In the previous chapter, you found the commodity bundle that a consumer with a given utility function would choose in a specific price-income situation. In this chapter, we take this idea a step further. We find demand *functions*, which tell us for *any* prices and income you might want to name, how much of each good a consumer would want. In general, the amount of each good demanded may depend not only on its own price, but also on the price of other goods and on income. Where there are two goods, we write demand functions for Goods 1 and 2 as $x_1(p_1, p_2, m)$ and $x_2(p_1, p_2, m)$.*

When the consumer is choosing positive amounts of all commodities and indifference curves have no kinks, the consumer chooses a point of tangency between her budget line and the highest indifference curve that it touches.

Consider a consumer with utility function $U(x_1, x_2) = (x_1 + 2)(x_2 + 10)$. To find $x_1(p_1, p_2, m)$ and $x_2(p_1, p_2, m)$, we need to find a commodity bundle (x_1, x_2) on her budget line at which her indifference curve is tangent to her budget line. The budget line will be tangent to the indifference curve at (x_1, x_2) if the price ratio equals the marginal rate of substitution. For this utility function, $MU_1(x_1, x_2) = x_2 + 10$ and $MU_2(x_1, x_2) = x_1 + 2$. Therefore the "tangency equation" is $p_1/p_2 = (x_2 + 10)/(x_1 + 2)$. Cross-multiplying the tangency equation, one finds $p_1x_1 + 2p_1 = p_2x_2 + 10p_2$.

The bundle chosen must also satisfy the budget equation, $p_1x_1 + p_2x_2 = m$. This gives us two linear equations in the two unknowns, x_1 and x_2. You can solve these equations yourself, using high school algebra. You will find that the solution for the two "demand functions" is

$$x_1 = \frac{m - 2p_1 + 10p_2}{2p_1}$$
$$x_2 = \frac{m + 2p_1 - 10p_2}{2p_2}.$$

There is one thing left to worry about with the "demand functions" we just found. Notice that these expressions will be positive only if $m - 2p_1 + 10p_2 > 0$ and $m + 2p_1 - 10p_2 > 0$. If either of these expressions is negative, then it doesn't make sense as a demand function. What happens in this case is that the consumer will choose a "boundary solution" where she

* For some utility functions, demand for a good may not be affected by all of these variables. For example, with Cobb-Douglas utility, demand for a good depends on the good's own price and on income but not on the other good's price. Still, there is no harm in writing demand for Good 1 as a function of p_1, p_2, and m. It just happens that the derivative of $x_1(p_1, p_2, m)$ with respect to p_2 is zero.

consumes only one good. At this point, her indifference curve will not be tangent to her budget line.

When a consumer has kinks in her indifference curves, she may choose a bundle that is located at a kink. In the problems with kinks, you will be able to solve for the demand functions quite easily by looking at diagrams and doing a little algebra. Typically, instead of finding a tangency equation, you will find an equation that tells you "where the kinks are." With this equation and the budget equation, you can then solve for demand.

You might wonder why we pay so much attention to kinky indifference curves, straight line indifference curves, and other "funny cases." Our reason is this. In the funny cases, computations are usually pretty easy. But often you may have to draw a graph and think about what you are doing. That is what we want you to do. Think and fiddle with graphs. Don't just memorize formulas. Formulas you will forget, but the habit of thinking will stick with you.

When you have finished this workout, we hope that you will be able to do the following:

- Find demand functions for consumers with Cobb-Douglas and other similar utility functions.
- Find demand functions for consumers with quasilinear utility functions.
- Find demand functions for consumers with kinked indifference curves and for consumers with straight-line indifference curves.
- Recognize complements and substitutes from looking at a demand curve.
- Recognize normal goods, inferior goods, luxuries, and necessities from looking at information about demand.
- Calculate the equation of an inverse demand curve, given a simple demand equation.

6.1 (0) Charlie is back—still consuming apples and bananas. His utility function is $U(x_A, x_B) = x_A x_B$. We want to find his demand function for apples, $x_A(p_A, p_B, m)$, and his demand function for bananas, $x_B(p_A, p_B, m)$.

(a) When the prices are p_A and p_B and Charlie's income is m, the equation for Charlie's budget line is $p_A x_A + p_B x_B = m$. The slope of Charlie's indifference curve at the bundle (x_A, x_B) is $-MU_1(x_A, x_B)/MU_2(x_A, x_B) =$

_____________ The slope of Charlie's budget line is _____________ Charlie's indifference curve will be tangent to his budget line at the point

(x_A, x_B) if the following equation is satisfied:_________________________.

(b) You now have two equations, the budget equation and the tangency equation, that must be satisfied by the bundle demanded. Solve these two equations for x_A and x_B. Charlie's demand function for apples is $x_A(p_A, p_B, m) =$______ , and his demand function for bananas is $x_B(p_A, p_B, m) =$______.

(c) In general, the demand for both commodities will depend on the price of both commodities and on income. But for Charlie's utility function, the demand function for apples depends only on income and the price of apples. Similarly, the demand for bananas depends only on income and the price of bananas. Charlie always spends the same fraction of his income on bananas. What fraction is this?______.

6.2 (0) Douglas Cornfield's preferences are represented by the utility function $u(x_1, x_2) = x_1^2 x_2^3$. The prices of x_1 and x_2 are p_1 and p_2.

(a) The slope of Cornfield's indifference curve at the point (x_1, x_2) is ______.

(b) If Cornfield's budget line is tangent to his indifference curve at (x_1, x_2), then $\frac{p_1 x_1}{p_2 x_2} =$______ (Hint: Look at the equation that equates the slope of his indifference curve with the slope of his budget line.) When he is consuming the best bundle he can afford, what fraction of his income does Douglas spend on x_1?______.

(c) Other members of Doug's family have similar utility functions, but the exponents may be different, or their utilities may be multiplied by a positive constant. If a family member has a utility function $U(x, y) = c x_1^a x_2^b$ where a, b, and c are positive numbers, what fraction of his or her income will that family member spend on x_1?______.

6.3 (0) Our thoughts return to Ambrose and his nuts and berries. Ambrose's utility function is $U(x_1, x_2) = 4\sqrt{x_1} + x_2$, where x_1 is his consumption of nuts and x_2 is his consumption of berries.

(a) Let us find his demand function for nuts. The slope of Ambrose's indifference curve at (x_1, x_2) is ______ Setting this slope equal to the slope of the budget line, you can solve for x_1 without even using the budget equation. The solution is $x_1 =$______.

(b) Let us find his demand for berries. Now we need the budget equation. In Part (a), you solved for the amount of x_1 that he will demand. The budget equation tells us that $p_1x_1 + p_2x_2 = M$. Plug the solution that you found for x_1 into the budget equation and solve for x_2 as a function of income and prices. The answer is $x_2 =$______________________________.

(c) When we visited Ambrose in Chapter 5, we looked at a "boundary solution," where Ambrose consumed only nuts and no berries. In that example, $p_1 = 1$, $p_2 = 2$, and $M = 9$. If you plug these numbers into the formulas we found in Parts (a) and (b), you find $x_1 =$____________, and $x_2 =$_____________. Since we get a negative solution for x_2, it must be that the budget line $x_1 + 2x_2 = 9$ is not tangent to an indifference curve when $x_2 \geq 0$. The best that Ambrose can do with this budget is to spend all of his income on nuts. Looking at the formulas, we see that at the prices $p_1 = 1$ and $p_2 = 2$, Ambrose will demand a positive amount of both goods if and only if $M >$____.

6.4 (0) Donald Fribble is a stamp collector. The only things other than stamps that Fribble consumes are Hostess Twinkies. It turns out that Fribble's preferences are represented by the utility function $u(s,t) = s + \ln t$ where s is the number of stamps he collects and t is the number of Twinkies he consumes. The price of stamps is p_s and the price of Twinkies is p_t. Donald's income is m.

(a) Write an expression that says that the ratio of Fribble's marginal utility for Twinkies to his marginal utility for stamps is equal to the ratio of the price of Twinkies to the price of stamps. ________________ (Hint: The derivative of $\ln t$ with respect to t is $1/t$, and the derivative of s with respect to s is 1.)

(b) You can use the equation you found in the last part to show that if he buys both goods, Donald's demand function for Twinkies depends only on the price ratio and not on his income. Donald's demand function for Twinkies is____.

(c) Notice that for this special utility function, if Fribble buys both goods, then the total amount of money that he spends on Twinkies has the peculiar property that it depends on only one of the three variables m, p_t, and p_s, namely the variable ________ (Hint: The amount of money that he spends on Twinkies is $p_t t(p_s, p_t, m)$.)

(*d*) Since there are only two goods, any money that is not spent on Twinkies must be spent on stamps. Use the budget equation and Donald's demand function for Twinkies to find an expression for the number of stamps he will buy if his income is m, the price of stamps is p_s and the price of Twinkies is p_t.____.

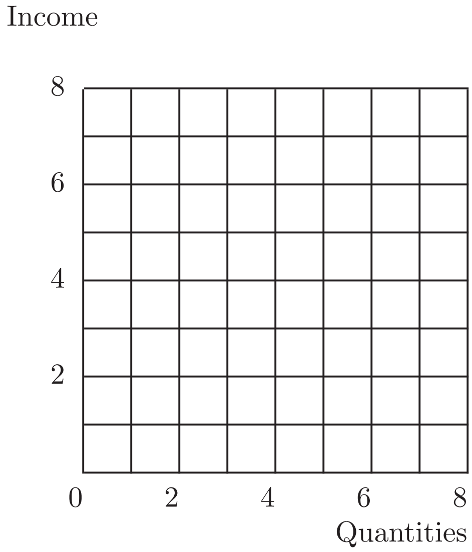
(*e*) The expression you just wrote down is negative if $m < p_s$. Surely it makes no sense for him to be demanding negative amounts of postage stamps. If $m < p_s$, what would Fribble's demand for postage stamps be?

__________ What would his demand for Twinkies be? __________
(Hint: Recall the discussion of boundary optimum.)

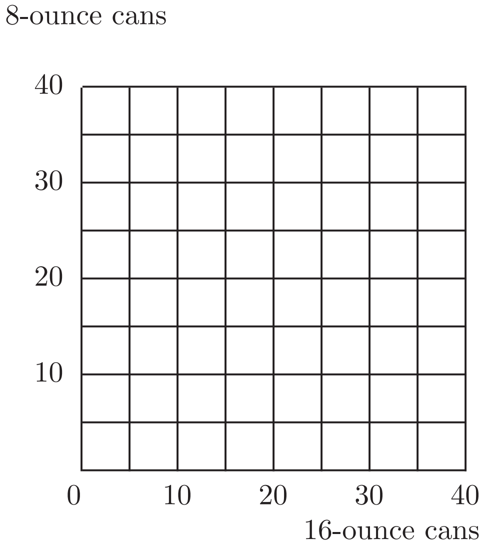
(*f*) Donald's wife complains that whenever Donald gets an extra dollar, he always spends it all on stamps. Is she right? (Assume that $m > p_s$.)

____.

(*g*) Suppose that the price of Twinkies is \$2 and the price of stamps is \$1. On the graph below, draw Fribble's Engel curve for Twinkies in red ink and his Engel curve for stamps in blue ink. (Hint: First draw the Engel curves for incomes greater than \$1, then draw them for incomes less than \$1.)



6.5 (0) Shirley Sixpack, as you will recall, thinks that two 8-ounce cans of beer are exactly as good as one 16-ounce can of beer. Suppose that these are the only sizes of beer available to her and that she has \$30 to spend on beer. Suppose that an 8-ounce beer costs \$.75 and a 16-ounce beer costs \$1. On the graph below, draw Shirley's budget line in blue ink, and draw some of her indifference curves in red.



(a) At these prices, which size can will she buy, or will she buy some of each?____.

(b) Suppose that the price of 16-ounce beers remains \$1 and the price of 8-ounce beers falls to \$.55. Will she buy more 8-ounce beers?__________.

(c) What if the price of 8-ounce beers falls to \$.40? How many 8-ounce beers will she buy then?__________________________________.

(d) If the price of 16-ounce beers is \$1 each and if Shirley chooses some 8-ounce beers and some 16-ounce beers, what must be the price of 8-ounce beers?____.

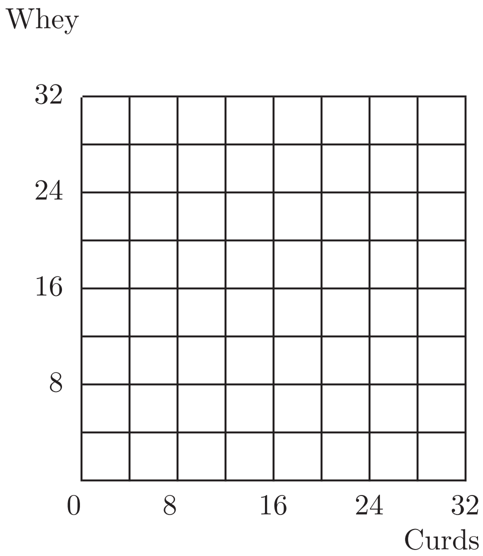
(e) Now let us try to describe Shirley's demand function for 16-ounce beers as a function of general prices and income. Let the prices of 8-ounce and 16-ounce beers be p_8 and p_{16}, and let her income be m. If $p_{16} < 2p_8$, then the number of 16-ounce beers she will demand is __________ If $p_{16} > 2p_8$, then the number of 16-ounce beers she will demand is __________ If $p_{16} =$ __________ p_8, she will be indifferent between any affordable combinations.

6.6 (0) Miss Muffet always likes to have things "just so." In fact the only way she will consume her curds and whey is in the ratio of 2 units of whey per unit of curds. She has an income of \$20. Whey costs \$.75 per unit. Curds cost \$1 per unit. On the graph below, draw Miss Muffet's budget line, and plot some of her indifference curves. (Hint: Have you noticed something kinky about Miss Muffet?)

____

(a) How many units of curds will Miss Muffet demand in this situation?

_______ How many units of whey? _______________.



(b) Write down Miss Muffet's demand function for whey as a function of the prices of curds and whey and of her income, where p_c is the price of curds, p_w is the price of whey, and m is her income. $D(p_c, p_w, m) =$ _______

_______ (Hint: You can solve for her demands by solving two equations in two unknowns. One equation tells you that she consumes twice as much whey as curds. The second equation is her budget equation.)

6.7 (1) Mary's utility function is $U(b, c) = b + 100c - c^2$, where b is the number of silver bells in her garden and c is the number of cockle shells. She has 500 square feet in her garden to allocate between silver bells and cockle shells. Silver bells each take up 1 square foot and cockle shells each take up 4 square feet. She gets both kinds of seeds for free.

(a) To maximize her utility, given the size of her garden, Mary should plant _______ silver bells and _______ cockle shells. (Hint: Write down her "budget constraint" for space. Solve the problem as if it were an ordinary demand problem.)

(b) If she suddenly acquires an extra 100 square feet for her garden, how much should she increase her planting of silver bells? _______________

_______ How much should she increase her planting of cockle shells?

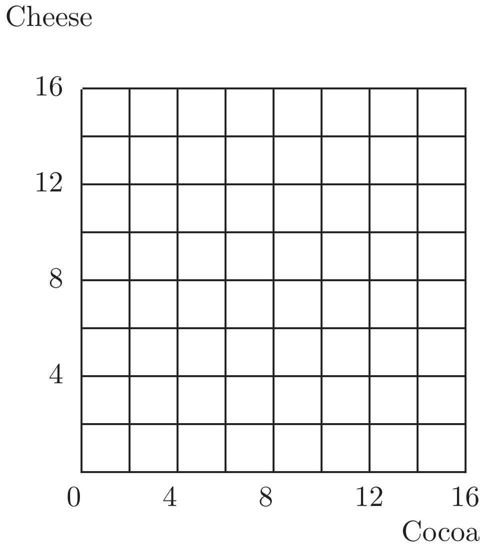
_______________________________.

(c) If Mary had only 144 square feet in her garden, how many cockle shells would she grow?____________________.

(d) If Mary grows both silver bells and cockle shells, then we know that the number of square feet in her garden must be greater than________.

6.8 (0) Casper consumes cocoa and cheese. He has an income of $16. Cocoa is sold in an unusual way. There is only one supplier and the more cocoa one buys from him, the higher the price one has to pay per unit. In fact, x units of cocoa will cost Casper a total of x^2 dollars. Cheese is sold in the usual way at a price of $2 per unit. Casper's budget equation, therefore, is $x^2 + 2y = 16$ where x is his consumption of cocoa and y is his consumption of cheese. Casper's utility function is $U(x, y) = 3x + y$.

(a) On the graph below, draw the boundary of Casper's budget set in blue ink. Use red ink to sketch two or three of his indifference curves.



(b) Write an equation that says that at the point (x, y), the slope of Casper's budget "line" equals the slope of his indifference "curve."________

________ Casper demands ________ units of cocoa and ________ units of cheese.

6.9 (0) Perhaps after all of the problems with imaginary people and places, you would like to try a problem based on actual fact. The U.S. government's Bureau of Labor Statistics periodically makes studies of family budgets and uses the results to compile the consumer price index. These budget studies and a wealth of other interesting economic data can be found in the annually published *Handbook of Labor Statistics.* The tables below report total current consumption expenditures and expenditures on certain major categories of goods for 5 different income groups in the United States in 1961. People within each of these groups all had similar incomes. Group A is the lowest income group and Group E is the highest.

Table 6.1

Expenditures by Category for Various Income Groups in 1961

Income Group	A	B	C	D	E
Food Prepared at Home	465	783	1078	1382	1848
Food Away from Home	68	171	213	384	872
Housing	626	1090	1508	2043	4205
Clothing	119	328	508	830	1745
Transportation	139	519	826	1222	2048
Other	364	745	1039	1554	3490
Total Expenditures	1781	3636	5172	7415	14208

Table 6.2

Percentage Allocation of Family Budget

Income Group	A	B	C	D	E
Food Prepared at Home	26	22	21	19	13
Food Away from Home	3.8	4.7	4.1	5.2	6.1
Housing	35	30			
Clothing	6.7	9.0			
Transportation	7.8	14			

(a) Complete Table 6.2.

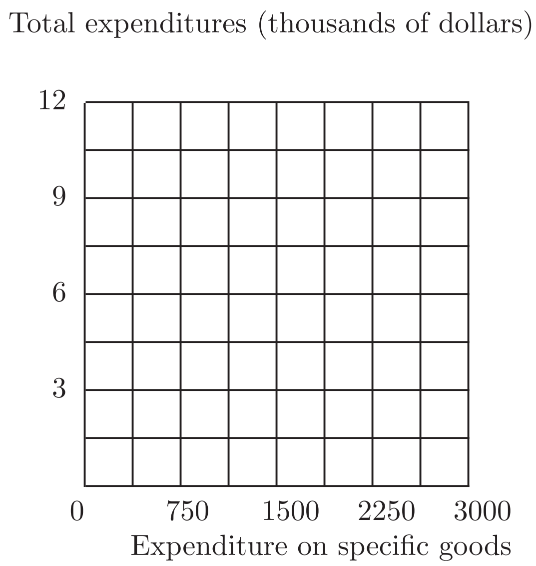
(b) Which of these goods are normal goods?______________________.

(c) Which of these goods satisfy your textbook's definition of *luxury goods* at most income levels?____________________________________.

(d) Which of these goods satisfy your textbook's definition of *necessity goods* at most income levels?________________________________.

(e) On the graph below, use the information from Table 6.1 to draw "Engel curves." (Use total expenditure on current consumption as income for purposes of drawing this curve.) Use red ink to draw the Engel curve for food prepared at home. Use blue ink to draw an Engel curve for food away from home. Use pencil to draw an Engel curve for clothing. How does the shape of an Engel curve for a luxury differ from the shape of an Engel curve for a necessity?________________________________

____.



6.10 (0) Percy consumes cakes and ale. His demand function for cakes is $q_c = m - 30p_c + 20p_a$, where m is his income, p_a is the price of ale, p_c is the price of cakes, and q_c is his consumption of cakes. Percy's income is \$100, and the price of ale is \$1 per unit.

(a) Is ale a substitute for cakes or a complement? Explain.________________

____.

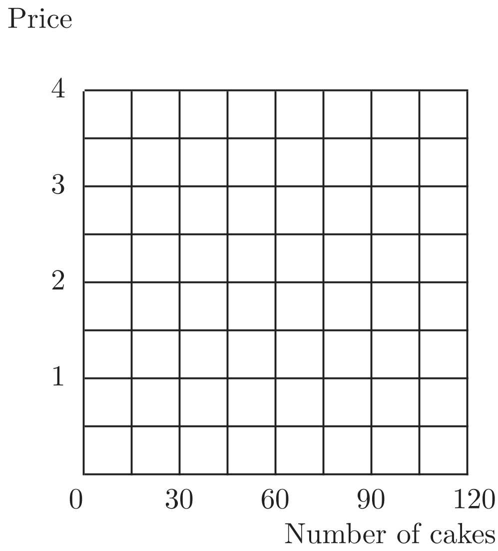
(b) Write an equation for Percy's demand function for cakes where income and the price of ale are held fixed at \$100 and \$1.______________________.

(c) Write an equation for Percy's inverse demand function for cakes where income is \$100 and the price of ale remains at \$1.____________________ At what price would Percy buy 30 cakes? ________ Use blue ink to draw Percy's inverse demand curve for cakes.

(d) Suppose that the price of ale rises to \$2.50 per unit and remains there.

Write an equation for Percy's inverse demand for cakes. ______________

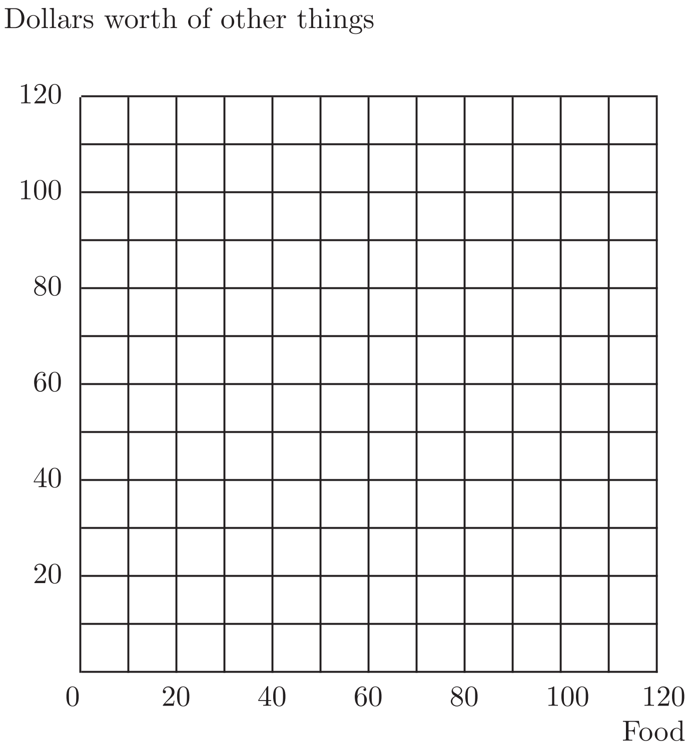
_______ Use red ink to draw in Percy's new inverse demand curve for cakes.



6.11 (0) Richard and Mary Stout have fallen on hard times, but remain rational consumers. They are making do on \$80 a week, spending \$40 on food and \$40 on all other goods. Food costs \$1 per unit. On the graph below, use black ink to draw a budget line. Label their consumption bundle with the letter A.

(a) The Stouts suddenly become eligible for food stamps. This means that they can go to the agency and buy coupons that can be exchanged for \$2 worth of food. Each coupon costs the Stouts \$1. However, the maximum number of coupons they can buy per week is 10. On the graph, draw their new budget line with red ink.

(b) If the Stouts have homothetic preferences, how much more food will they buy once they enter the food stamp program?____________________.



6.12 (2) As you may remember, Nancy Lerner is taking an economics course in which her overall score is the *minimum* of the number of correct answers she gets on two examinations. For the first exam, each correct answer costs Nancy 10 minutes of study time. For the second exam, each correct answer costs her 20 minutes of study time. In the last chapter, you found the best way for her to allocate 1200 minutes between the two exams. Some people in Nancy's class learn faster and some learn slower than Nancy. Some people will choose to study more than she does, and some will choose to study less than she does. In this section, we will find a general solution for a person's choice of study times and exam scores as a function of the time costs of improving one's score.

(a) Suppose that if a student does not study for an examination, he or she gets no correct answers. Every answer that the student gets right on the first examination costs P_1 minutes of studying for the first exam. Every answer that he or she gets right on the second examination costs P_2 minutes of studying for the second exam. Suppose that this student spends a total of M minutes studying for the two exams and allocates the time between the two exams in the most efficient possible way. Will the student have the same number of correct answers on both exams?

__________ Write a general formula for this student's overall score for the course as a function of the three variables, P_1, P_2, and M: $S =$__________

If this student wants to get an overall score of S, with the smallest possible total amount of studying, this student must spend ________ minutes studying for the first exam and ________ studying for the second exam.

(b) Suppose that a student has the utility function

$$U(S, M) = S - \frac{A}{2}M^2,$$

where S is the student's overall score for the course, M is the number of minutes the student spends studying, and A is a variable that reflects how much the student dislikes studying. In Part (a) of this problem, you found that a student who studies for M minutes and allocates this time wisely between the two exams will get an overall score of $S = \frac{M}{P_1+P_2}$. Substitute $\frac{M}{P_1+P_2}$ for S in the utility function and then differentiate with respect to M to find the amount of study time, M, that maximizes the student's utility. $M =$________ Your answer will be a function of the variables P_1, P_2, and A. If the student chooses the utility-maximizing amount of study time and allocates it wisely between the two exams, he or she will have an overall score for the course of $S =$______________.

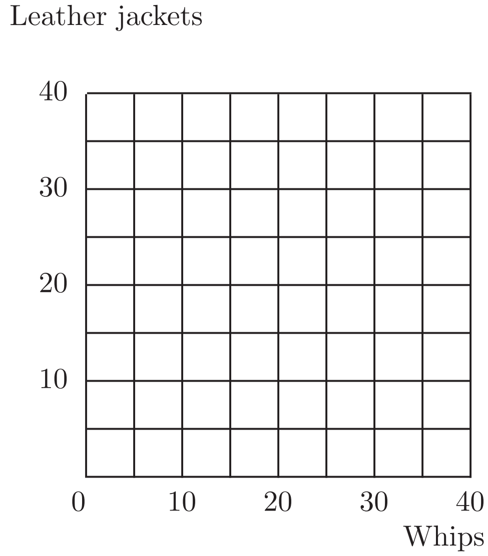
(c) Nancy Lerner has a utility function like the one presented above. She chose the utility-maximizing amount of study time for herself. For Nancy, $P_1 = 10$ and $P_2 = 20$. She spent a total of $M = 1,200$ minutes studying for the two exams. This gives us enough information to solve for the variable A in Nancy's utility function. In fact, for Nancy, $A =$________.

(d) Ed Fungus is a student in Nancy's class. Ed's utility function is just like Nancy's, with the same value of A. But Ed learns more slowly than Nancy. In fact it takes Ed exactly twice as long to learn anything as it takes Nancy, so that for him, $P_1 = 20$ and $P_2 = 40$. Ed also chooses his amount of study time so as to maximize his utility. Find the ratio of the amount of time Ed spends studying to the amount of time Nancy spends studying. ________ Will his score for the course be greater than half, equal to half, or less than half of Nancy's?______________________.

6.13 (1) Here is a puzzle for you. At first glance, it would appear that there is not nearly enough information to answer this question. But when you graph the indifference curve and think about it a little, you will see that there is a neat, easily calculated solution.

Kinko spends all his money on whips and leather jackets. Kinko's utility function is $U(x, y) = \min\{4x, 2x + y\}$, where x is his consumption of whips and y is his consumption of leather jackets. Kinko is consuming 15 whips and 10 leather jackets. The price of whips is \$10. You are to find Kinko's income.

(a) Graph the indifference curve for Kinko that passes through the point $(15, 10)$. What is the slope of this indifference curve at $(15, 10)$?_______ _______ What must be the price of leather jackets if Kinko chooses this point?_______ Now, what is Kinko's income?_________________________.



It is useful to think of a price change as having two distinct effects, a substitution effect and an income effect. The **substitution effect** of a price change is the change that would have happened *if* income changed at the same time in such a way that the consumer could exactly afford her old consumption bundle. The rest of the change in the consumer's demand is called the **income effect**. Why do we bother with breaking a real change into the sum of two hypothetical changes? Because we know things about the pieces that we wouldn't know about the whole without taking it apart. In particular, we know that the substitution effect of increasing the price of a good *must* reduce the demand for it. We also know that the income effect of an increase in the price of a good is equivalent to the effect of a *loss* of income. Therefore if the good whose price has risen is a normal good, then both the income and substitution effect operate to reduce demand. But if the good is an inferior good, income and substitution effects act in opposite directions.

A consumer has the utility function $U(x_1, x_2) = x_1 x_2$ and an income of \$24. Initially the price of good 1 was \$1 and the price of good 2 was \$2. Then the price of good 2 rose to \$3 and the price of good 1 stayed at \$1. Using the methods you learned in Chapters 5 and 6, you will find that this consumer's demand function for good 1 is $D_1(p_1, p_2, m) = m/2p_1$ and her demand function for good 2 is $D_2(p_1, p_2, m) = m/2p_2$. Therefore initially she will demand 12 units of good 1 and 6 units of good 2. If, when the price of good 2 rose to \$3, her income had changed enough so that she could exactly afford her old bundle, her new income would have to be $(1 \times 12) + (3 \times 6) = \$30$. At an income of \$30, at the new prices, she would demand $D_2(1, 3, 30) = 5$ units of good 2. Before the change she bought 6 units of 2, so the substitution effect of the price change on her demand for good 2 is $5 - 6 = -1$ units. Our consumer's income didn't *really* change. Her income stayed at \$24. Her actual demand for good 2 after the price change was $D_2(1, 3, 24) = 4$. The difference between what she actually demanded after the price change and what she would have demanded if her income had changed to let her just afford the old bundle is the income effect. In this case the income effect is $4 - 5 = -1$ units of good 2. Notice that in this example, both the income effect and the substitution effect of the price increase worked to reduce the demand for good 2.

When you have completed this workout, we hope that you will be able to do the following:

- Find Slutsky income effect and substitution effect of a specific price change if you know the demand function for a good.
- Show the Slutsky income and substitution effects of a price change on an indifference curve diagram.

- Show the Hicks income and substitution effects of a price change on an indifference curve diagram.
- Find the Slutsky income and substitution effects for special utility functions such as perfect substitutes, perfect complements, and Cobb-Douglas.
- Use an indifference-curve diagram to show how the case of a Giffen good might arise.
- Show that the substitution effect of a price increase unambiguously decreases demand for the good whose price rose.
- Apply income and substitution effects to draw some inferences about behavior.

8.1 (0) Gentle Charlie, vegetarian that he is, continues to consume apples and bananas. His utility function is $U(x_A, x_B) = x_A x_B$. The price of apples is \$1, the price of bananas is \$2, and Charlie's income is \$40 a day. The price of bananas suddenly falls to \$1.

(a) Before the price change, Charlie consumed ________ apples and ________ bananas per day. On the graph below, use black ink to draw Charlie's original budget line and put the label A on his chosen consumption bundle.

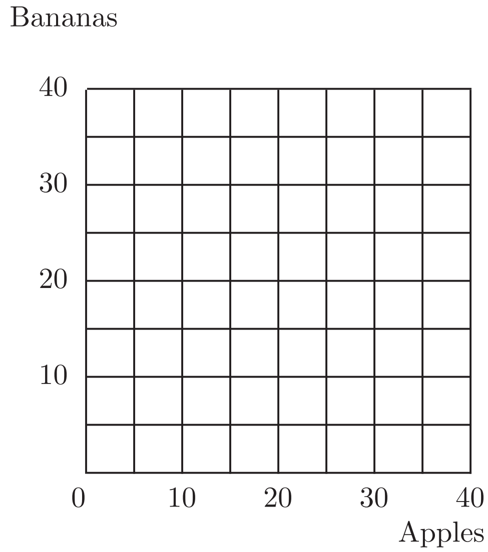
(b) If, after the price change, Charlie's income had changed so that he could exactly afford his old consumption bundle, his new income would have been ______ With this income and the new prices, Charlie would consume ________ apples and ________ bananas. Use red ink to draw the budget line corresponding to this income and these prices. Label the bundle that Charlie would choose at this income and the new prices with the letter B.

(c) Does the substitution effect of the fall in the price of bananas make him buy more bananas or fewer bananas? ________________ How many more or fewer?____.

(d) After the price change, Charlie actually buys ________ apples and ________ bananas. Use blue ink to draw Charlie's actual budget line after the price change. Put the label C on the bundle that he actually chooses after the price change. Draw 3 horizontal lines on your graph, one from A to the vertical axis, one from B to the vertical axis, and one from C to the vertical axis. Along the vertical axis, label the income effect, the substitution effect, and the total effect on the demand for bananas. Is the

blue line parallel to the red line or the black line that you drew before?

________________________________.



(e) The income effect of the fall in the price of bananas on Charlie's demand for bananas is the same as the effect of an (increase, decrease) __________ in his income of \$_______ per day. Does the income effect make him consume more bananas or fewer? ________ How many more or how many fewer?____________________.

(f) Does the substitution effect of the fall in the price of bananas make Charlie consume more *apples* or fewer? ________ How many more or fewer? __________ Does the income effect of the fall in the price of bananas make Charlie consume more apples or fewer? ________ What is the total effect of the change in the price of bananas on the demand for apples?__________________________.

8.2 (0) Neville's passion is fine wine. When the prices of all other goods are fixed at current levels, Neville's demand function for high-quality claret is $q = .02m - 2p$, where m is his income, p is the price of claret (in British pounds), and q is the number of bottles of claret that he demands. Neville's income is 7,500 pounds, and the price of a bottle of suitable claret is 30 pounds.

(a) How many bottles of claret will Neville buy?________________.

(b) If the price of claret rose to 40 pounds, how much income would Neville have to have in order to be exactly able to afford the amount of claret and the amount of other goods that he bought before the price change?

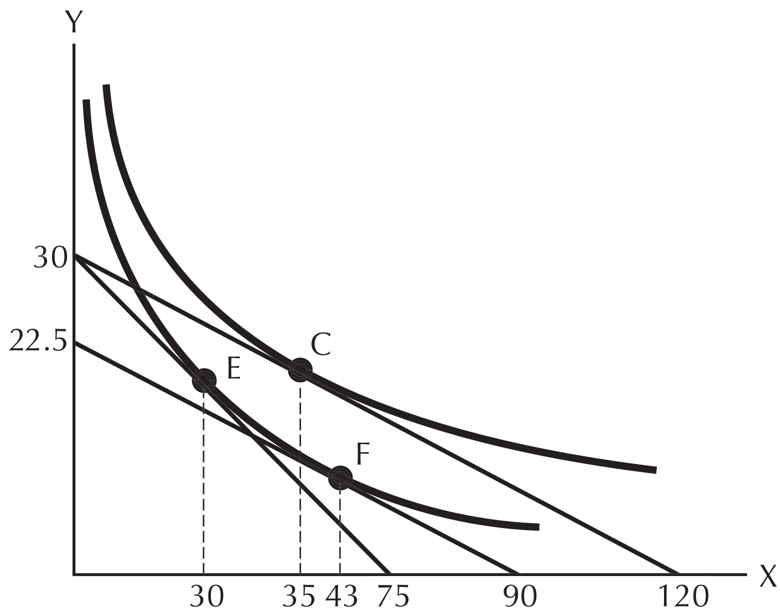
________________ At this income, and a price of 40 pounds, how many bottles would Neville buy?________________________________.

(c) At his original income of 7,500 and a price of 40, how much claret would Neville demand?________________________________.

(d) When the price of claret rose from 30 to 40, the number of bottles that Neville demanded decreased by ______ The substitution effect (increased, reduced)__________ his demand by ________ bottles and the income effect (increased, reduced)__________ his demand by__________

____.

8.3 (0) *Note: Do this problem only if you have read the section entitled "Another Substitution Effect" that describes the "Hicks substitution effect".* Consider the figure below, which shows the budget constraint and the indifference curves of good King Zog. Zog is in equilibrium with an income of \$300, facing prices $p_X = \$4$ and $p_Y = \$10$.



(a) How much X does Zog consume?________________________________.

(b) If the price of X falls to \$2.50, while income and the price of Y stay constant, how much X will Zog consume?____________________.

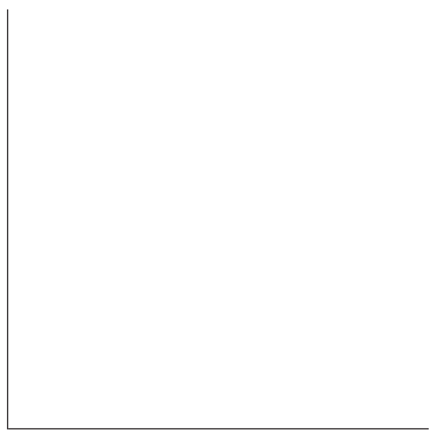
(c) How much income must be taken away from Zog to isolate the Hicksian income and substitution effects (i.e., to make him just able to afford to reach his old indifference curve at the new prices)?________________.

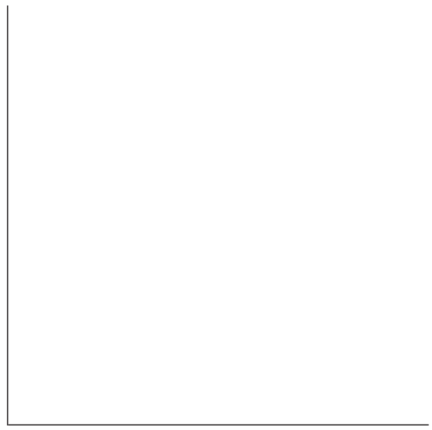
(d) The total effect of the price change is to change consumption from the point ________ to the point________________________.

(e) The income effect corresponds to the movement from the point ________ to the point ________ while the substitution effect corresponds to the movement from the point ________ to the point__________.

(f) Is X a normal good or an inferior good?____________________.

(g) On the axes below, sketch an Engel curve and a demand curve for Good X that would be reasonable given the information in the graph above. Be sure to label the axes on both your graphs.



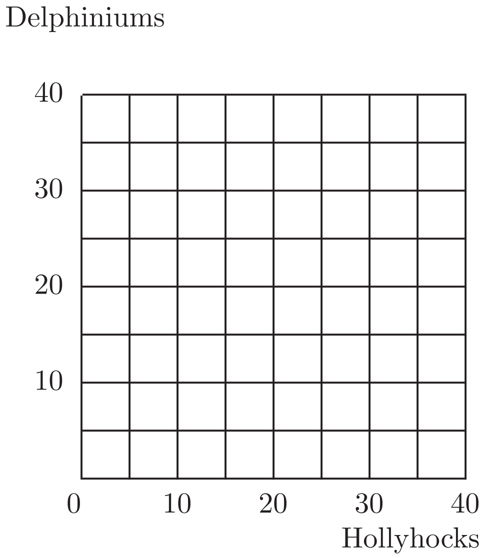


8.4 (0) Maude spends *all* of her income on delphiniums and hollyhocks. She thinks that delphiniums and hollyhocks are perfect substitutes; one delphinium is just as good as one hollyhock. Delphiniums cost \$4 a unit and hollyhocks cost \$5 a unit.

(a) If the price of delphiniums decreases to \$3 a unit, will Maude buy more of them? __________ What part of the change in consumption is due to the income effect and what part is due to the substitution effect?

____.

(b) If the prices of delphiniums and hollyhocks are respectively $p_d = \$4$ and $p_h = \$5$ and if Maude has \$120 to spend, draw her budget line in blue ink. Draw the highest indifference curve that she can attain in red ink, and label the point that she chooses as A.



(c) Now let the price of hollyhocks fall to \$3 a unit, while the price of delphiniums does not change. Draw her new budget line in black ink. Draw the highest indifference curve that she can now reach with red ink. Label the point she chooses now as B.

(d) How much would Maude's income have to be after the price of hollyhocks fell, so that she could just exactly afford her old commodity bundle A?____________________.

(e) When the price of hollyhocks fell to \$3, what part of the change in Maude's demand was due to the income effect and what part was due to the substitution effect?____________________.

8.5 (1) Suppose that two goods are perfect complements. If the price of one good changes, what part of the change in demand is due to the substitution effect, and what part is due to the income effect?__________

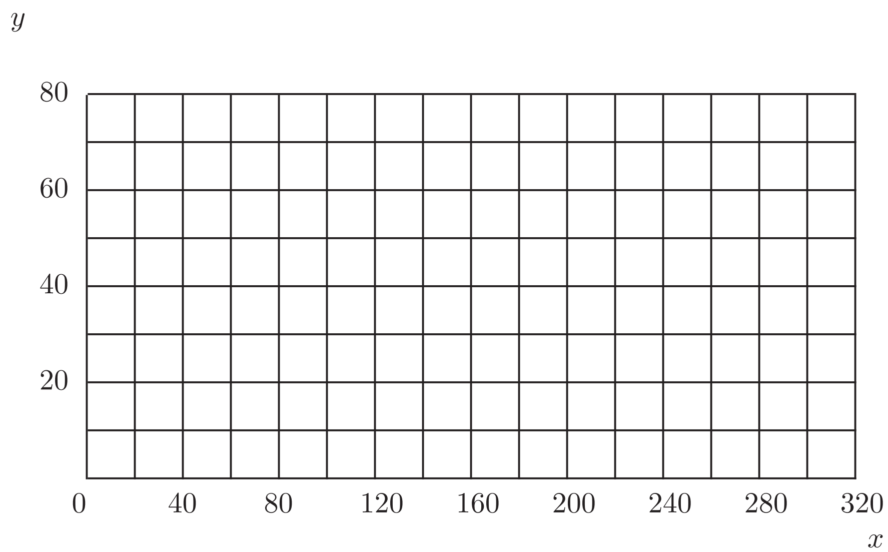
______________________________.

8.6 (0) Douglas Cornfield's demand function for good x is $x(p_x, p_y, m) = 2m/5p_x$. His income is \$1,000, the price of x is \$5, and the price of y is \$20. If the price of x falls to \$4, then his demand for x will change from ________ to____________________.

(a) If his income were to change at the same time so that he could exactly afford his old commodity bundle at $p_x = 4$ and $p_y = 20$, what would his new income be? __________ What would be his demand for x at this new level of income, at prices $p_x = 4$ and $p_y = 20$?____________.

(b) The substitution effect is a change in demand from ________ to ______ The income effect of the price change is a change in demand from ________ to____________________.

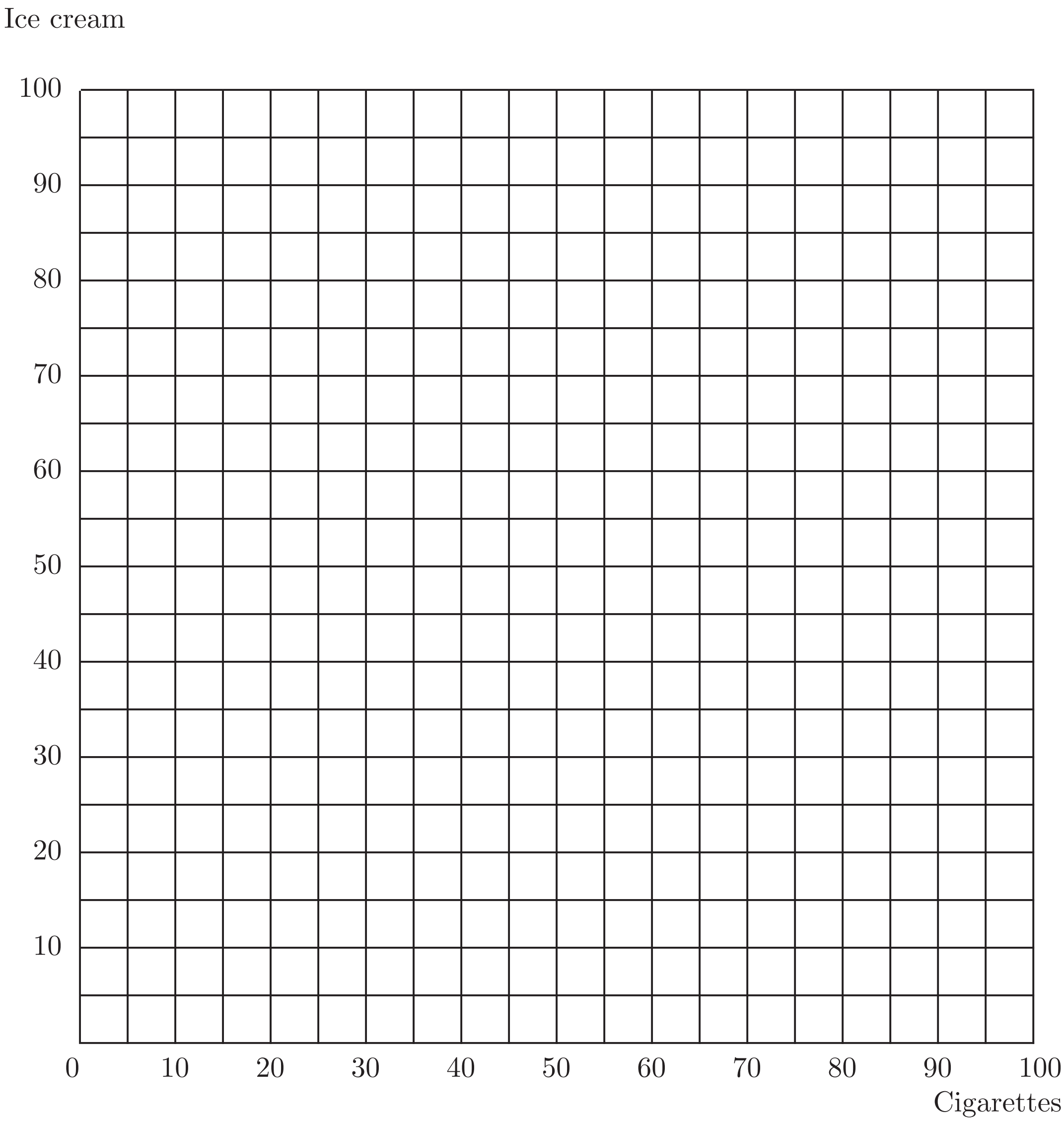
(c) On the axes below, use blue ink to draw Douglas Cornfield's budget line before the price change. Locate the bundle he chooses at these prices on your graph and label this point A. Use black ink to draw Douglas Cornfield's budget line after the price change. Label his consumption bundle after the change by B.



(d) On the graph above, use black ink to draw a budget line with the new prices but with an income that just allows Douglas to buy his old bundle, A. Find the bundle that he would choose with this budget line and label this bundle C.

8.7 (1) Mr. Consumer allows himself to spend \$100 per month on cigarettes and ice cream. Mr. C's preferences for cigarettes and ice cream are unaffected by the season of the year.

(a) In January, the price of cigarettes was \$1 per pack, while ice cream cost \$2 per pint. Faced with these prices, Mr. C bought 30 pints of ice cream and 40 packs of cigarettes. Draw Mr. C's January budget line with blue ink and label his January consumption bundle with the letter J.



(b) In February, Mr. C again had \$100 to spend and ice cream still cost \$2 per pint, but the price of cigarettes rose to \$1.25 per pack. Mr. C consumed 30 pints of ice cream and 32 packs of cigarettes. Draw Mr. C's February budget line with red ink and mark his February bundle with the letter F. The substitution effect of this price change would make him buy (less, more, the same amount of) ________ cigarettes and (less, more, the same amount of) ________ ice cream. Since this is true and the total change in his ice cream consumption was zero, it must be that the income effect of this price change on his consumption of ice cream makes him buy (more, less, the same amount of) ________ ice cream. The

income effect of this price change is like the effect of an (increase, decrease) ____________ in his income. Therefore the information we have suggests that ice cream is a(n) (normal, inferior, neutral) _________ good.

(c) In March, Mr. C again had $100 to spend. Ice cream was on sale for $1 per pint. Cigarette prices, meanwhile, increased to $1.50 per pack. Draw his March budget line with black ink. Is he better off than in January, worse off, or can you not make such a comparison?____________ How does your answer to the last question change if the price of cigarettes had increased to $2 per pack?____.

8.8 (1) This problem continues with the adventures of Mr. Consumer from the previous problem.

(a) In April, cigarette prices rose to $2 per pack and ice cream was still on sale for $1 per pint. Mr. Consumer bought 34 packs of cigarettes and 32 pints of ice cream. Draw his April budget line with pencil and label his April bundle with the letter A. Was he better off or worse off than in January?____________ Was he better off or worse off than in February, or can't one tell?____.

(b) In May, cigarettes stayed at $2 per pack and as the sale on ice cream ended, the price returned to $2 per pint. On the way to the store, however, Mr. C found $30 lying in the street. He then had $130 to spend on cigarettes and ice cream. Draw his May budget with a dashed line. Without knowing what he purchased, one can determine whether he is better off than he was in at least one previous month. Which month or months?____.

(c) In fact, Mr. C buys 40 packs of cigarettes and 25 pints of ice cream in May. Does he satisfy WARP?____.

8.9 (2) In the last chapter, we studied a problem involving food prices and consumption in Sweden in 1850 and 1890.

(a) Potato consumption was the same in both years. Real income must have gone up between 1850 and 1890, since the amount of food staples purchased, as measured by either the Laspeyres or the Paasche quantity index, rose. The price of potatoes rose less rapidly than the price of either meat or milk, and at about the same rate as the price of grain flour. So real income went up and the price of potatoes went down relative to other goods. From this information, determine

____

whether potatoes were most likely a normal or an inferior good. Explain your answer.____

____

____.

(b) Can one also tell from these data whether it is likely that potatoes were a Giffen good?____

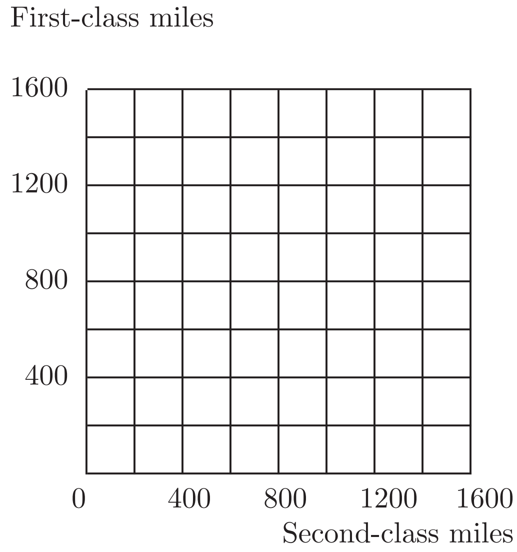
____

____

____.

8.10 (1) Agatha must travel on the Orient Express from Istanbul to Paris. The distance is 1,500 miles. A traveler can choose to make any fraction of the journey in a first-class carriage and travel the rest of the way in a second-class carriage. The price is 10 cents a mile for a second-class carriage and 20 cents a mile for a first-class carriage. Agatha much prefers first-class to second-class travel, but because of a misadventure in an Istanbul bazaar, she has only $200 left with which to buy her tickets. Luckily, she still has her toothbrush and a suitcase full of cucumber sandwiches to eat on the way. Agatha plans to spend her entire $200 on her tickets for her trip. She will travel first class as much as she can afford to, but she must get all the way to Paris, and $200 is not enough money to get her all the way to Paris in first class.

(a) On the graph below, use red ink to show the locus of combinations of first- and second-class tickets that Agatha can just afford to purchase with her $200. Use blue ink to show the locus of combinations of first- and second-class tickets that are sufficient to carry her the entire distance from Istanbul to Paris. Locate the combination of first- and second-class miles that Agatha will choose on your graph and label it A.



(b) Let m_1 be the number of miles she travels by first-class coach and m_2 be the number of miles she travels by second-class coach. Write down two equations that you can solve to find the number of miles she chooses to travel by first-class coach and the number of miles she chooses to travel by second-class coach.________________________________.

(c) The number of miles that she travels by second-class coach is______

____.

(d) Just before she was ready to buy her tickets, the price of second-class tickets fell to \$.05 while the price of first-class tickets remained at \$.20. On the graph that you drew above, use pencil to show the combinations of first-class and second-class tickets that she can afford with her \$200 at these prices. On your graph, locate the combination of first-class and second-class tickets that she would now choose. (Remember, she is going to travel as much first-class as she can afford to and still make the 1,500 mile trip on \$200.) Label this point B. How many miles does she travel by second class now? __________ (Hint: For an exact solution you will have to solve two linear equations in two unknowns.) Is second-class travel a normal good for Agatha? ______ Is it a Giffen good for her?__________.

8.11 (0) We continue with the adventures of Agatha, from the previous problem. Just after the price change from \$.10 per mile to \$.05 per mile for second-class travel, and just before she had bought any tickets, Agatha misplaced her handbag. Although she kept most of her money in her sock, the money she lost was just enough so that at the new prices, she could exactly afford the combination of first- and second-class tickets that she would have purchased at the old prices. How much money did she lose?

__________ On the graph you started in the previous problem, use black ink to draw the locus of combinations of first- and second-class tickets that she can just afford after discovering her loss. Label the point that she chooses with a C. How many miles will she travel by second class now?____.

(a) Finally, poor Agatha finds her handbag again. How many miles will she travel by second class now (assuming she didn't buy any tickets before she found her lost handbag)? __________ When the price of second-class tickets fell from \$.10 to \$.05, how much of a change in Agatha's demand for second-class tickets was due to a substitution effect? __________ How much of a change was due to an income effect?__________________.