8. Households allocate income among goods and services to maximize utility. This implies choosing activities that yield the highest marginal utility per dollar. In a two-good world, households will choose to equate the marginal utility per dollar spent on *X* with the marginal utility per dollar spent on *Y*. This is the *utility-maximizing rule*.

6.3 INCOME AND SUBSTITUTION EFFECTS *p. 126*

9. The fact that demand curves have a negative slope can be explained in two ways: (1) Marginal utility for all goods diminishes. (2) For most normal goods, both the *income and the substitution effects* of a price decline lead to more consumption of the good.

6.4 HOUSEHOLD CHOICE IN INPUT MARKETS *p. 128*

10. In the labor market, a trade-off exists between the value of the goods and services that can be bought in the market or produced at home and the value that one places on leisure. The opportunity cost of paid work is leisure and unpaid work. The wage rate is the price, or opportunity cost, of the benefits of unpaid work or leisure.

11. The income and substitution effects of a change in the wage rate work in opposite directions. Higher wages mean that (1) leisure is more expensive (likely response: people work *more*—substitution effect) and (2) more income is earned in a given number of hours, so some time may be spent on leisure (likely response: people work *less*—income effect).

12. In addition to deciding how to allocate its present income among goods and services, a household may also decide to save or borrow. When a household decides to save part of its current income, it is using current income to finance future spending. When a household borrows, it finances current purchases with future income.

13. An increase in interest rates has a positive effect on saving if the substitution effect dominates the income effect and a negative effect if the income effect dominates the substitution effect. Most empirical evidence shows that the substitution effect dominates here.

REVIEW TERMS AND CONCEPTS

budget constraint, *p. 117*

choice set *or* opportunity set, *p. 118*

diamond/water paradox, *p. 125*

financial capital market, *p. 132*

homogeneous products, *p. 115*

labor supply curve, *p. 130*

law of diminishing marginal utility, *p. 121*

marginal utility (MU), *p. 122*

perfect competition, *p. 115*

perfect knowledge, *p. 115*

real income, *p. 120*

total utility, *p. 122*

utility, *p. 121*

utility-maximizing rule, *p. 124*

PROBLEMS

All problems are available on MyLab Economics.

6.1 HOUSEHOLD CHOICE IN OUTPUT MARKETS

LEARNING OBJECTIVE: Explain where the budget constraint comes from and the role it plays in household demand.

1.1 Sketch the following budget constraints:

	P_X	P_Y	Income
a.	$ 100	$ 25	$ 5,000.00
b.	200	125	5,000.00
c.	50	400	2,000.00
d.	40	16	800.00
e.	3	2	12.00
f.	0.125	0.75	3.00
g.	0.75	0.125	3.00

1.2 On January 1, Professor Smith made a resolution to lose some weight and save some money. He decided that he would strictly budget $100 for lunches each month. For lunch, he has only two choices: the faculty club, where the price of a lunch is $5, and Alice's Restaurant, where the price of a lunch is $10. Every day that he does not eat lunch, he runs five miles.

a. Assuming that Professor Smith spends the $100 each month at either Alice's or the club, sketch his budget constraint. Show actual numbers on the axes.

b. Last month Professor Smith chose to eat at the club ten times and at Alice's five times. Does this choice fit within his budget constraint? Explain your answer.

c. Last month Alice ran a half-price lunch special all month. All lunches were reduced to $5. Show the effect on Professor Smith's budget constraint.

1.3 Assume that Diego has $400 per month to divide between playing paintball and playing golf. Assume that playing paintball costs $40 and playing golf costs $20. Suppose Diego plays paintball six times per month and plays golf eight times per month.

a. Draw Diego's budget constraint and show that he can afford six games of paintball and eight rounds of golf.

b. Assume that Diego has some unexpected expenses one month and can only spend $320 that month. Draw his new budget constraint.

c. As a result of the decrease in income, Diego decides to play 11 rounds of golf and two games of paintball. What kind of a good is paintball? What kind of a good is golf?

d. Assume Diego has his original $400 per month to spend and the price of paintball is still $40, but the price of golf doubles. Draw his new budget constraint.

1.4 Suppose the price of *X* is $5 and the price of *Y* is $10 and a hypothetical household has $500 to spend per month on goods *X* and *Y*.

a. Sketch the household budget constraint.

b. Assume that the household splits its income equally between *X* and *Y*. Show where the household ends up on the budget constraint.

c. Suppose the household income doubles to $1,000. Sketch the new budget constraint facing the household.

d. Suppose after the change the household spends $200 on *Y* and $800 on *X*. Does this imply that *X* is a normal or an inferior good? What about *Y*?

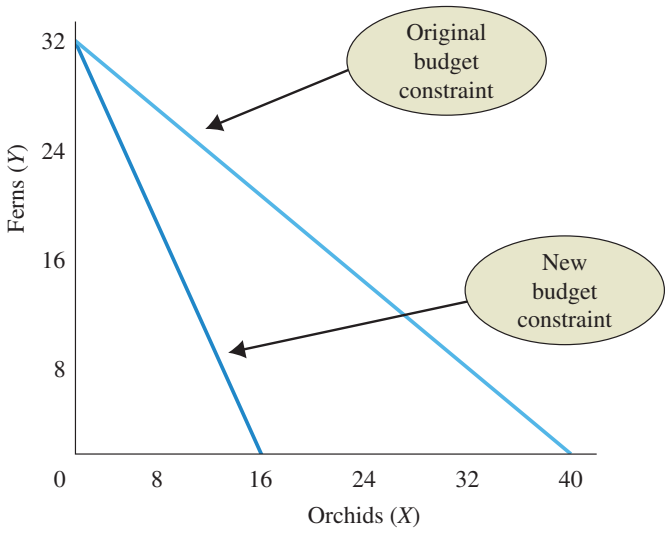
1.5 Katarina and Ivanna are sisters and plant lovers and have saved a total of $640 to spend on plants for their new apartment in Miami. They have decided to use this money on orchids and ferns. Their original budget constraint is shown in the graph below. Let *X* represent orchids and *Y* represent ferns.

a. What is the equation of the original budget constraint?

b. What is the price of an orchid? a fern?

c. Assume a price change occurs and Katarina and Ivanna now face the new budget constraint. What is the equation of the new budget constraint?

d. With the new budget constraint, what is the price of an orchid? a fern?



6.2 THE BASIS OF CHOICE: UTILITY

LEARNING OBJECTIVE: Understand how the utility maximizing rule works in household choice of products.

2.1 The following table gives a hypothetical total utility schedule for the Cookie Monster (CM):

# of Cookies Per Day	Total Utility per Day
0	0
1	100
2	200
3	275
4	325
5	350
6	360
7	360

Calculate the CM's marginal utility schedule. Draw a graph of total and marginal utility. If cookies cost the CM 5 cents each and CM had a good income, what is the maximum number of cookies he would most likely eat in a day?

2.2 **[Related to the *Economics in Practice* on *p. 125*]** At the beginning of 2012, a U.S. Department of Transportation regulation requiring airlines to include all mandatory taxes and fees in published airfares went into effect. Prior to this "full-fare advertising" rule, airlines were allowed to advertise tickets without disclosing these taxes and fees, resulting in advertised fares which could be less than half the actual price that was paid. Legislation proposed in the FAA Reauthorization Act of 2018 would rescind this full-fare advertising rule, again allowing airlines to initially quote low ticket prices, while disclosing mandatory taxes and fees separately before payment is required. How might the rescinding of this rule affect the demand for airline tickets? Explain if this rule would make these airline taxes and fees more salient or less salient for consumers? What are some other charges airlines impose that are not usually disclosed in published airfares, and how do they impact price salience for air travel?

2.3 For this problem, assume that Kendrick has $144 to spend on cigars and brandy each month and that both goods must be purchased whole (no fractional units). Cigars cost $6 each, and brandy costs $30 per bottle. Kendrick's preferences for cigars and brandy are summarized by the following information:

	Cigars				Brandy			
No. per Month	*TU*	*MU*	*MU/S*		Bottles per Month	*TU*	*MU*	*MU/S*
1	28	—	—		1	150	—	—
2	46	—	—		2	270	—	—
3	62	—	—		3	360	—	—
4	74	—	—		4	420	—	—
5	80	—	—		5	450	—	—
6	84	—	—		6	470	—	—
7	86	—	—		7	480	—	—

a. Fill in the figures for marginal utility and marginal utility per dollar for both cigars and brandy.

b. Are these preferences consistent with the law of diminishing marginal utility? Explain briefly.

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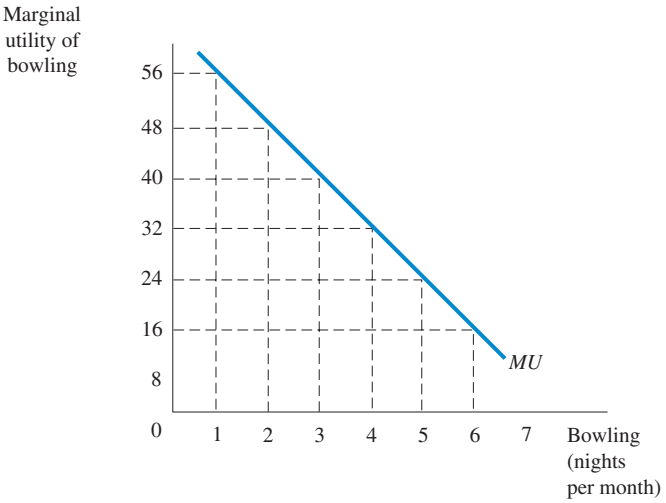
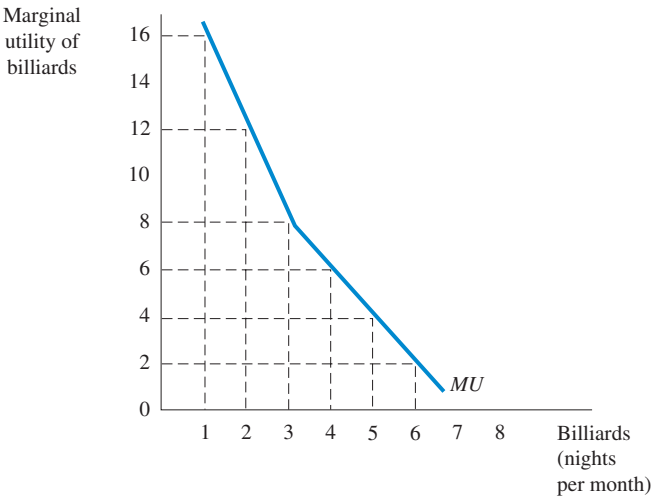
c. Given the budget of $144, what quantity of cigars and what quantity of brandy will maximize Kendrick's level of satisfaction? Explain briefly.

d. Now suppose the price of cigars rises to $8. Which of the columns in the table must be recalculated? Do the required recalculations.

e. After the price change, how many cigars and how many bottles of brandy will Kendrick purchase?

2.4 Thomas has allocated $48 per month for entertainment expenses, which he uses either to go bowling or to play billiards. One night of bowling costs Thomas $8, and one night of billiards costs Thomas $4. Use the information in the following graphs to determine how many nights Thomas should spend bowling and how many nights he should play billiards in order to maximize his utility. Explain your answer.





2.5 Adrian has $21 to spend on energy drinks and protein bars and wants to maximize his utility on his purchase. Based on the data in the table, how many energy drinks and protein bars should Adrian purchase, and what is his total utility from the purchase? Does the utility-maximizing rule hold true for his purchase? Explain.

Energy Drinks $3.00			Protein Bars $1.50		
Quantity	*MU*	*TU*	Quantity	*MU*	*TU*
1	84	84	1	36	36
2	72	156	2	30	66
3	60	216	3	24	90
4	48	264	4	18	108
5	36	300	5	12	120
6	24	324	6	6	126
7	12	336	7	0	126
8	0	336	8	–6	120

2.6 The table shows Darlene's marginal utility numbers for ice cream sundaes and milkshakes. Darlene is trying to decide which item to purchase first, a sundae or a milkshake, knowing that she wants to receive the most utility for each dollar she spends. Assuming she has enough money in her budget to purchase either item, which item should she purchase first? Explain.

Ice Cream Sundaes $6		Milkshakes $4	
Quantity	*MU*	Quantity	*MU*
1	24	1	16
2	16	2	6
3	6	3	2

6.3 INCOME AND SUBSTITUTION EFFECTS

LEARNING OBJECTIVE: Describe the income and substitution effects of a decrease in the price of food.

3.1 Remy is a New Orleans native who has lived for the past seven years in Boston. For each of the last seven years, he has made trips back to New Orleans for Mardi Gras, Jazz Fest, and Halloween. During 2018, the price of a round-trip ticket from Boston to New Orleans decreased from $575 to $350. As a result, Remy decided to buy new Mardi Gras and Halloween costumes that year and also decided to purchase tickets to see Big Freedia perform at the Brighton Music Hall in Boston.

a. Explain how Remy's demand for costumes and concert tickets can be affected by a decrease in air travel prices.

b. By using this example, explain why both income and substitution effects might be expected to increase Remy's number of trips to New Orleans.

3.2 **[Related to the *Economics in Practice* on *p. 129*]** The average cost of living is approximately the same in the following four cities: Dallas, TX, Toledo, OH, Gainesville, FL, and Salt Lake City, UT. Use the information you have learned about marginal utility and the substitution effect to explain whether you believe your purchasing choices

would remain the same in each of these cities. Assume that your income would be the same in each city.

3.3 For most normal goods, the income effect and the substitution effect work in the same direction; so when the price of a good falls, both the income and substitution effects lead to a higher quantity demanded. How would this change if the good is an inferior good?

6.4 HOUSEHOLD CHOICE IN INPUT MARKETS

LEARNING OBJECTIVE: Discuss factors that affect the labor and saving decisions of households.

4.1 For each of the following events, consider how you might react. What things might you consume more or less of? Would you work more or less? Would you increase or decrease your saving? Are your responses consistent with the discussion of household behavior in this chapter?

- **a.** The price of gasoline falls by 50 percent, and you drive 40 miles each way to and from school.
- **b.** Your 98-year-old great aunt passes away and, much to your surprise, leaves you an inheritance of $50,000.
- **c.** Your mother's employer transfers her to an office in another state, and the rest of your family stays behind so you can continue to live at home while going to school. She returns to visit every other weekend.
- **d.** You are awarded a scholarship that will pay half of your tuition for the next three years.
- **e.** The 100 shares of Apple stock you bought for $30 per share in 2010 with your babysitting money have turned into 700 shares after stock splits and are now worth $190 per share.
- **f.** The small company where you work part time has a banner year, and the boss gives all part-time employees a 25 percent raise.

4.2 On December 22, 2017, President Trump signed the Tax Cuts and Jobs Act of 2017, which cut the corporate tax rate and individual income tax rates beginning in 2018 and increased the standard deduction and child tax credit. By reducing individual income tax rates, take-home pay for taxpaying workers would increase. The purpose of the individual income tax cuts, in part, was to encourage work and increase the supply of labor. These income tax cuts would, indeed, tend to encourage work and increase the supply of labor, but only if income effects were stronger than substitution effects. Do you agree or disagree? Explain your answer.

4.3 Explain why in product markets the substitution and income effects work in the same direction for normal goods, but in the labor market, the income and substitution effects work in opposite directions when leisure is considered a normal good.

4.4 **[Related to the *Economics in Practice* on *p. 131*]** As Uber continues to become a more convenient, and in many cases, less costly alternative to traditional taxi service for many of its customers, the income and substitution effects have an impact on the demand side of the market. Also, because a majority of Uber drivers have another job and therefore driving for Uber becomes a way to supplement their income, the income and substitution effects impact the labor supply market. Discuss the income and substitution effects generated by Uber from both the customers' demand perspective and the drivers' labor supply perspective.

CRITICAL THINKING QUESTIONS

QUESTION 1 Suppose that you have season passes for your favorite sports team. The team's new managers have decided to double the price of a season ticket to raise more revenue. The managers plan to spend this new revenue on attracting better players. Explain how this will affect the likelihood that you purchase season tickets next year, referencing the substitution and income effects.

QUESTION 2 Banks rely on the money that you deposit into your savings account to finance the loans they make to borrowers. That is, your savings are the money that banks use to make loans. Explain how the interest rate paid on your savings account balance affects the availability of money for making loans.

CHAPTER 6 APPENDIX: Indifference Curves

LEARNING OBJECTIVE

Understand how to derive a demand curve from indifference curves and budget constraints.

Early in this chapter, we saw how a consumer choosing between two goods is constrained by the prices of those goods and by his or her income. This Appendix returns to that example and analyzes the process of choice more formally. (Before we proceed, carefully review the text under the heading "The Budget Constraint More Formally," p. 119)

Assumptions MyLab Economics Concept Check

We base the following analysis on four assumptions:

1. We assume that this analysis is restricted to goods that yield positive marginal utility, or, more simply, that "more is better." One way to justify this assumption is to say that when more of something makes you worse off, you can simply throw it away at no cost. This is the assumption of *free disposal*.
2. The **marginal rate of substitution** is defined as MU_X/MU_Y, or the ratio at which a household is willing to substitute X for Y. When MU_X/MU_Y is equal to 4, for example, I would be willing to trade 4 units of Y for 1 additional unit of X. We assume a diminishing marginal rate of substitution. That is, as more of X and less of Y are consumed, MU_X/MU_Y declines. As you consume more of X and less of Y, X becomes less valuable in terms of units of Y, or Y becomes more valuable in terms of X. This is almost, but not precisely equivalent to assuming diminishing marginal utility.
3. We assume that consumers have the ability to choose among the combinations of goods and services available. Confronted with the choice between two alternative combinations of goods and services, A and B, a consumer responds in one of three ways: (1) She prefers A over B, (2) she prefers B over A, or (3) she is indifferent between A and B—that is, she likes A and B equally.
4. We assume that consumer choices are consistent with a simple assumption of rationality. If a consumer shows that he prefers A to B and subsequently shows that he prefers B to a third alternative, C, he should prefer A to C when confronted with a choice between the two.

marginal rate of substitution MU_X/MU_Y; the ratio at which a household is willing to substitute good Y for good X.

Deriving Indifference Curves MyLab Economics Concept Check

If we accept these four assumptions, we can construct a "map" of a consumer's preferences. These preference maps are made up of indifference curves. An **indifference curve** is a set of points, each point representing a combination of goods X and Y, all of which yield the same total utility.

indifference curve A set of points, each point representing a combination of goods X and Y, all of which yield the same total utility.

Figure 6A.1 shows how we might go about deriving an indifference curve for a hypothetical consumer. Each point in the diagram represents some amount of X and some amount of Y. Point A in the diagram, for example, represents X_A units of X and Y_A units of Y. Now suppose we take some amount of Y away from our hypothetical consumer, moving him or her to A'. At A', the consumer has the same amount of X—that is, X_A units—but less Y and now has only Y_C units of Y. Because "more is better," our consumer is unequivocally worse off at A' than at A.

To compensate for the loss of Y, we begin giving our consumer some more X. If we give the individual just a little, he or she will still be worse off than at A. If we give this individual a great deal of X, he or she will be better off. There must be some quantity of X that will just compensate for the loss of Y. By giving the consumer that amount, we will have put together a bundle, Y_C and X_C that yields the same total utility as bundle A. This is bundle C in Figure 6A.1. If confronted with a choice between bundles A and C, our consumer will say, "Either one; I do not care." In other words, the consumer is *indifferent* between A and C. When confronted with a choice between bundles C and B (which represent X_B and Y_B units of X and Y), this person is also indifferent. The points along the curve labeled i in Figure 6A.1 represent all the combinations of X and Y that yield the same total utility to our consumer. That curve is thus an indifference curve.

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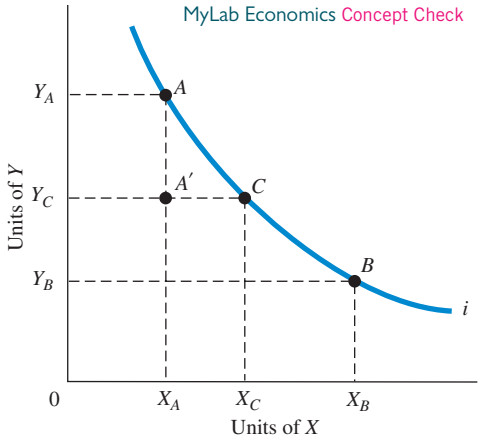

FIGURE 6A.1 An Indifference Curve
An indifference curve is a set of points, each representing a combination of some amount of good *X* and some amount of good *Y*, that all yield the same amount of total utility. The consumer depicted here is indifferent between bundles *A* and *B*, *B* and *C*, and *A* and *C*.

Each consumer has a whole set of indifference curves. Return for a moment to Figure 6A.1. Starting at point *A* again, imagine that we give the consumer a tiny bit more *X and* a tiny bit more *Y*. Because more is better, we know that the new bundle will yield a higher level of total utility and the consumer will be better off. Now just as we constructed the first indifference curve, we can construct a second one. What we get is an indifference curve that is *higher* and to the *right* of the first curve. Because utility along an indifference curve is constant at all points, every point along the new curve represents a higher level of total utility than every point along the first.

Figure 6A.2 shows a set of four indifference curves. The curve labeled i_4 represents the combinations of *X* and *Y* that yield the highest level of total utility among the four. Many other indifference curves exist between those shown on the diagram; in fact, their number is infinite. Notice that as you move up and to the right, utility increases.

The shapes of the indifference curves depend on the preferences of the consumer, and the whole set of indifference curves is called a **preference map**. Each consumer has a unique preference map.

preference map A consumer's set of indifference curves.

Properties of Indifference Curves MyLab Economics Concept Check

The indifference curves shown in Figure 6A.2 are drawn bowing in toward the origin, or zero point, on the axes. In other words, the absolute value of the slope of the indifference curves decreases, or the curves get flatter, as we move to the right. Thus, we say that indifference curves are convex

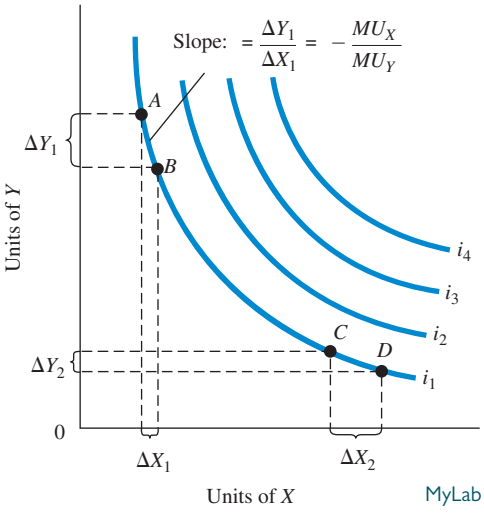

FIGURE 6A.2 A Preference Map: A Family of Indifference Curves
Each consumer has a unique family of indifference curves called a preference map. Higher indifference curves represent higher levels of total utility.

MyLab Economics Concept Check

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toward the origin. This shape follows directly from the assumption of diminishing marginal rate of substitution and makes sense if you remember the law of diminishing marginal utility.

To understand the convex shape, compare the segment of curve i_1 between *A* and *B* with the segment of the same curve between *C* and *D*. Moving from *A* to *B*, the consumer is willing to give up a substantial amount of *Y* to get a small amount of *X*. (Remember that total utility is constant along an indifference curve; the consumer is therefore indifferent between *A* and *B*.) Moving from *C* and *D*, however, the consumer is willing to give up only a small amount of *Y* to get more *X*.

This changing trade-off makes complete sense when you remember the law of diminishing marginal utility. Notice that between *A* and *B*, a great deal of *Y* is consumed and the marginal utility derived from a unit of *Y* is likely to be small. At the same time, though, only a little of *X* is being consumed; so the marginal utility derived from consuming a unit of *X* is likely to be high.

Suppose, for example, that *X* is pizza and *Y* is soda. Near *A* and *B*, a thirsty, hungry football player who has 10 sodas in front of him but only 1 slice of pizza will trade several sodas for another slice. Down around *C* and *D*, however, he has 20 slices of pizza and a single soda. Now he will trade several slices of pizza to get an additional soda.

We can show how the trade-off changes more formally by deriving an expression for the slope of an indifference curve. Let us look at the arc (that is, the section of the curve) between *A* and *B*. We know that in moving from *A* to *B*, total utility remains constant. That means that the utility lost as a result of consuming less *Y* must be matched by the utility gained from consuming more *X*. We can approximate the loss of utility by multiplying the marginal utility of *Y* (MU_Y) by the number of units by which consumption of *Y* is curtailed (Δ_Y). Similarly, we can approximate the utility gained from consuming more *X* by multiplying the marginal utility of *X* (MU_X) by the number of additional units of *X* consumed (Δ_X). Remember, because the consumer is indifferent between points *A* and *B*, total utility is the same at both points. Thus, these two must be equal in magnitude—that is, the gain in utility from consuming more *X* must equal the loss in utility from consuming less *Y*. Because ΔY is a negative number (because consumption of *Y* decreases from *A* to *B*), it follows that

$$MU_X \cdot \Delta X = -(MU_Y \cdot \Delta Y)$$

When we divide both sides by MU_Y and by ΔX, we obtain

$$\frac{\Delta Y}{\Delta X} = -\left(\frac{MU_X}{MU_Y}\right)$$

Recall that the slope of any line is calculated by dividing the change in *Y*—that is, ΔY—by the change in *X*—that is, ΔX. Thus, the slope of an indifference curve is the ratio of the marginal utility of *X* to the marginal utility of *Y*, and it is negative.

Now let us return to our pizza (*X*) and soda (*Y*) example. As we move down from the *A*:*B* area to the *C*:*D* area, our football player is consuming less soda and more pizza. The marginal utility of pizza (MU_X) is falling, and the marginal utility of soda (MU_Y) is rising. That means that MU_X/MU_Y (the marginal rate of substitution) is falling and the absolute value of the slope of the indifference curve is declining. Indeed, it does get flatter.

Consumer Choice MyLab Economics Concept Check

As you recall, demand depends on income, the prices of goods and services, and preferences or tastes. We are now ready to see how preferences as embodied in indifference curves interact with budget constraints to determine how the final quantities of *X* and *Y* will be chosen.

In Figure 6A.3, a set of indifference curves is superimposed on a consumer's budget constraint. Recall that the budget constraint separates those combinations of *X* and *Y* that are available from those that are not. The constraint simply shows those combinations that can be purchased with an income of *I* at prices P_X and P_Y. The budget constraint crosses the *X*-axis at I/P_X, or the number of units of *X* that can be purchased with *I* if nothing is spent on *Y*. Similarly, the budget constraint crosses the *Y*-axis at I/P_Y, or the number of units of *Y* that can be purchased with an income of *I* if nothing is spent on *X*. The shaded area is the consumer's opportunity set. The slope of a budget constraint is $-P_X/P_Y$.

MyLab Economics Concept Check

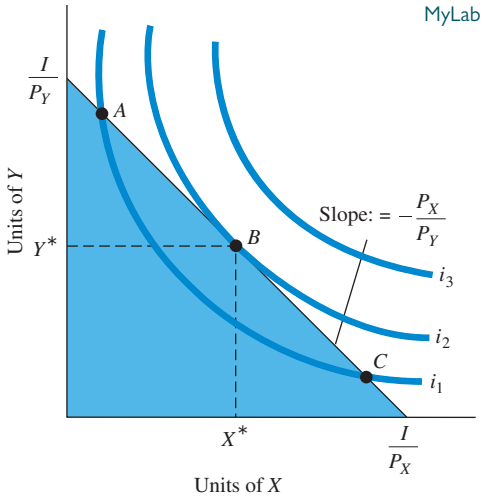


FIGURE 6A.3 Consumer Utility-Maximizing Equilibrium
Consumers will choose the combination of X and Y that maximizes total utility. Graphically, the consumer will move along the budget constraint until the highest possible indifference curve is reached. At that point, the budget constraint and the indifference curve are tangent. This point of tangency occurs at X^* and Y^* (point B).

Consumers will choose from among available combinations of X and Y the one that maximizes utility. In graphic terms, a consumer will move along the budget constraint until he or she is on the highest possible indifference curve. Utility rises by moving from points such as A or C (which lie on i_1) toward B (which lies on i_2). Any movement away from point B moves the consumer to a lower indifference curve—a lower level of utility. In this case, utility is maximized when our consumer buys X^* units of X and Y^* units of Y. At point B, the budget constraint is just tangent to—that is, just touches—indifference curve i_2. As long as indifference curves are convex to the origin, utility maximization will take place at that point at which the indifference curve is just tangent to the budget constraint.

The tangency condition has important implications. Where two curves are tangent, they have the same slope, which implies that the slope of the indifference curve is equal to the slope of the budget constraint at the point of tangency:

$$\underbrace{-\frac{MUX}{MUY}}_{\text{slope of indifference curve}} = \underbrace{-\frac{PX}{PY}}_{\text{slope of budget constraint}}$$

By multiplying both sides of this equation by MU_Y and dividing both sides by P_X, we can rewrite this utility-maximizing rule as

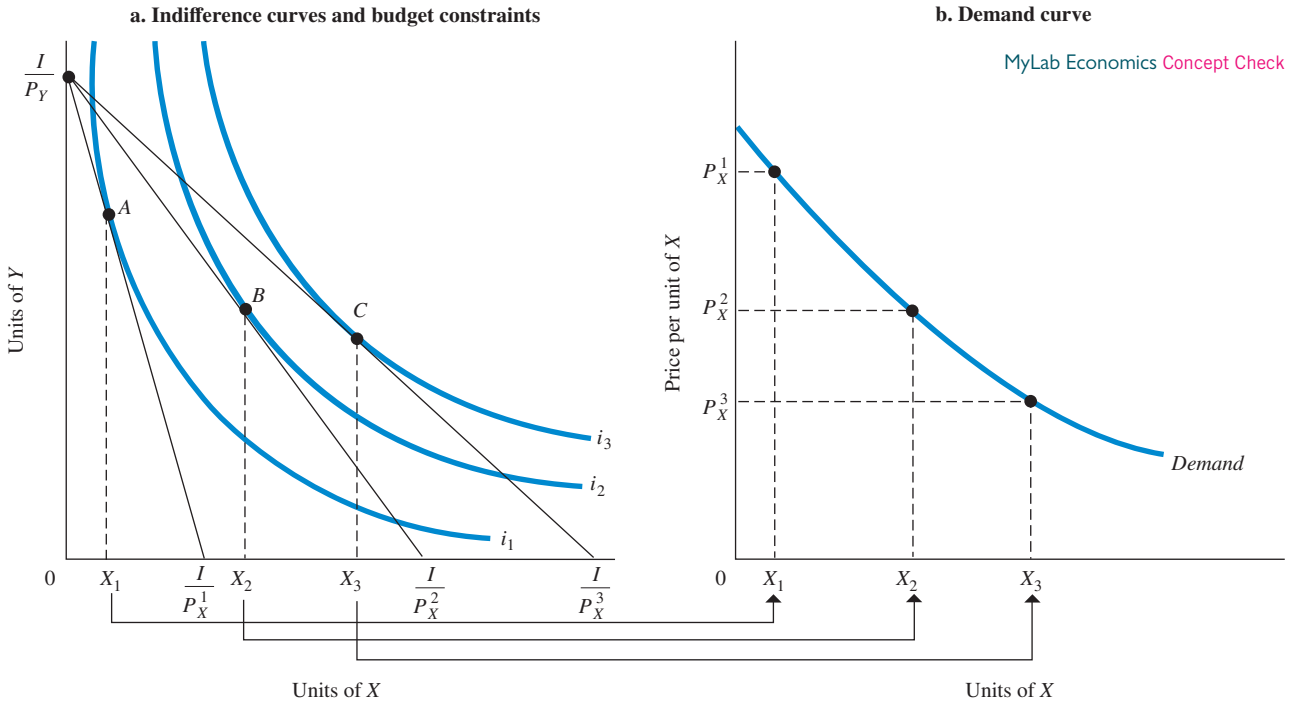
$$\frac{MU_X}{P_X} = \frac{MU_Y}{P_Y}$$

This is the same rule derived in our previous discussion without using indifference curves. We can describe this rule intuitively by saying that consumers maximize their total utility by equating the marginal utility per dollar spent on X with the marginal utility per dollar spent on Y. If this rule did not hold, utility could be increased by shifting money from one good to the other.

Deriving a Demand Curve from Indifference Curves and Budget Constraints MyLab Economics Concept Check

We now turn to the task of deriving a simple demand curve from indifference curves and budget constraints. A demand curve shows the quantity of a single good, X in this case, that a consumer will demand at various prices. To derive the demand curve, we need to confront our consumer with several alternative prices for X while keeping other prices, income, and preferences constant.

Figure 6A.4 shows the derivation. We begin with price P_X^1. At that price, the utility-maximizing point is A, where the consumer demands X_1 units of X. Therefore, in the right-hand diagram, we plot P_X^1 against X_1. This is the first point on our demand curve.



▲ **FIGURE 6A.4 Deriving a Demand Curve from Indifference Curves and Budget Constraint**
Indifference curves are labeled i_1, i_2, and i_3; budget constraints are shown by the three diagonal lines from I/P_Y to I/P_X^1, I/P_X^2, and I/P_X^3. Lowering the price of X from P_X^1 to P_X^2 and then to P_X^3 swivels the budget constraint to the right. At each price, there is a different utility-maximizing combination of X and Y. Utility is maximized at point A on i_1, point B on i_2, and point C on i_3. Plotting the three prices against the quantities of X chosen results in a standard downward-sloping demand curve.

Now we lower the price of X to P_X^2. Lowering the price expands the opportunity set, and the budget constraint swivels to the right. Because the price of X has fallen, when our consumer spends all of the income on X, he or she can buy more of it. Our consumer is also better off because of being able to move to a higher indifference curve. The new utility-maximizing point is B, where the consumer demands X_2 units of X. Because the consumer demands X_2 units of X at a price of P_X^2, we plot P_X^2 against X_2 in the right-hand diagram. A second price cut to P_X^3 moves our consumer to point C, with a demand of X_3 units of X, and so on. Thus, we see how the demand curve can be derived from a consumer's preference map and budget constraint.

APPENDIX SUMMARY

1. An *indifference curve* is a set of points, each point representing a combination of goods X and Y, all of which yield the same total utility. A particular consumer's set of indifference curves is called a *preference map*.
2. The slope of an indifference curve is the ratio of the marginal utility of X to the marginal utility of Y, and it is negative.
3. As long as indifference curves are convex to the origin, utility maximization will take place at that point at which the indifference curve is just tangent to—that is, just touches—the budget constraint. The utility-maximizing rule can also be written as $MU_X/P_X = MU_Y/P_Y$.

APPENDIX REVIEW TERMS AND CONCEPTS

Indifference curve, *p. 138*
Marginal rate of substitution, *p. 138*
Preference map, *p. 139*

APPENDIX PROBLEMS

All problems are available on MyLab Economics.

APPENDIX 6A: INDIFFERENCE CURVES

LEARNING OBJECTIVE: Understand how to derive a demand curve from indifference curves and budget constraints.

1A.1 Which of the four assumptions made at the beginning of the Appendix are violated by the indifference curves in Figure 1? Explain.

1A.2 Assume that a household receives a weekly income of $100. If Figure 2 represents the choices of that household as the price of X changes, plot three points on the household demand curve.

1A.3 If Tony's marginal rate of substitution of X for Y is 12—that is, $MU_X/MU_Y = 12$—the price of X is $39, and the price of Y is $3, he is spending too much of his income on Y. Do you agree or disagree? Explain.

*1A.4 Assume that Jim is a rational consumer who consumes only two goods, apples (A) and nuts (N). Assume that his marginal rate of substitution of apples for nuts is given by the following formula:

$$MRS = MU_N/MU_A = A/N$$

That is, Jim's MRS is equal to the ratio of the number of apples consumed to the number of nuts consumed.

a. Assume that Jim's income is $100, the price of nuts is $5, and the price of apples is $10. What quantities of apples and nuts will he consume?
b. Find two additional points on his demand curve for nuts ($P_N = \$10$ and $P_N = \$2$).
c. Sketch one of the equilibrium points on an indifference curve graph.

FIGURE 1

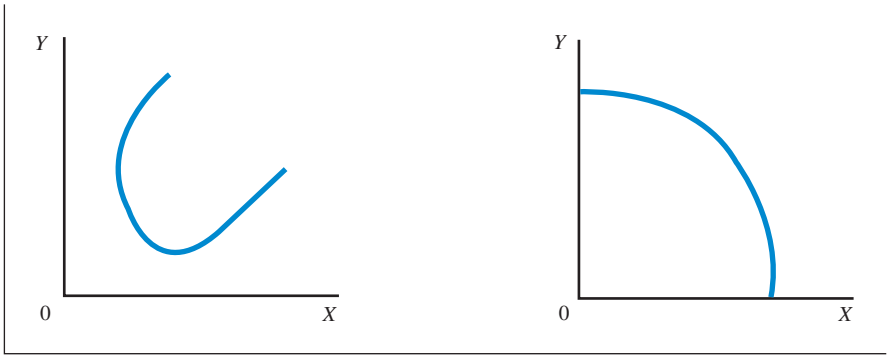
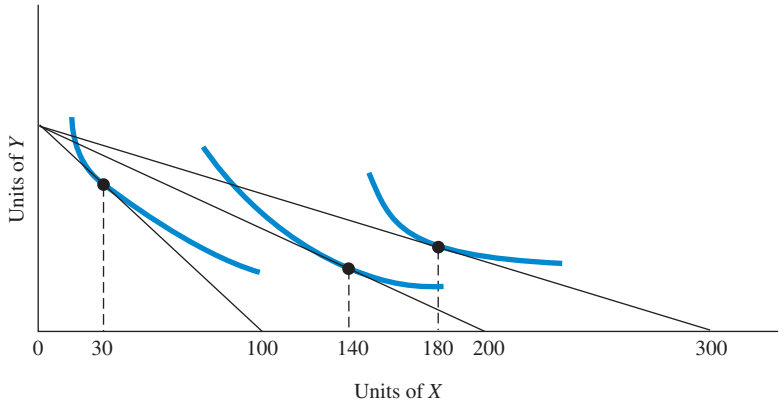


FIGURE 2



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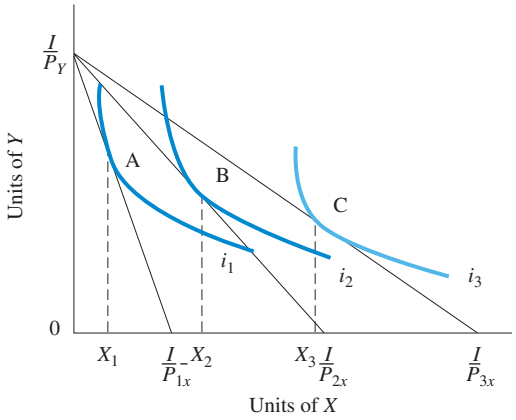
1A.5 Carmen has $84 to spend on California rolls and eel sashimi, and the data in the following table represents an indifference curve for these two products. If California rolls are $4.00 each and eel sashimi is $6.00 each, draw a graph showing Carmen's indifference curve and her budget constraint, putting California rolls on the vertical axis and eel sashimi on the horizontal axis. What combination of California rolls and eel sashimi will Carmen purchase? Will this combination maximize Carmen's total utility? Explain.

California Rolls	Eel Sashimi
16	5
10	8
6	10
2	18

1A.6 The following graph shows three indifference curves and the accompanying budget constraints for products *X* and *Y*. The graph represents the price of product *X* falling from P_{1x} to P_{2x} and then to P_{3x}. Explain how a demand curve for product *X* can be derived from this graph and draw a graph showing the demand curve for product *X*.



**Note:* Problems marked with an asterisk are more challenging.

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