curve.



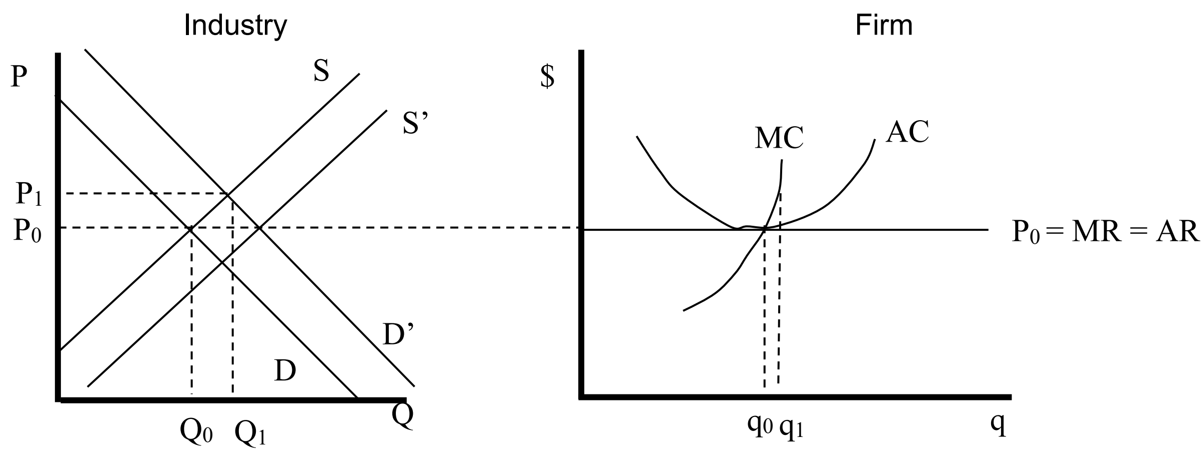
b) Because of bad weather conditions this year, many pine trees were killed. As a result, fewer natural Christmas trees are available. How will this affect the equilibrium price and quantity for artificial Christmas trees this year? How will this affect profits in the artificial Christmas tree industry? Redraw the diagram of the firm from part a and illustrate the changes you have just described.

Natural Christmas trees are a substitute for artificial trees. Thus, a shortage of natural trees increases demand for artificial trees. This causes the equilibrium price and quantity of artificial trees to increase. Firms will now earn a profit.



c) Assuming that the Christmas tree shortage is permanent, what will happen to the artificial tree industry over the next several years? What will the long-run price and quantity of artificial trees be? Redraw your diagrams from parts a and b and depict the changes that occur in the long run.

Because firms are making money, more firms will enter the market. As a result, the supply curve shifts out, lowering the equilibrium price. Firms enter until the price is once again equal to marginal cost at the minimum of AC. That is, long-run equilibrium is restored when firms are again making zero profits.



12. The owner of a small retail store does her own accounting work. How would you measure the opportunity cost of her work?

The opportunity cost of her work is the value of her time spent doing accounting. For example, if her time is valued at $20/hour, and she spends 5 hours a week on accounting tasks, the opportunity cost is $100 per week. Note that the opportunity cost *is not the cost of hiring an accountant*. Rather, to decide whether or not an accountant should be hired, the store owner should compare this opportunity cost to the rates charged by an accountant.

13. In the village of Pleasantville, residents either work as salaried employees at local offices or are proprietors of stores on Main Street. Salaried employees earn $30,000 per year. All of the stores are rented to the proprietors by one of several real estate companies who own the buildings. Business is brisk at these stores, so currently the typical store brings in $70,000 of revenue per year. The typical variable costs needed to run a store in Pleasantville (paying workers, buying material) are $20,000 year.

a) What is the opportunity cost of running a store? Explain how you know this.

The opportunity cost of running a store is the value of the next best opportunity. Here, the next best opportunity is working at a salaried job for $30,000 per year. Thus, the opportunity cost is $30,000.

b) Given this opportunity cost, what rent will the real estate companies charge? Why?

The stores currently bring in $70,000 of revenue per year. The variable costs are $20,000 per year. In addition, the opportunity cost is $30,000. Thus, storeowners make $20,000 per year before paying rent. Thus, the rent must equal $20,000 per year.

To see why, remember that positive profits cannot persist in a competitive market. If the rent were less than $20,000 per year, more people would want to run stores, since they could do better running a store than working at a salaried job. (Since we've included the opportunity cost of losing a $30,000 salary as part of the cost of running a store, this is true whenever there are any positive profits for running a store.) More demand for renting stores would drive the rent up until a rent of $20,000 was reached. Similarly, if the rent were higher than $20,000 per year, store managers would be losing money, and would leave the business once their leases expired. Demand for stores would fall, causing rents to fall.

c) Suppose that a new highway brings more visitors to town, so that a new store now brings in $100,000 of revenue per year. What will happen to rents after the increase in revenues? Who will benefit – shop owners or the real estate companies?

With a rent of $20,000, stores will now make $30,000 profit (= $100,000 - $20,000 variable costs - $30,000 opportunity cost - $20,000 rent). This will increase demand for stores, driving up the rents. The rent will increase until a zero profit condition is reached again. This occurs at a rent of $50,000. Thus, the entire benefit of the increased traffic goes to the real estate companies that own the stores, rather than to the people that rent the space and run the stores.

14. Through the miracles of 19th century medicine, Earnest's Extraordinary Elixir has discovered the cure for the common cold. As Earnest is the only one that knows the formula, Earnest has a monopoly on the cold medicine market. The demand for cold medicine is P=100 – 5Q. The marginal costs of production are equal to $10. There are no fixed costs.

a) What is Earnest's profit-maximizing output and price?

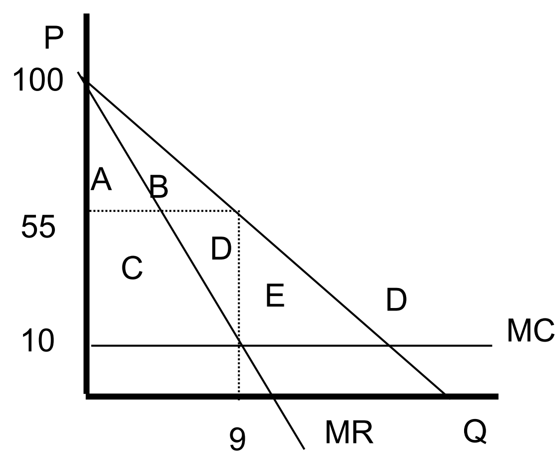
Profits are maximized where MR=MC. Since Earnest is a monopolist, his marginal revenue curve bisects the demand curve. Thus, MR = 100 – 10Q.

$$MR = 100 - 10Q = 10 = MC$$
$$10Q = 90$$
$$\mathbf{Q = 9}$$

To get the price, we need to look at the demand curve, to see how much consumers are willing to pay for 9 bottles of medicine. We get:

$$P = 100 - 5(9)$$
$$\mathbf{P = \$55}$$

b) What is the producer surplus that corresponds with your answer to part (a)? What is the consumer surplus?



Producer surplus is the area below price and above marginal cost. It is areas C and D on the graph. The area of this is equal to 45x9 = **$405.**

Consumer surplus is the area above the price and below demand. It is equal to areas A and B. This area is a triangle with base of 9, and a height of 45 (=100-55). Thus, consumer surplus = 0.5(9)(45) = **$202.50**.

c) Suppose that, over time, others learn the secret to Earnest's Elixir, and the market becomes perfectly competitive. What will the new price and quantity be? Explain how this problem differs from the monopoly problem in part (a).

If competition is allowed, Earnest becomes a price taker, so that MR= P. In equilibrium, price is equated with MC, which is 10. Thus, the new equilibrium price is **$10**.

To get Q, we plug into the demand equation to get:

$$10 = 100 - 5Q$$
$$5Q = 90$$
$$\mathbf{Q=18}.$$

d) Find the new consumer surplus and producer surplus in perfect competition. How does the sum of consumer surplus and producer surplus in the monopoly case [part (b)] compare to consumer surplus with perfect competition? Explain any differences between the two.

Referring back to the graph in part b, the consumer surplus is now areas ABCDE. This is a triangle of base 18, and height 90. Its area is 0.5(18)(90) = 810. Thus, consumer surplus = **$810**.

There is no producer surplus in this case.

The sum of consumer surplus and profits is $202.50 greater than the sum from part b. The difference was the deadweight loss from the monopoly (area E). These are beneficial transactions that could have taken place but do not because a monopoly restricts quantity.

15. The city of Danville has just built a new public transportation system, designed as a roller coaster that travels throughout the Tri-State area. They need to decide how much to charge riders of the roller coaster transport system. Because of your background in economics, you have been asked by the city to help set the price.

The fixed costs of operating the system are $64,000. In addition, the marginal costs of operation are $8 per rider. Having researched the demand for the roller coaster transport system in Danville, the city has come up with the following table with price, quantity, marginal revenue, and various costs filled in:[1]

P	Q	MR	AC	MC
48	0	48		
44	1000	40	72.00	8
40	2000	32	40.00	8
36	3000	24	29.33	8
32	4000	16	24.00	8
28	5000	8	20.80	8
24	6000	0	18.67	8
20	7000	-8	17.14	8
16	8000	-16	16.00	8
12	9000	-24	15.11	8
8	10000	-32	14.40	8
4	11000	-40	13.82	8
0	12000	-48	13.33	8

[1] For those that are interested, the table was derived using a demand curve of $P = 48 - 4Q$ where Q represents 1,000 riders per day. Note that you do not need to know this to solve the problem.

a) Phineas, a member of the city council, has taken some economics, and wants to ensure that there is no inefficiency, and thus no deadweight loss, from the pricing scheme. What price will achieve this goal? How many riders will use the roller coaster? How much revenue will these riders generate? What will be the total costs of serving this many riders? Will Danville make money, lose money, or break even on the roller coaster transport system at this price?

To have no deadweight loss, the price should equal marginal cost. This is where the demand curve intersects marginal cost. At this point, all transactions worth at least as much as the cost of providing another ride take place. Since the marginal cost is $8, this requires setting the price at $8. From the table, we see that at this price, there will be **10,000** riders.[2]

These riders will generate **$80,000** of revenue (= $8 x 10,000).

The total cost of serving these riders is **$144,000**. You could find this in one of two ways: (1) You could multiply the marginal cost per unit of $8 by the quantity, and then add the $64,000 fixed cost (= $8 x 10,000 + $64,000). (2) You could simply multiply average costs by quantity (=$14.40 x 10,000).

Since the total costs are greater than the total revenues, the community loses money. Danville loses **$64,000** on the roller coaster transport system if it uses marginal cost pricing.

b) Dr. Doofenshmirtz, a second council member, prefers that Danville take advantage of its market power whenever it can. He asks you to determine the price at which the city, which has a monopoly as the only provider of roller coaster transportation, would maximize its profit from roller coaster riders. What price would that be? How many riders use the roller coaster at that price? Please calculate the total revenue and total costs, as well as the profit for these sales.

To maximize profits, we must find the point where marginal revenue equals marginal costs. Since the marginal cost is $8, we find the quantity where marginal revenue equals $8, which occurs when there are **5,000** riders. The price for this quantity is **$28**.[3]

These riders will generate **$140,000** of revenue (= $28 x 5,000).

The total cost of providing these rides is **$104,000**. You could find this in one of two ways. First, you could multiply the marginal cost per unit of $8 by the quantity, and then add the $64,000 fixed cost (= $8 x 5,000 + $64,000). Second, you could simply multiply average costs by quantity (=$20.80 x 5,000).

Finally, we find the profit by subtracting total costs from total revenue. The city makes **$36,000** of profit at this price.

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[2] Note that you could also get this answer by setting the demand curve equal to marginal cost: $48 – 4Q = 8$ implies that $Q = 10$. However, since I gave you the information in the tables, such calculations were not necessary.

[3] Again, you could use the bisection rule and then find this algebraically. Given the demand curve of $48 – 4Q$, we know that $MR = 48 – 8Q$. Setting this equal to 8 gives us $48 – 8Q = 8$, which simplifies to $8Q = 40$, or $Q = 5$. We get the price by plugging this quantity into the original demand curve.

c) A third member of the council, Perry, is concerned about consumers, and does not want the city to maximize its profits. However, it is important to Perry that the city covers its costs, so that Danville does not lose money on its roller coaster venture. Based on the numbers above, what price should the city set to meet Perry's goal? How do you know this?

At this price, how many riders will use the roller coaster? How much revenue will these riders generate? What will be the total costs of serving these riders? What profit, if any, does Danville make from these riders?

Since Perry wants Danville to cover its costs, the profits should equal zero. The trick here is to remember what holds when the profits are equal to zero. When profits equal zero, total costs and total revenue are equal. Thus, *average revenue* and *average cost* are also equal. Since average revenue is just the price, we need to find the price and quantity sold when average costs and price are equal. This is the intuition of average cost pricing that we discussed as a potential policy solution for natural monopolies.

Referring to the table, we see that average costs and price are equal two places: at a price of $40 or a price of $16. While I gave students that chose a price of $40 partial credit for recognizing the P=AC relationship, given Perry's goals, the better choice is a price of **$16**. At this price, there will be **8,000** riders. Because Perry is concerned about consumers, it makes more sense to choose the lower price, and thus the ridership. Moreover, choosing a price of $40 results in a higher price, lower number of riders (2,000) and lower profits than the profit maximizing strategy in part (b). Thus, neither the city nor consumers are better off choosing that price.

These riders will generate **$128,000** of revenue (= $16 x 8,000).

The total cost of serving these riders is also **$128,000**. You could find this in one of two ways. First, you could multiply the marginal cost per unit of $8 by the quantity, and then add the $64,000 fixed cost (= $8 x 8,000 + $64,000). Second, you could simply multiply average costs by quantity (=$16 x 8,000).

As expected, Danville makes no profit from the roller coaster transport system in this case. It just breaks even. Thus, it satisfies the goal of serving as many people as possible without losing money.