

Theory of Consumer Behavior

Learning Objectives

After reading Chapter 5 and working the problems in this chapter of your Workbook, you should be able to:

- Explain the concept of utility and the basic assumptions underlying consumer preferences.
- Explain the equilibrium condition for an individual consumer to be maximizing utility subject to a budget constraint.
- Use indifference curves to derive a demand curve for an individual consumer.
- Identify the substitution, income, and total effects of a change in the price of a good.
- Explain why demand curves are downward sloping.
- Derive a market demand curve by horizontally summing individual demand curves.
- Explain why market demand can be interpreted as the marginal benefit curve for a good.

Essential Concepts

1. The basic consumer optimization problem facing each individual can be stated as follows: Individual consumption decisions are made with the goal of maximizing total satisfaction from consuming various goods and services, subject to the constraint that spending on goods exactly equals the individual's money income.
2. Basic consumer theory assumes that buyers are completely informed about all things that matter to consumers: the range of products available, the prices of all products, the capacity of products to satisfy, and their income.
3. Consumer theory requires that consumers be able to rank all consumption bundles according to the level of satisfaction they would receive from consuming the various bundles.
4. Consumer preference ranking must satisfy two properties: preferences must be complete and transitive. Preferences are complete when for every possible pair of consumption bundles, A and B , the consumer can say one of the following relations holds: A is preferred to B , B is preferred to A , or the consumer is indifferent between A and B . Preferences are transitive when they are consistent in the

following way: If bundle A is preferred to bundle B , and bundle B is preferred to bundle C , then bundle A *must* be preferred to bundle C .

5. While completeness and transitivity are absolutely necessary assumptions in consumer theory, it is convenient to add a third assumption (nonsatiation): more of a good is always preferred to less of a good.
6. The benefits consumers obtain from the goods and services they consume is called *utility*. A *utility function* shows an individual's perception of the level of utility that would be attained from consuming each conceivable bundle of goods.
7. Indifference curves provide a means of depicting graphically the preferences of a consumer. An *indifference curve* is a locus of points, representing different bundles of goods and services, each of which yields the same level of total utility or satisfaction.
8. Indifference curves are negatively sloped and convex. Therefore, if the consumption of one good is increased, consumption of the other must be reduced to maintain a constant level of utility. The *marginal rate of substitution (MRS)*—the absolute value of the slope of the indifference curve—diminishes as the consumer moves downward along an indifference curve, increasing X and decreasing Y .
9. An *indifference map* consists of several indifference curves. The higher (or further to the right) an indifference curve is on the map, the greater the level of utility associated with the curve.
10. *Marginal utility* is the addition to total utility that is attributable to the addition of one unit of a good to the current rate of consumption, holding constant the amounts of all other goods consumed ($MU = \Delta U / \Delta X$).
11. The marginal rate of substitution shows the rate at which one good can be substituted for another while keeping utility constant. It can be interpreted as the ratio of the marginal utility of X divided by the marginal utility of Y :

$$MRS \equiv -\frac{\Delta Y}{\Delta X} = \frac{MU_x}{MU_y}$$

where $-\Delta Y / \Delta X$ is the negative of the slope of the indifference curve.

12. The consumer's budget line shows all possible commodity bundles that can be purchased at given prices with a fixed amount of money income. The relation between money income (M) and the amount of goods X and Y purchased can be expressed as

$$M = P_x X + P_y Y$$

Alternatively, the equation for the budget line can be rewritten in the form of a straight line

$$Y = \frac{M}{P_y} - \frac{P_x}{P_y} X$$

The first term, M/P_y , gives the amount of Y the consumer can buy if no X is purchased. The term P_x/P_y is the absolute value of the slope of the budget line.

13. An increase (decrease) in money income causes a parallel outward (backward) shift in the budget line. An increase (decrease) in the price of X causes the budget line to pivot inward (outward) around the original vertical intercept.
14. A consumer maximizes utility subject to a limited money income at the combination of goods for which the indifference curve is just tangent to the budget line. At this combination, the marginal rate of substitution (the absolute value of the slope of the indifference curve) is equal to the price ratio (the absolute value of the slope of the budget line)

$$MRS = -\frac{\Delta Y}{\Delta X} = \frac{MU_x}{MU_y} = \frac{P_x}{P_y}$$

Thus a consumer allocates money income so that the marginal utility per dollar spent on each good is the same for all commodities purchased

$$\frac{MU_x}{P_x} = \frac{MU_y}{P_y}$$

and all income is spent.

15. The demand curve of an individual for a specific commodity relates utility-maximizing quantities purchased to market prices, holding constant money income and the prices of all other goods. The slope of the demand curve illustrates the law of demand: quantity demanded varies inversely with price.
16. When the price of a good changes, the total change in quantity demanded can be decomposed into two parts: (i) the substitution effect, and (ii) the income effect. The *substitution effect* is the change in consumption of a good after a change in its price, when the consumer is forced by a change in money income to consume at some point on the original indifference curve. Considering the substitution effect only, the amount of the good consumed must vary inversely with its price. The *income effect* of a price change is the change in the consumption of a good resulting strictly from the change in purchasing power. The total effect of a price change is equal to the sum of the substitution and income effects:

$$\text{Total effect of price change} = \text{Substitution effect} + \text{Income effect}$$

17. Considering the substitution effect alone, an increase (decrease) in the price of a good causes less (more) of the good to be demanded. For a normal good, the income effect adds to (or reinforces) the substitution effect. The income effect in the case of an inferior good offsets (or takes away from) the substitution effect.
18. *Market demand* is a list of prices and the quantities consumers are willing and able to purchase at each price in the list, other things being held constant. Market demand is derived by horizontally summing the demand curves for all the individuals in the market.
19. Because demand prices along market demand measure the economic value of each unit of the good, a market demand can be interpreted as the marginal benefit curve for a good.

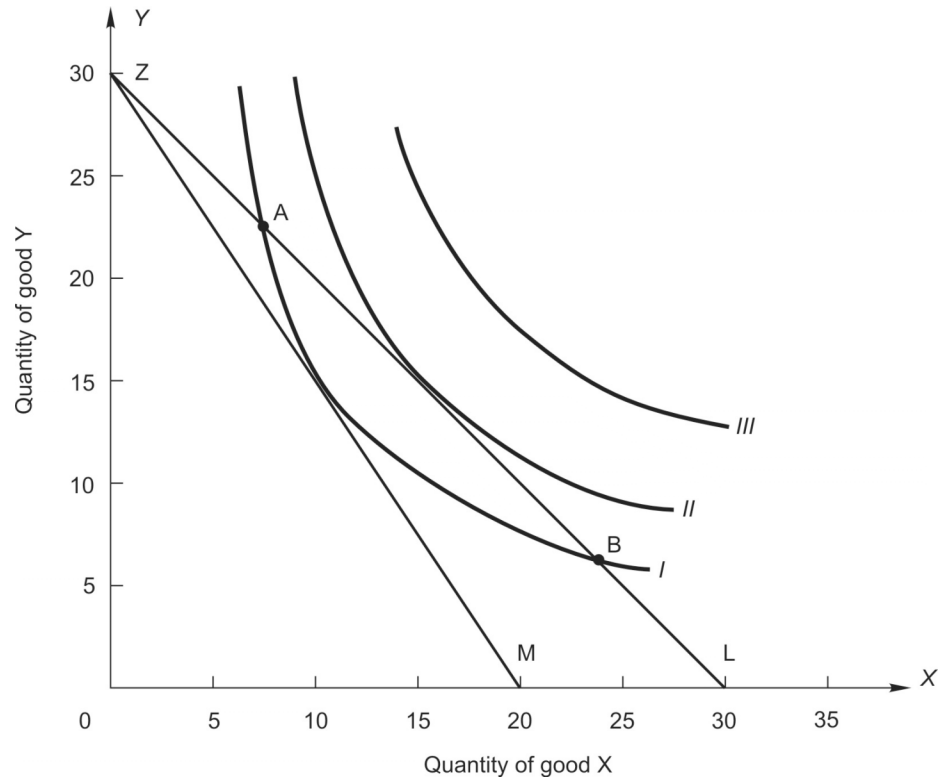
Matching Definitions

budget line	marginal utility
complete property of preferences	market demand
consumption bundle	substitution effect
Giffen good	total effect
income effect	transitive property of preferences
indifference curves	utility
marginal rate of substitution	utility function

1. _____ The satisfaction or benefit that consumers receive from consuming goods or services.
2. _____ A particular combination of specific quantities of goods or services.
3. _____ Consumers can rank all conceivable bundles of goods or services.
4. _____ If A is preferred to B , and B is preferred to C , then A is always preferred to C .
5. _____ Equation showing a consumer's perception of the total utility forthcoming from consuming each bundle of goods and services.
6. _____ A set of consumption bundles each and every one of which provides a consumer with exactly the same level of total utility.
7. _____ The number of units of Y that must be given up for total utility to remain the same when one more unit of X is consumed.
8. _____ The addition to total utility attributable to consuming one more unit of a good, holding the consumption of all other goods constant.
9. _____ Line showing all bundles of goods that can be purchased at given prices if the entire income is spent.
10. _____ The change in the consumption of a good that would result if the consumer remained on the original indifference curve after the price of the good changes.
11. _____ The change in consumption of a good resulting strictly from the change in purchasing power after the price of a good changes.
12. _____ The sum of the substitution and income effects.
13. _____ A good for which quantity demanded varies directly with price, causing an upward sloping demand curve.
14. _____ A list of prices and the corresponding quantity consumers are willing and able to purchase at each price.

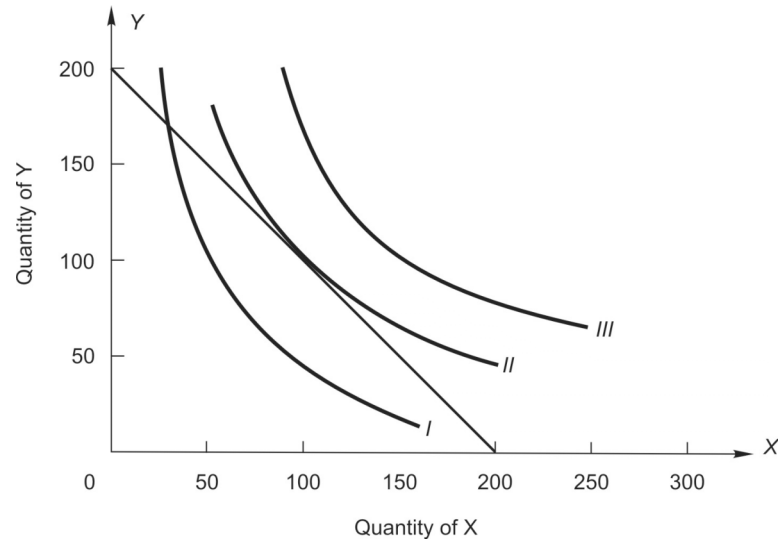
Study Problems

1. The following figure shows a portion of a consumer's indifference map. The consumer faces the budget line ZL , and the price of Y is \$20.

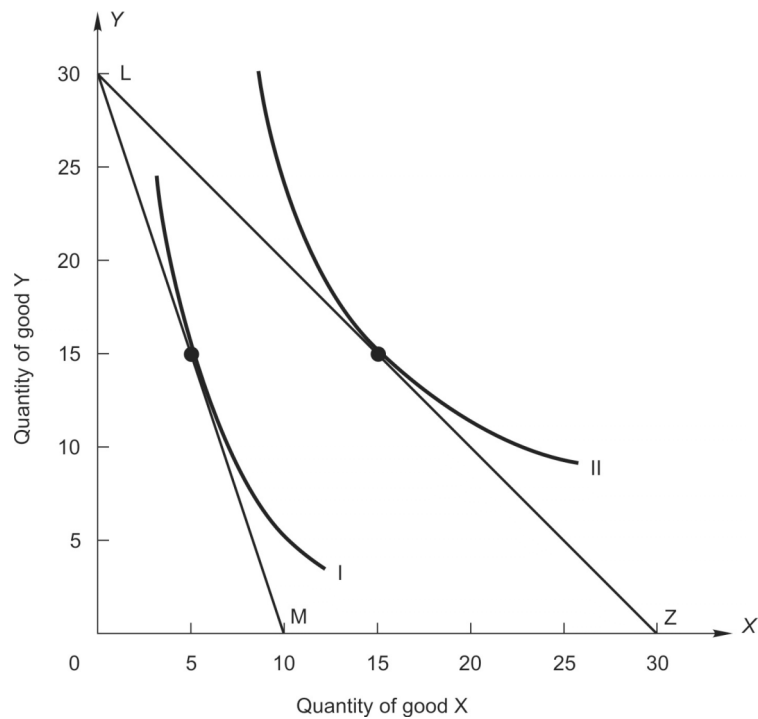


- The consumer's income = \$. The price of X is \$.
- The equation for the budget line ZL is $Y =$.
- What combination of X and Y would the consumer choose? Why?
- The marginal rate of substitution at the combination in part c is.
- Explain in terms of the MRS why the consumer would not choose either combination A or B .
- If the budget line pivots to ZM , the consumer chooses _____ units of good X and _____ units of good Y .
- Along budget line ZM , the price of X is \$ and the price of Y is \$.
- The new MRS is equal to.

2. The figure below shows a portion of a consumer's indifference map, and a budget line. The consumer's income is \$1,200 and the price of Y is \$6.



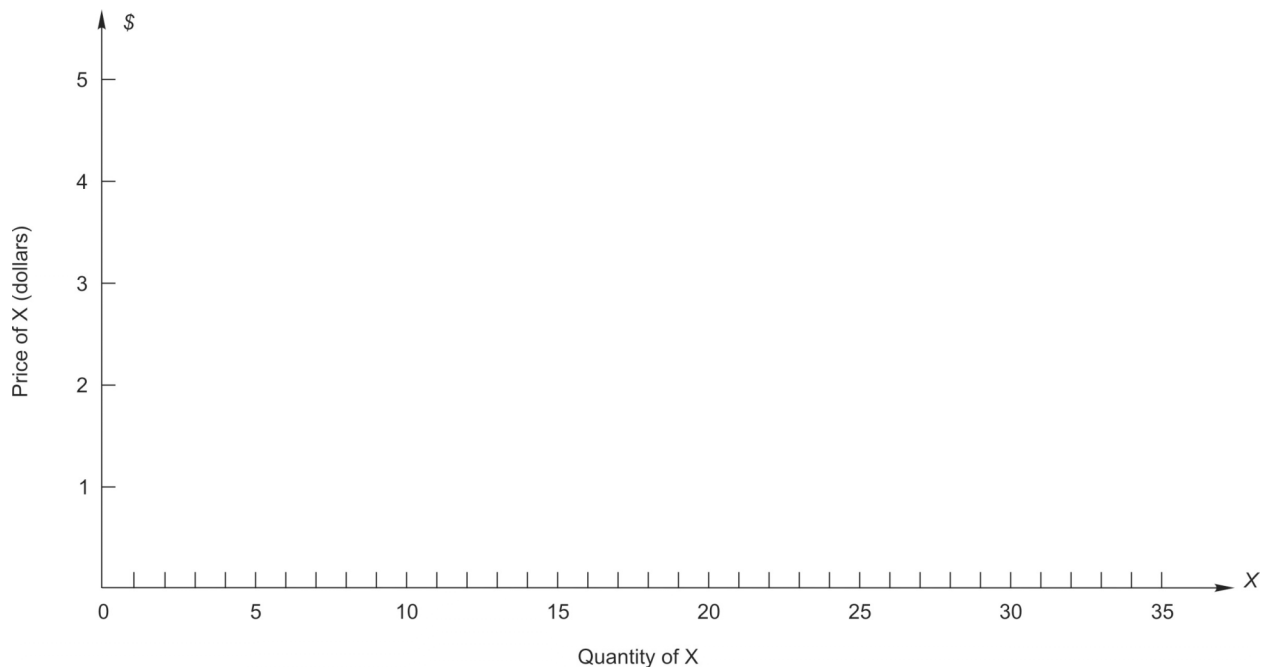
- Using the given budget line, what is one point on the consumer's demand for X ?
 - Pivot the budget line and derive two other points on the consumer's demand for X .
3. Using the consumer's indifference map shown in the figure below, derive the total, substitution, and income effects caused by a decrease in the price of X .



4. Suppose the marginal utility of the last unit of X consumed is 40, and the marginal utility of the last unit consumed of Y is 30. The prices of X and Y are \$4 and \$2, respectively. Should the consumer increase or decrease consumption of X ? Explain carefully.
5. Suppose there are four consumers in the market for good X . The quantities demanded by each of the four consumers at each price between \$1 and \$5 are shown in the table below:

Price of X	Quantity Demanded				Market Demand
	Consumer 1	Consumer 2	Consumer 3	Consumer 4	
\$1	5	12	8	3	_____
\$2	4	10	7	2	_____
\$3	3	8	6	1	_____
\$4	2	6	3	0	_____
\$5	1	4	1	0	_____

- a. Fill in the blanks in the table for the market quantity demanded at each price.
- b. Using the following graph, draw the demand curves for each of the four consumers. Label them D_1 , D_2 , D_3 , and D_4 .
- c. Construct the market demand curve in the graph and label it $D_{\text{market demand}}$.



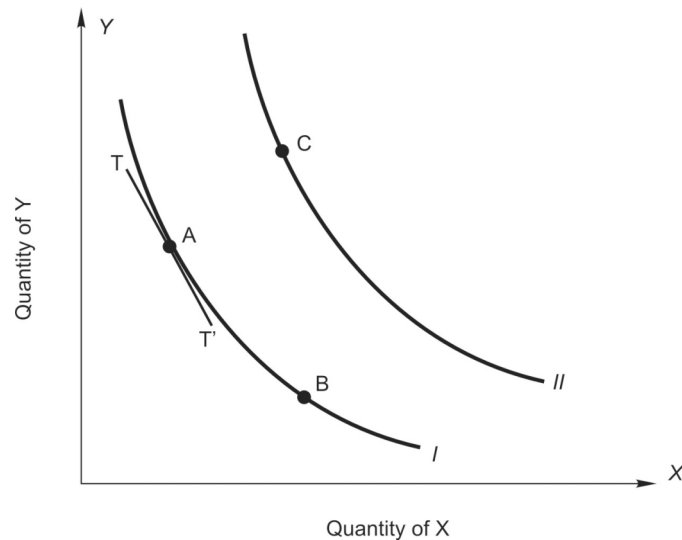
6. A consumer is indifferent between $6X$ and $4Y$ and $4X$ and $8Y$.
- The marginal rate of substitution between these points is equal to _____.
 - Over this range, the consumer is just willing to give up _____ units of Y to obtain another X .
 - Over this range, the consumer is just willing to give up _____ units of X to obtain another Y .
7. The following table shows the marginal utility for each of six units of X and Y . The price of X is \$4 and the price of Y is \$2.

Quantity	MU_X	MU_Y
1	20	14
2	16	12
3	12	8
4	10	6
5	8	5
6	6	4

- If the consumer's income is \$20, the consumer will purchase _____ units of good X and _____ units of good Y .
 - If the consumer's income is \$26, the consumer will purchase _____ units of good X and _____ units of good Y .
8. Fill in the blanks.
- How much of one good a consumer must give up in the market to obtain another unit of some other good is given by _____.
 - How much of one good a consumer is just willing to give up to obtain one more unit of another good is given by _____.

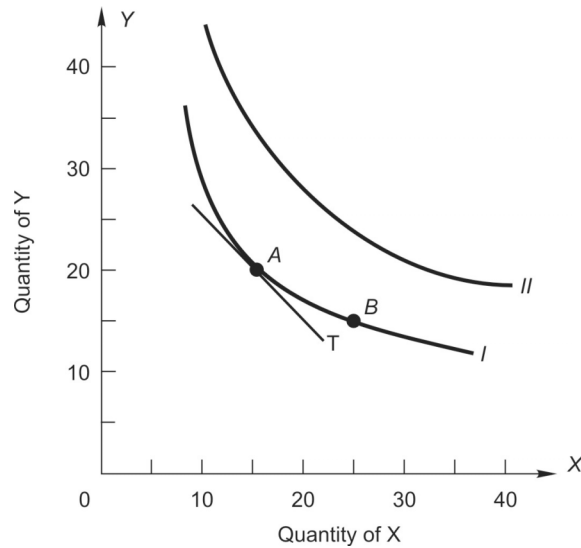
Multiple Choice / True-False

For questions 1 and 2 use the figure below that shows a consumer's indifference map.



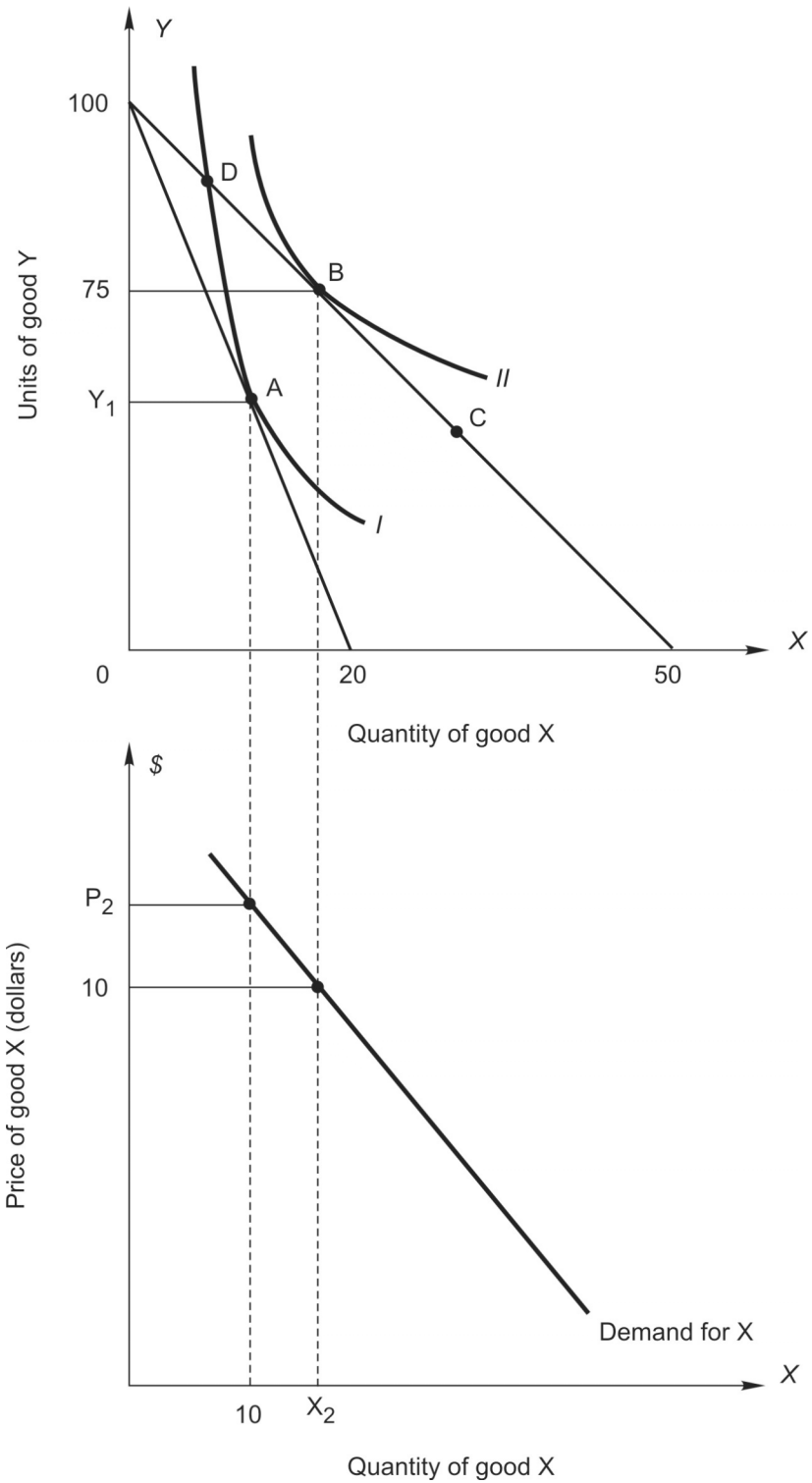
1. Which of the following statements is (are) true?
 - a. The consumer is indifferent between bundles *A* and *B*.
 - b. The consumer prefers bundle *B* to *C*.
 - c. Bundle *B* is less expensive than bundle *A*.
 - d. both *a* and *c*.
 - e. both *a* and *b*.
2. The marginal rate of substitution at point *A*
 - a. is equal to the absolute value of the slope of the tangent line *TT'*.
 - b. is smaller than the *MRS* at point *B*.
 - c. measures the increase in total satisfaction from consuming one more unit of *X* and one less unit of *Y*.
 - d. is equal to the *MRS* at point *B*.
3. Which of the following is NOT one of the assumptions for the theory of consumer behavior?
 - a. Consumers have complete knowledge regarding their money income, the prices of all goods and services, and the capacity of each good to satisfy the consumer.
 - b. More of a good is preferred to less of a good.
 - c. Consumers can rank order all bundles of goods.
 - d. Indifference curves are concave.

Use the following figure to answer Questions 4 – 7. This figure shows two indifference curves for a consumer.



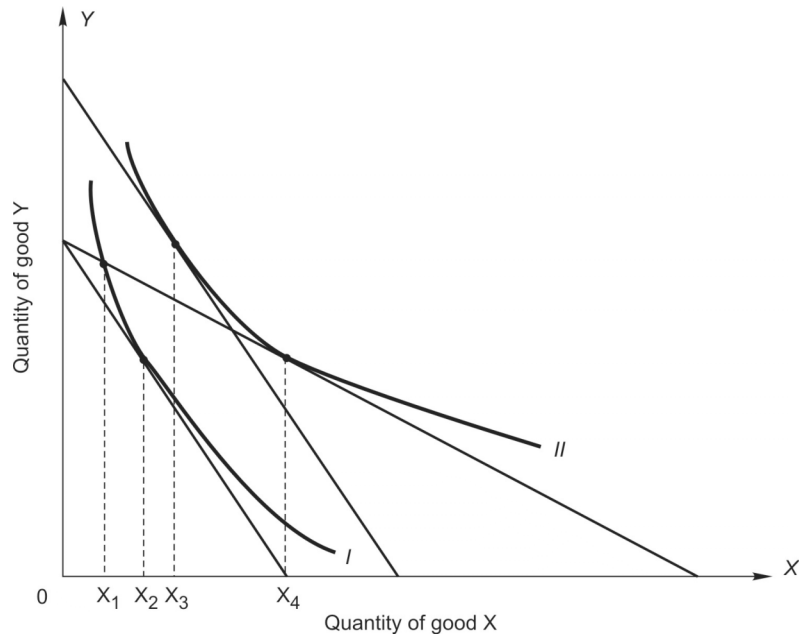
4. The marginal rate of substitution at point *A* is _____.
 - a. 1
 - b. 2
 - c. 3
 - d. 4
 - e. 5
5. The marginal rate of substitution between points *A* and *B* is _____.
 - a. 1
 - b. 2
 - c. $1/2$
 - d. $2/3$
 - e. $3/2$
6. If the consumer moves from *B* to *A*, that consumer is willing to give up *X* for *Y* at the rate _____ *X* for _____ *Y*.
 - a. 1; 1
 - b. $1/2$; 1
 - c. 3; 2
 - d. 2; 1
 - e. 1; 2
7. If utility-maximizing equilibrium is at point *A*, what could make the consumer move to a point on curve *II*?
 - a. The price of *Y* falls.
 - b. The price of *X* falls.
 - c. Income rises.
 - d. All of the above.
 - e. None of the above.

Use the following figure to answer questions 8 – 13. The consumer's income is \$500.



8. The price of Y is _____.
a. \$1
b. \$2
c. \$4
d. \$5
e. \$10
9. The value of P_2 is _____.
a. \$1
b. \$5
c. \$10
d. \$20
e. \$25
10. The value of X_2 is _____.
a. 5
b. 10
c. 12.5
d. 15
e. 20
11. The value of Y_I is _____.
a. 5
b. 10
c. 15
d. 20
e. 50
12. Commodity bundle C costs _____.
a. \$100.
b. \$250.
c. \$500.
d. \$750.
e. none of the above
13. At point D , _____.
a. $MRS < 2$
b. $MRS > 5$
c. $MU_x < MU_y$
d. $P_x < P_y$
e. $MU_x/MU_y < P_x/P_y$

Use the following figure to answer questions 14 – 17. In the figure, assume the price of X increases.



14. The substitution effect is the movement from
 - a. X_3 to X_2 .
 - b. X_2 to X_1 .
 - c. X_1 to X_2 .
 - d. X_3 to X_1 .
 - e. X_4 to X_3 .
15. The income effect is the movement from
 - a. X_3 to X_2 .
 - b. X_2 to X_1 .
 - c. X_1 to X_2 .
 - d. X_3 to X_1 .
 - e. X_4 to X_3 .
16. Good X is
 - a. normal.
 - b. inferior.
 - c. a Giffen good.
 - d. both b and c .
17. The total effect is the movement from
 - a. X_3 to X_2 .
 - b. X_4 to X_1 .
 - c. X_3 to X_1 .
 - d. X_4 to X_2 .
 - e. X_2 to X_4 .

Assume that an individual consumes two goods, X and Y . The total utility (assumed measurable) of each good is independent of the rate of consumption of other goods. The prices of X and Y are respectively \$2 and \$3. Use the following table of total utilities to answer questions 18 – 20.

<i>Units of Good</i>	<i>Total Utility of X</i>	<i>Total Utility of Y</i>
1	20	45
2	38	78
3	54	108
4	68	135
5	80	159
6	90	180

18. If the consumer buys the fourth unit of X ,
 - a. the marginal utility of the fourth unit is 14 units of satisfaction.
 - b. the marginal utility per dollar spent on X is 7.
 - c. the marginal utility of the fourth unit is 10 units of satisfaction.
 - d. the marginal utility per dollar spent on X is 14.
 - e. both a and b .
19. If the consumer has \$26 to spend on X and Y , the utility maximizing bundle (given the budget constraint) is
 - a. $7X$ and $7Y$.
 - b. $4X$ and $6Y$.
 - c. $6X$ and $4.67Y$.
 - d. $6X$ and $4Y$.
 - e. $2X$ and $4Y$.
20. If the consumer has \$16 to spend on X and Y , which combination will the consumer choose?
 - a. $5X$ and $2Y$
 - b. $2X$ and $1Y$
 - c. $2X$ and $3Y$
 - d. $2X$ and $4Y$
 - e. The consumer is indifferent between a and d .

Use the following information to answer questions 21 – 23. A consumer with an income of \$240 is spending it all on 12 units of good X and 18 units of good Y . The price of X is \$5 and the price of Y is \$10. The marginal utility of the last X is 20 and the marginal utility of the last Y is 30.

21. What should the consumer do?
 - a. Nothing, this is the utility maximizing choice.
 - b. Buy more Y and less X because MU_y is higher than MU_x .
 - c. Buy more Y and less X because the marginal utility per dollar of Y is higher.
 - d. Buy more X and less Y because the price of X is lower.
 - e. Buy more X and less Y because the marginal utility per dollar of X is higher.
22. If the consumer buys one less Y this person can, spending the same income,
 - a. increase total utility by 40 with two more units of X .
 - b. buy two more X but lose 10 units of utility.
 - c. buy two more X and increase utility by 10.
 - d. buy one more X and reduce utility by 10.
 - e. none of the above.
23. When the consumer attains equilibrium,
 - a. MU_x will be lower than 20.
 - b. MU_y will be higher than 30.
 - c. MU_y will be double MU_x .
 - d. All of the above.
 - e. None of the above.
24. T F Demand curves are downward sloping because the income effect always reinforces the substitution effect.
25. T F In utility-maximizing equilibrium it must be the case that the marginal rate of substitution equals the ratio of the prices of the two goods and the marginal utilities per dollar of each of the goods are equal.
26. T F A consumer maximizes utility from a given income by choosing the combination of goods so the marginal utilities are equal.
27. T F Market demand is the horizontal sum of the demands of all consumers in the market.
28. T F An indifference curve shows all combinations of two goods that can be purchased from a given income.
29. T F A consumer in equilibrium can reach a higher indifference curve if and only if income increases.
30. T F A budget line gives the amount of one good that can be purchased at each amount of the other good with a given income and prices.

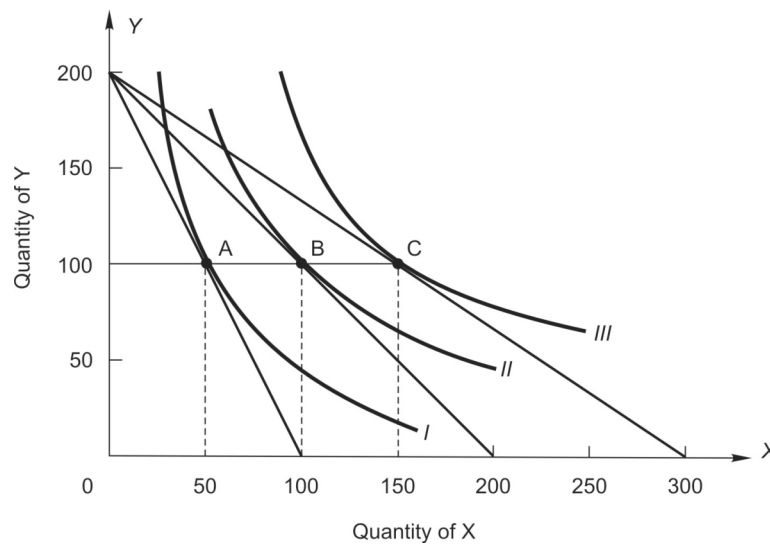
Answers

MATCHING DEFINITIONS

1. utility
2. consumption bundle
3. complete property of preferences
4. transitive property of preferences
5. utility function
6. indifference curves
7. marginal rate of substitution
8. marginal utility
9. budget line
10. substitution effect
11. income effect
12. total effect
13. Giffen good
14. market demand

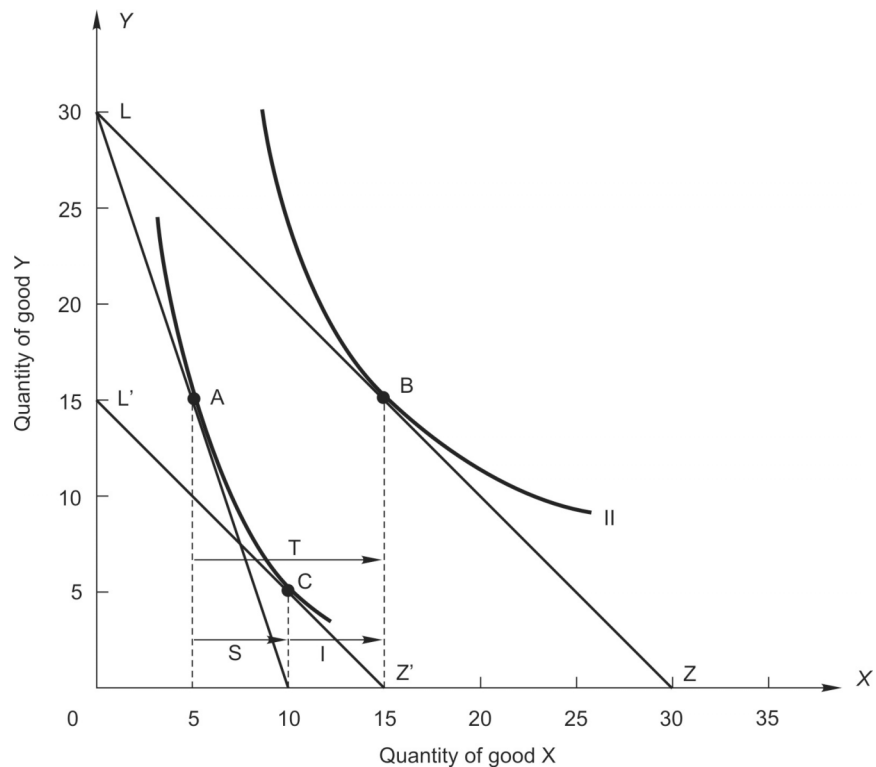
STUDY PROBLEMS

1.
 - a. \$600; \$20
 - b. $30 - 1.0X$
 - c. The consumer chooses $15X$ and $15Y$. This combination lies on the highest indifference curve that can be attained with budget line ZL .
 - d. $MRS = 1(P_x/P_y = \$20/\$20)$
 - e. At A , $MRS > P_x/P_y$ and at B , $MRS < P_x/P_y$. Therefore, at $A(B)$ the consumer is willing to give up more $Y(X)$ in order to get more $X(Y)$ than the amount that must be given up in the market.
 - f. $10X$ and $15Y$
 - g. $P_x = \$30$, $P_y = \$20$
 - h. $MRS = 30/20 = 1.5$
2.
 - a. $P_x = \$1,200/200 = \6 and $X = 100$
 - b. The graph below shows the derivation of the other two combinations.

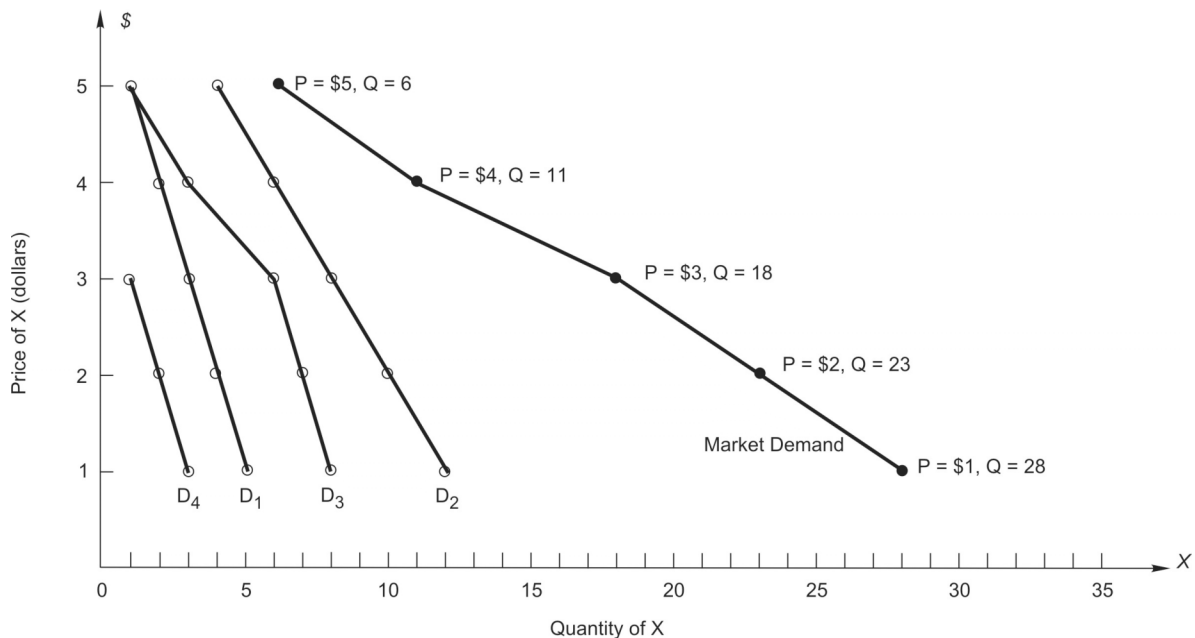


At A , $P_x = \$1,200/100 = \12 and $X = 50$. At B , $P_x = \$1,200/200 = \6 and $X = 100$ as above. At C , $P_x = \$1,200/300 = \4 and $X = 150$.

3. The figure below illustrates how to isolate the substitution and income effects for a decrease in the price of X , shown by the outward rotation from LM to LZ . First isolate the substitution effect by laying a ruler (or any straight-edge) along the new budget line LZ . Now move your ruler carefully backwards and parallel to LZ until it is just tangent to the original indifference curve I at Point C . The change in X caused by moving along the original indifference curve (point A to point C) is $+5$ units because $X = 5$ at point A and $X = 10$ at point C . [Note: You get the values of X by “eye-balling” their locations on the graph. No formulas are used in this problem.] The income effect is the change in X when the hypothetically removed income is restored, and the budget line shifts rightward to LZ . The movement from bundle C to bundle B causes consumption of X to change by $+5$ units (from 10 to 15 units). Again the values of X are found by visual inspection, not mathematical formulas. The total effect is $+10$ because consumption of X increases from 5 to 15 units as a result of the decrease in the price of X .



4. Since $MU_x/P_x = 40/4 = 10 < 15 = 30/2 = MU_y/P_y$, the consumer should spend more on Y and less on X . The reduction in utility from spending one less dollar on X (10 units of utility) is less than the increase in utility from spending one more dollar on Y (15 units of utility).
5. The following figure shows the individual demand curves for the four consumers and the market demand curve (the horizontal sum of the four individual curves).



6.
 - a. $MRS = -\Delta Y / \Delta X = 4/2 = 2$
 - b. 2 units of Y
 - c. $1/2$ unit of X
7.
 - a. $X = 3$ where $MU_x / P_x = 12/4 = 3$ and $Y = 4$ where $MU_y / P_y = 6/2 = 3$. $\$4 \times 3 + \$2 \times 4 = \$20$
 - b. $X = 4$ where $MU_x / P_x = 10/4 = 2.5$ and $Y = 5$ where $MU_y / P_y = 5/2 = 2.5$. $\$4 \times 4 + \$2 \times 5 = \$26$
8.
 - a. The slope of the budget line: P_x / P_y
 - b. The slope of the indifference curve: the MRS

MULTIPLE CHOICE / TRUE-FALSE

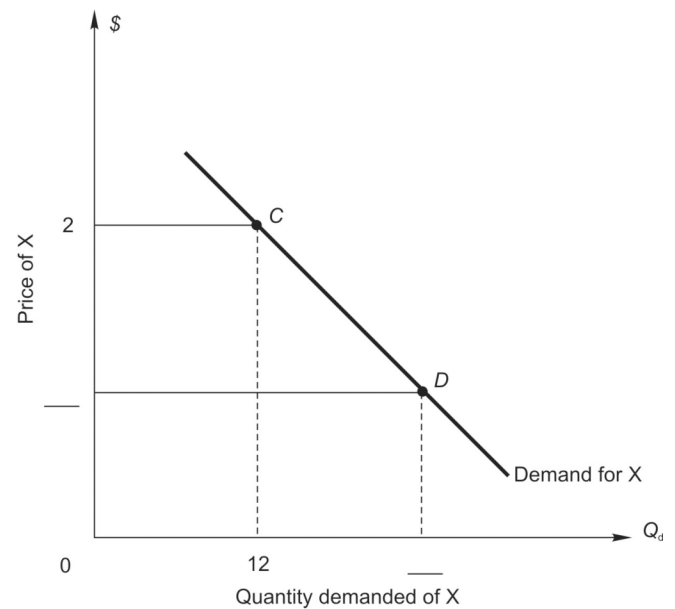
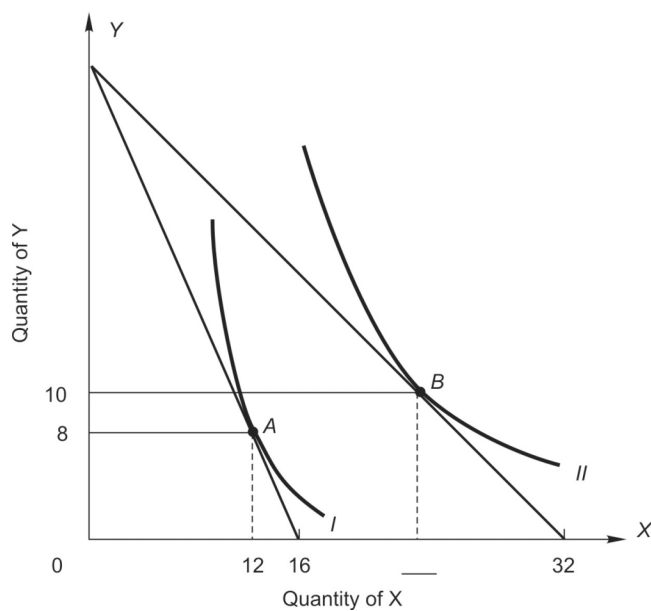
1.
 - a. Bundles A and B lie on the same indifference curve. Note that you cannot tell from the graph which bundle costs more, and they may even cost the same if they both lie on the same budget line.
2.
 - a. $MRS = \text{slope of indifference curve} = \text{slope of tangent line}$
3.
 - d. Indifference curves are assumed to be convex.
4.
 - a. Extend tangent T to both axes. The slope is $35/35 = 1$
5.
 - c. $MRS = -\Delta Y / \Delta X = 5/10 = 1/2$
6.
 - d. Since $-\Delta Y / \Delta X = 1/2$, $-\Delta X / \Delta Y = 2$
7.
 - d. Each change would move the budget line outward.
8.
 - d. Since the Y -intercept is 100, 100 units of Y (and zero units of X) can be purchased

with an income of \$500. Thus, the price of Y must be \$5.

9. e Since the slope at point A is $5(= Y/X = 100/20)$ and since the slope of the budget line equals P_x/P_y , it follows that $P_x/5 = 5$. Therefore, P_x must equal \$25.
10. c At point B , \$375 is being spent on Y ($\$5 \times 75$). Since income is equal to \$500, \$125 ($= \$500 - \375) is being spent on X . The price of X along the budget line passing through point B is \$10. If the consumer spends \$125 on X at a price of \$10/unit of X , then 12.5 units of X are purchased.
11. e At point A , \$250 ($= \25×10) is being spent on X leaving \$250 to spend on Y . Since $P_y = \$5$, Y_1 must be 50.
12. c Bundle C costs the same as bundle B because they are on the same budget line.
13. b Since $MRS = 5$ at point A , and since MRS diminishes along an indifference curve, $MRS > 5$ at point D .
14. e The increase in P_x causes consumption of X to decrease from X_4 to X_3 along the original indifference curve.
15. a Taking away the hypothetical income that was given to the consumer to isolate the substitution effect causes the budget line to shift parallel backwards. Consumption of X decreases from X_3 to X_2 .
16. a Good X is normal because the income and substitution effects move in the same direction.
17. d From indifference curve II to I .
18. e $TU_3 = 54$ and $TU_4 = 68 \Rightarrow MU_4 = 14$ units of satisfaction. The marginal utility per dollar spent on X is $7(= MU_x/P_x = 14/2)$.
19. b At $4X$ and $6Y$, $MU_x/P_x = MU_y/P_y = 7$ and all \$26 dollars are spent.
20. d At $2X$ and $4Y$, $MU_x/P_x = MU_y/P_y = 9$ and all \$16 dollars are spent.
21. e $MU_x/P_x = 4 > MU_y/P_y = 3$
22. c Utility falls by 30 with one less Y but rises by 40 with two more X at \$5 each.
23. d In equilibrium, $MU_x/5 = MU_y/10$.
24. F Income effect can work in the opposite direction of substitution effect.
25. T One condition implies the other.
26. F The marginal utilities per dollar are equal.
27. T This is the definition of market demand.
28. F This is the definition of a budget line.
29. F A consumer can also reach higher indifference curve if the price of one or both goods falls.
30. T A budget line is $Y = M/P_y - (P_x/P_y)X$.

Homework Exercises

1. Use the information given in the figure below to answer the following questions.
 - a. The consumer's income is \$_____.
 - b. The price of Y is \$_____.
 - c. When the price of X is \$2, the marginal rate of substitution is _____.
 - d. The equation of the budget line passing through point A is $Y =$ _____.
 - e. At point D on the demand curve for X , the price of X is \$_____.
 - f. At point D on the demand curve for X , the quantity demanded is _____.
 - g. At point B on the indifference curve II , the MRS is _____.
 - h. At point B , the consumer's budget is \$_____.



2. Assume that an individual consumes two goods, X and Y . The total utility (assumed measurable) of each good is independent of the rate of consumption of other good. The price of X and Y are respectively \$40 and \$60. Use the following table of total utilities to answer the following questions.

<i>Units of Good</i>	<i>Total Utility of X</i>	<i>Total Utility of Y</i>
1	20	45
2	38	78
3	54	108
4	68	135
5	80	159
6	90	180

- The marginal utility of the fifth unit of Y is _____.
- The marginal utility of the sixth unit of X is _____.
- The marginal utility per dollar spent on the fourth unit of X is _____.
- The marginal utility per dollar spent on the third unit of Y is _____.
- If the consumer has \$420 to spend, _____ unit of X and _____ units of Y maximize utility subject to the budget constraint.
- If the consumer has \$220 to spend, _____ units of X and _____ units of Y maximize utility subject to the budget constraint.