

# Elasticity: The Responsiveness of Demand and Supply

## Chapter Summary

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**Elasticity** measures how much one variable responds to changes in another variable. The **price elasticity of demand** measures the responsiveness of the quantity demanded of a good or service to changes in its price. Price elasticity of demand is calculated by dividing the percentage change in quantity demanded by the percentage change in the product's price. Demand can be either elastic, inelastic, or unit elastic.

Demand curves slope downward. That means any increase in price (a positive change) will cause a decrease in quantity demanded (a negative change). Dividing a negative number by a positive number always equals a negative number. Price elasticity of demand is always negative. Because all economists know this, they often don't bother writing the minus sign. If you ever encounter a price elasticity of demand that is positive, the first thing you should do is write a minus sign in front of the number. When we say that one price elasticity is "larger" than another, we mean larger in absolute value (that, is, when the negative value is turned into a positive value).

There are five main determinants of the price elasticity of demand for a good:

1. *Availability of close substitutes*: The more substitutes for a good, the larger the price elasticity of demand.
2. *The passage of time*: Demand becomes more elastic as more time passes.
3. *Luxuries versus necessities*: The demand curve for a luxury is more elastic than the demand curve for a necessity.
4. *The definition of the market*: A narrowly defined good will have a more elastic demand than a broadly defined good. For example, the demand for one brand of toothpaste is more elastic than the demand for toothpaste as a product.
5. *Share of the good in the consumer's budget*: The larger the share of the good in the consumer's budget, the more elastic the demand for that good will be.

Business owners should be aware of the price elasticity of demand for their product because of the effect of elasticity on the company's total revenue. **Total revenue** equals price per unit multiplied by the number of units sold. If demand is elastic, then when price increases, total revenue decreases, and when price decreases, total revenue increases. (Price and total revenue move in opposite directions.) If demand is inelastic, an increase in price will increase total revenue and a decrease in price will decrease total revenue. (Price and total revenue move in the same direction.)

There are two other measures of demand elasticity economists often use. The **cross-price elasticity of demand** equals the percentage change in the quantity demanded of one good divided by the percentage change in price of a related good. The sign of the cross-price elasticity is positive for two substitute goods

and negative for two complements. The **income elasticity of demand** equals the percentage change in the quantity demanded for a good or service divided by the percentage change in income. The sign of the income elasticity will be positive for a normal good and negative for an inferior good.

The **price elasticity of supply** equals the percentage change in quantity supplied divided by the percentage change in price. The price elasticity of supply will always be a positive number (or will equal zero if supply is perfectly inelastic).

## Learning Objectives

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When you finish this chapter, you should be able to:

1. **Define the price elasticity of demand and understand how to measure it.** The price elasticity of demand for a good is equal to the percentage change in quantity demanded divided by the percentage change in price. Economists use percentage changes when measuring the response of quantity demanded to a change in the price of a good because percentage changes are not dependent on units of measurement. Demand is elastic when the percentage change in quantity demanded is greater than the percentage change in price, so the price elasticity of demand is greater than 1 in absolute value. Demand is inelastic when the percentage change in quantity demanded is less than the percentage change in price, so the price elasticity is less than 1 in absolute value. Demand is unit-elastic when the percentage change in quantity demanded is equal to the percentage change in price, so the price elasticity is equal to 1 in absolute value.
2. **Understand the determinants of the price elasticity of demand.** The key determinants of the price elasticity of demand for a good are the availability of close substitutes for the good, the passage of time, whether the good is a necessity or a luxury, the definition of the market for the good, and the share of good in the consumer's budget.
3. **Understand the relationship between the price elasticity of demand and total revenue.** Knowledge of the price elasticity of demand is important because it allows a firm to predict how a change in the price of a good it sells will affect its total revenue. An increase in price will decrease total revenue if demand is elastic but will increase total revenue if demand is inelastic. A decrease in price will increase total revenue if demand is elastic but will decrease total revenue if demand is inelastic.
4. **Define the cross-price elasticity of demand and the income elasticity of demand, and understand their determinants and how they are measured.** The cross-price elasticity of demand measures the percentage change in the quantity demanded of one good divided by the percentage change in the price of another good. The cross price elasticity will be positive for two products that are substitutes and will be negative for two products that are complements. The income elasticity of demand measures the percentage change in the quantity demanded of a product divided by a percentage change in income. A normal good will have a positive income elasticity, while an inferior good will have a negative income elasticity.
5. **Use price elasticity and income elasticity to analyze economic issues.** Knowledge of income elasticity values can be used to predict changes in the demand for products during expansions and recessions. The price elasticity and income elasticity for agricultural products explains why the number of farms and farmers have declined over time. Price and income elasticities are used to analyze the responses of consumers to changes in prices of alcoholic beverages, cigarettes, and illegal drugs.

6. **Define the price elasticity of supply and understand its main determinants and how it is measured.** The price elasticity of supply measures the responsiveness of firms to changes in the prices of the products they sell. This elasticity is measured by dividing the percentage change in the quantity supplied by the percentage change in the price of a product. The elasticity of supply is affected by the ease or difficulty firms have in altering the use of resources used in production. In general, supply curves will be more elastic the longer the period firms have to respond to price changes.

## Chapter Review

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### Chapter Opener: Do People Care about the Prices of Books? (pages 172-173)

The book publishing industry, formerly dominated by relatively small firms owned and run by the families that founded them, has changed to an industry with firms that have become part of multinational corporations. Publishers have to be careful about how many copies of a book they publish because they give bookstores the right to return unsold books, which is not the case in most other businesses. Barnes & Noble, for example, can return unsold copies of Harry Potter to its publisher, Scholastic. The book publishing industry demonstrates the importance to firms of taking into account the price elasticity of demand when setting price. Choosing the best price for a book can make the difference between making a profit or suffering a loss.

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#### Helpful Study Hint

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At the end of this chapter, *An Inside Look*, “Borders Slashes Buyers Rewards, Cuts Discounts,” analyzes changes in the Borders Rewards Program for its repeat buyers. The previous discount system applied to the Christmas buying season and did not seem to increase sales. The new system is designed to provide frequent purchasers with discounts throughout the year in hopes that this will increase Borders’ sales. The total revenue for Borders will increase if the price elasticity of demand for their books is high enough in absolute value.

*Economics in YOUR Life!* asks how sensitive you are to price when purchasing a book and if Barnes & Noble’s discounting of *Harry Potter and the Deathly Hallows* will help them sell a lot of books. Keep these questions in mind as you read the chapter. The authors will answer these questions at the end of the chapter.

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#### 6.1 LEARNING OBJECTIVE

### 6.1 The Price Elasticity of Demand and Its Measurement (pages 174-180)

**Learning Objective 1** Define the price elasticity of demand and understand how to calculate measure it.

The **price elasticity of demand** is the responsiveness of the quantity demanded to a change in price, measured by dividing the percentage change in the quantity demanded of a product by the percentage change in the product’s price. All elasticity formulas are stated as ratios of two percentage change values. Because of the law of demand, the sign of the price elasticity of demand is always negative. When

economists refer to one elasticity being “larger” than another, they mean larger in absolute value (with the negative value turned into a positive value). So, for example, an elasticity of  $-3$  is larger than an elasticity of  $-2$ .

**Elastic demand** means the percentage change in quantity demanded is greater than the percentage change in price, so price elasticity is greater than 1 in absolute value. **Inelastic demand** means the percentage change in quantity demanded is less than the percentage change in price, so price elasticity is less than 1 in absolute value. **Unit-elastic demand** means the percentage change in quantity demanded is equal to the percentage change in price, so price elasticity is equal to 1 in absolute value.

Because the value of the price elasticity of demand is different for each price and quantity combination, the *mid-point formula* is used to calculate elasticity values. In this formula, the change in quantity that results from a price change,  $(Q_2 - Q_1)$  or  $\Delta Q$ , is divided by the average of the quantities  $(Q_2 + Q_1)/2$  to calculate the percentage change in quantity demanded. The percentage change in price is calculated by dividing the change in price,  $(P_2 - P_1)$  or  $\Delta P$ , by the average of these prices  $(P_2 + P_1)/2$ . The elasticity values obtained with the mid-point formula are the same for either a price increase or price decrease between  $P_2$  and  $P_1$ .

There are two extreme cases of elasticity. A **perfectly inelastic demand curve** is vertical. If price elasticity of demand is zero, a change in price will not cause quantity demanded to change. A **perfectly elastic demand curve** is horizontal. If price elasticity of demand is very large (approaching infinity), even the smallest change in price will cause a very large change in quantity demanded (also approaching infinity).



### Helpful Study Hint

Your understanding of elasticity may be increased by rewriting the formula given in the textbook as:

$$E(\text{lasticity}) = \frac{\frac{\Delta Q}{Q_1 + Q_2}}{\frac{\Delta P}{P_1 + P_2}} = \frac{\Delta Q}{\Delta P} \times \frac{P_1 + P_2}{Q_1 + Q_2}$$

Because the slope of a linear, or straight line, demand curve is constant and can be written  $\Delta P/\Delta Q$ , the elasticity formula can be written as:

$$E = (1/\text{slope}) \times \frac{P_1 + P_2}{Q_1 + Q_2}$$

This formula illustrates several important points: (1) Elasticity is not equal to the slope of a linear demand curve. (2) Although a linear demand curve has a constant slope, the elasticity will be different for every segment of the demand curve. (3) Because relatively high values for price are associated with relatively low values for quantity demanded (and vice versa) the absolute values for elasticity will be high at high prices (demand is elastic) and relatively low at low prices (demand is

inelastic). This can be shown by substituting price and quantity values for a given demand curve into the rewritten formula and observing the change in the ratio of  $(P_2 + P_1)$  to  $(Q_2 + Q_1)$ .

**Solved Problem 6-1** in the textbook gives you an opportunity to practice calculating the price elasticity of demand using an example of a Harry Potter book. If the price elasticity of demand is greater than 1 in absolute value, then demand is price elastic. If the price elasticity of demand is less than 1 in absolute value, then demand is price inelastic.

**Don't Let This Happen to YOU!** “Don't Confuse Inelastic with Perfectly Inelastic” reminds you that a demand curve that is perfectly inelastic is different from a demand curve that is inelastic. If the price of the good decreases, the quantity demanded would increase a relatively small amount (compared to the change in price) if demand is inelastic, but the quantity demanded would not change at all if the demand is perfectly inelastic.

## 6.2 LEARNING OBJECTIVE

### 6.2 The Determinants of the Price Elasticity of Demand (pages 180-182)

**Learning Objective 2** Understand the determinants of the price elasticity of demand.

There are five key determinants of the price elasticity of demand: (1) The availability of close substitutes, (2) the passage of time, (3) whether the product is a necessity or luxury, (4) the definition of the market, and (5) the share of the consumer's budget accounted for by purchases of the product.

The availability of close substitutes is the most important determinant of price elasticity of demand. In general, the price elasticity of demand for a product will be more elastic the more substitutes there are for the product or the closer the substitutes are to the product. Time is an important factor because consumers do not adjust their buying habits immediately following a price change. The more time that passes, the more elastic the demand for a product becomes. The demand for a luxury is more elastic than the demand for a necessity. The more narrowly the market for a product is defined, the more elastic the demand will be. The larger portion of a consumer's budget that a good accounts for, the more elastic the demand for a good is.

#### Helpful Study Hint

It is useful to emphasize two important points. First, each of the five determinants should be considered separately from the others. A product that consumes a small part of a consumer's budget (this suggests demand would be relatively inelastic) may have several good substitutes (this suggests demand would be relatively elastic). Second, changes in the market price of any product will result in different values for price elasticity because each point on a demand curve will have a different price elasticity. Estimates of the price elasticity of demand, such as those cited in the text for breakfast cereals, utilize market prices for products at a particular time. Different market prices will usually result in different elasticity estimates.

***Making the Connection*** “The Price Elasticity of Demand for Breakfast Cereal” shows how the definition of the market affects the price elasticity of demand for the good. Post Raisin Bran is a very narrowly defined good and has an estimated price elasticity of demand of  $-2.5$ ; which means it is very elastic. All family breakfast cereals are part of a more broadly defined market and have a less elastic demand. The market for all breakfast cereals is price inelastic and is the broadest of the markets for breakfast cereals discussed in the article.

## Extra Solved Problem 6-2

Chapter 6 of the textbook includes three Solved Problems. Here is an extra Solved Problem to help you build your skills solving economic problems.

Supports Learning Objective 2: Understand the determinants of the price elasticity of demand.

### *Hailing a Cab in the Big Apple*

In New York City, the government sets the fares that taxi drivers can charge. In early 2002, some taxi drivers were upset when Mayor Michael Bloomberg proposed a fare increase. One driver was quoted as saying, “I get scared that we will start to lose passengers if rates go up and not gain a cent.”

- What was the driver assuming about the price elasticity of demand for taxi rides?
- Which of the five determinants of elasticity would be the most important determinant of the price elasticity of demand for taxi rides in New York City?

### SOLVING THE PROBLEM

**Step 1: Review the chapter material.**

This problem is about the price elasticity of demand, so you may want to review the section “The Determinants of the Price Elasticity of Demand,” which begins on page 180 in the textbook.

**Step 2: Interpret the taxi cab driver’s assumption regarding the price elasticity of demand for taxi rides.**

The driver asserted that if the price of a cab ride rose, the quantity demanded of rides would fall (“...we will start to lose passengers...”), but that the revenue he would receive from fares would be constant (“...we will...not gain a cent”). Therefore, the driver is assuming demand for cab rides is unit-elastic. Or, if by “not gain a cent” the driver was actually predicting his revenues would fall, then he is assuming the demand for cab rides is elastic.

**Step 3: Determine which of the determinants of the elasticity of taxi cab rides in New York City is the most important.**

The most important determinant of the price elasticity of demand is typically the availability of substitutes. On most occasions consumers can choose to travel by subway, bus, or taxi. Some consumers may drive their own automobiles. For many residents and tourists driving their own cars is impractical or more expensive than the others because of the difficulty and expense associated with finding parking spaces.

Source: Jayson Blair, “Some Taxi Drivers Say a Fare Increase Would Be Bad for Business,” New York Times, February 24, 2002.

## 6.3 LEARNING OBJECTIVE

### 6.3 The Relationship between Price Elasticity of Demand and Total Revenue (pages 182-186)

**Learning Objective 3** Understand the relationship between the price elasticity of demand and total revenue.

Changes in price and quantity demanded cause changes in the total revenue received by firms. **Total revenue** is the total amount of funds received by the seller of a good or service, calculated by multiplying price per unit by the number of units sold. This is also total spending on the product by consumers. Changes in total revenue are related to the price elasticity of demand. If demand is elastic, a change in price (increase or decrease) will result in a change in total revenue in the opposite direction. If demand is inelastic, a change in price will result in a change in total revenue in the same direction as the change in price. When demand is unit-elastic, a change in price (increase or decrease) results in no change in total revenue.

#### Helpful Study Hint

The relationship between elasticity and changes in revenue is very important. Setting and changing the price of a product are among the most important decisions firms make. But firms may not know the elasticity of demand for a product before a pricing decision is made. One way to estimate the elasticity is through a market experiment. **Making the Connection** “Determining the Price Elasticity of Demand for DVDs by Market Experiment” describes how variations in the prices of DVDs can be used to help determine the price elasticity. This experimentation is especially important for new products where a firm cannot rely on the past relationship between price and quantity demanded.

**Solved Problem 6-3** explains how price and total revenue do not always move in the same direction. If demand is price inelastic, then price and total revenue do move together. However, if the demand is price elastic, then price and total revenue will move in the opposite direction from one another, with revenue falling when price increases and rising when price decreases. Work end-of-chapter problem 3.8, which describes how elasticity can be determined by the change in revenue that follows a price change.

## 6.4 LEARNING OBJECTIVE

### 6.4 Other Demand Elasticities (pages 186-188)

**Learning Objective 4** Define the cross-price elasticity of demand and the income elasticity of demand, and understand their determinants and how they are measured.

The **cross-price elasticity of demand** is the percentage change in quantity demanded of one good divided by the percentage change in price of the other good. Because substitutes are products that can be used for the same purpose, an increase in the price of one of the products will lead to an increase in the quantity demanded of the substitute product. Therefore, the cross-price elasticity of demand will be positive.

Complements are products that are used together. An increase in the price of a product will lead to a decrease in the quantity demanded of its complement. Therefore, the cross-price elasticity of demand for these goods will be negative.

The **income elasticity of demand** is a measure of the responsiveness of quantity demanded to changes in income, measured by the percentage change in quantity demanded divided by the percentage change in income. An increase in income leads to an increase in the quantity demanded of a normal good. Therefore, the income elasticity of demand for a normal good is positive. A good is a luxury if the income elasticity is greater than 1. A good is a necessity if the income elasticity is positive but less than 1. A good is inferior if the quantity demanded falls when income increases. Therefore, the income elasticity of demand for an inferior good is negative.

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### Helpful Study Hint

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It is important not to confuse one type of elasticity with another. Review the list of the different elasticities in *Making the Connection* “Price Elasticity, Cross-Price Elasticity, and Income Elasticity in the Market for Alcoholic Beverages” and be sure you understand what these elasticities imply. This article provides a comparison of the elasticities for wine, beer, and spirits. Beer has a negative income elasticity of demand, which puts it in the inferior good category. Wine and spirits have income elasticities greater than one, so they are in the luxury goods category. Beer is price inelastic and the cross-price elasticities between beer and wine and spirits are positive, which means that wine and spirits are substitutes for beer. You can test your understanding by completing problem 4.8 on page 205 in the textbook.

Assume that the price elasticity of demand for iPods is  $-2.5$ . Are iPods a normal good? (Answer: You cannot determine whether iPods are normal or inferior by knowing only the price elasticity. The income elasticity of demand for iPods gives you this information.)

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## Extra Solved Problem 6-4

*Chapter 6 of the textbook includes three Solved Problems. Here is an extra Solved Problem to help you build your skills solving economic problems.*

**Supports Learning Objective 4:** Define the cross-price elasticity of demand and the income elasticity of demand, and understand their determinants and how they are measured.

### *The Demand for Margarine*

Suppose that the table below gives the demand this month for margarine in the city of Breadville. Each of the quantity columns, (b) and (c), is a different demand schedule. Column (a) shows the price of margarine. Column (b) shows the quantity demand of margarine for a fixed price of butter and a fixed income. Comparing columns (b) and (c), we can see the price of butter rises.

(a) price of margarine (dollars per pound)	(b) Quantity demanded (price of butter is \$1.00 per pound and family income is \$30,000) [hundreds of pounds]	(c) Quantity demanded (price of butter is \$1.60 per pound and family income is \$30,000) [hundreds of pounds]
\$1.60	24.02	32.91
1.40	25.00	34.25
1.20	26.18	35.87
1.00	27.65	37.89
0.80	29.57	40.51

- Calculate the cross-price elasticity of demand for margarine using the midpoint formula given a change in the price of butter from \$1.00 per pound to \$1.60 per pound. (Hint: use columns (b) and (c).)
- What can you say about the relationship between margarine and butter?

### SOLVING THE PROBLEM

**Step 1: Review the chapter material.**

This problem is about the other elasticities of demand, so you may want to review the section “Other Demand Elasticities,” which begins on page 186 of the textbook.

**Step 2: Calculate the cross-price elasticity of demand using the midpoint method.**

You can choose to analyze any row in the table, and you will get the following results. The price of butter rises from \$1.00 to \$1.60 per pound, while the quantity demanded of margarine rises from 24.02 hundred pounds to 32.91 hundred pounds. The cross-price elasticity of demand is 0.68.

**Step 3: Interpret the cross-price elasticity of demand.**

Because the cross-price elasticity of demand is positive, we know that margarine and butter are substitutes. We can also see that the response of the quantity demanded of margarine to the price change in butter is relatively small, which means that an increase in the price of butter did not cause consumers to strongly switch from buying butter to buying margarine.

### 6.5 LEARNING OBJECTIVE

## 6.5 Using Elasticity to Analyze the Disappearing Family Farm (pages 189-191)

**Learning Objective 5** Use price elasticity and income elasticity to analyze economic issues.

The demand for many agricultural commodities (for example, wheat) is price inelastic, while the income elasticity for these commodities is low (positive but less than one). Technological change has caused large increases in the supply of agricultural commodities over time. Because of the low income elasticity of demand for these commodities, demand has increased much less than supply. This has resulted in decreases in the relative prices of many agricultural commodities and falling revenues for farmers. At the same time, the technological improvements have meant fewer farmers are needed to produce agricultural commodities.

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 Helpful Study Hint
 

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The decline in the relative price of agricultural products is an example of how knowledge of elasticity explains an important economic and social issue. **Solved Problem 6-5**, “Using Price Elasticity to Analyze Policy toward Illegal Drugs,” is another excellent application of elasticity to an economic issue. How much consumption of cocaine will be affected by a change in price depends on the price elasticity of demand for cocaine. If the price elasticity is high in absolute value, the decrease in price that would result from legalization could nearly triple consumption. If the price elasticity is low, there will be only a slight increase in cocaine consumption. You can test your understanding by completing related problems 5.2 and 5.3 on page 206 in the textbook.

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**6.6 LEARNING OBJECTIVE**

## 6.6 The Price Elasticity of Supply and Its Measurement (pages 191-197)

**Learning Objective 6** Define the price elasticity of supply and understand its main determinants and how it is measured.

The **price elasticity of supply** is the responsiveness of the quantity supplied to a price change, measured by dividing the percentage change in the quantity supplied of a product by the percentage change in the product’s price. Because of the law of supply, this elasticity will have a positive numerical value. The longer the time period firms have to respond to a price change, the greater the elasticity of supply.

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 Helpful Study Hint
 

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**Making the Connection** “Why Are Oil Prices So Unstable?” explains how the elasticity of demand and supply affects the price of oil. In the short run, demand and supply are both relatively inelastic, so a reduction in the supply of oil will cause a large increase in the price of oil, but only a small change in the equilibrium quantity of oil produced and consumed. In the long run, consumers and firms have time to adjust their consumption preferences and productive capacity, so the demand and supply curves are relatively elastic. A change in the supply of oil has a smaller effect on the equilibrium price of oil in the long run.

At the start of the chapter, *Economics in YOUR Life!* asked how sensitive you are to price when purchasing a book and if Barnes & Noble’s discounting of *Harry Potter and the Deathly Hallows* will help them sell a lot of books. If you read all the earlier books in the series as soon as they came out, you are very likely to consider purchasing the book even at a high price. However, if you usually wait to purchase inexpensive paperback editions of books you like to read, you are more likely to purchase the hardcover book when Barnes & Noble discounts it. The answer to the second question depends on the prevalence of this last type of consumer. The more price-conscious consumers there are in the

market, the more responsive to price the quantity demanded for the hardcover version will be, and the more likely it is for Barnes & Noble's revenue to increase in response to the drop in price.

## Extra Solved Problem 6-6

Chapter 6 of the textbook includes three Solved Problems. Here is an extra Solved Problem to help you build your skills solving economic problems.

Supports Learning Objective 6: Define the price elasticity of supply and understand its main determinants and how it is measured.

### *Ethanol and Biodiesel*

Suppose that this summer your state government passes an immediate tax rebate to all citizens who use ethanol and biodiesel fuels in their automobiles. This causes the demand for ethanol and biodiesel to increase significantly. The main inputs for these alternative fuels are soy and corn. Because the supply of corn and soy are fixed for a given summer, the supply of these alternative fuels is fixed.

- What is the price elasticity of supply when the supply of a good is fixed?
- Explain what happens to the equilibrium price and quantity of alternative fuels in the summer that this rebate is introduced using a demand and supply graph.

### SOLVING THE PROBLEM

**Step 1: Review the chapter material.**

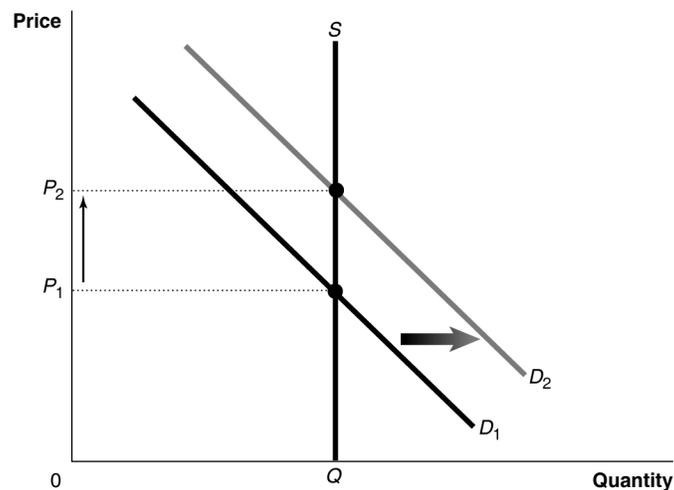
This problem is about the price elasticity of supply, so you may want to review the section “The Price Elasticity of Supply and Its Measurement,” which begins on page 191 in the textbook.

**Step 2: Interpret the fixed supply of alternative fuels and what that means in terms of the price elasticity of supply.**

If the supply is fixed, the quantity supplied is constant regardless of the market price, that is, supply is perfectly inelastic and is a vertical line. A vertical line has a price elasticity of supply of zero.

**Step 3: Apply the increase in demand and the vertical supply curve to the market for alternative fuels.**

The equilibrium quantity will be unaffected, and the increase in demand will cause an increase in the market price. Note that over time the elasticity of supply will increase, and the supply curve will become flatter, causing the quantity to increase in the long-run with a smaller increase in price.



## Key Terms

**Cross-price elasticity of demand.** The percentage change in quantity demanded of one good divided by the percentage change in the price of another good.

**Elastic demand.** Demand is elastic when the percentage change in quantity demanded is *greater* than the percentage change in price, so the price elasticity is *greater* than 1 in absolute value.

**Elasticity.** A measure of how much one economic variable responds to changes in another economic variable.

**Income elasticity of demand.** A measure of the responsiveness of quantity demanded to changes in income, measured by the percentage change in quantity demanded divided by the percentage change in income.

**Inelastic demand.** Demand is inelastic when the percentage change in quantity demanded is *less* than the percentage change in price, so the price elasticity is *less* than 1 in absolute value.

**Perfectly elastic demand.** The case where the quantity demanded is infinitely responsive to price, and the price elasticity of demand equals infinity.

**Perfectly inelastic demand.** The case where the quantity demanded is completely unresponsive to price, and the price elasticity of demand equals zero.

**Price elasticity of demand.** The responsiveness of the quantity demanded to a change in price, measured by dividing the percentage change in the quantity demanded of a product by the percentage change in the product's price.

**Price elasticity of supply.** The responsiveness of the quantity supplied to a change in price, measured by dividing the percentage change in the quantity supplied of a product by the percentage change in the product's price.

**Total revenue.** The total amount of funds received by a seller of a good or service, calculated by multiplying price per unit by the number of units sold.

**Unit-elastic demand.** Demand is unit-elastic when the percentage change in quantity demanded is *equal* to the percentage change in price, so the price elasticity is equal to 1 in absolute value.

## Self-Test

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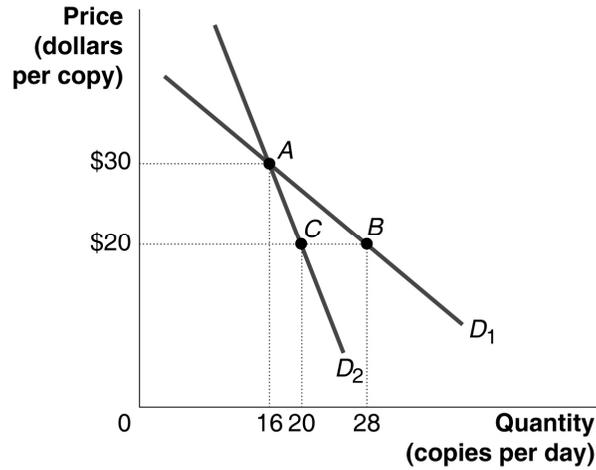
*(Answers are provided at the end of the Self-Test.)*

### Multiple Choice Questions

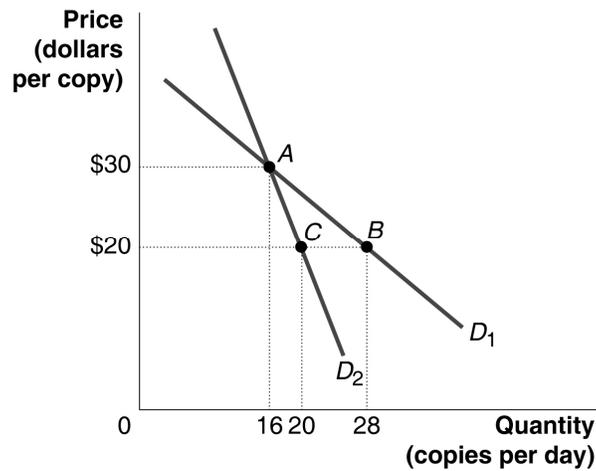
1. What do economists use the concept of elasticity for?
  - a. To explain how producers respond to consumers' needs
  - b. To measure how one economic variable responds to changes in another economic variable
  - c. To define the slope of supply and demand curves
  - d. All of the above
  
2. If you know the value for price elasticity of demand, then which of the following can you compute?
  - a. The effect of a price change on the quantity demanded
  - b. The responsiveness of the quantity supplied of a good to changes in its price
  - c. The price elasticity of supply
  - d. All of the above
  
3. What is the name given to the responsiveness of the quantity supplied of a good to changes in its price?
  - a. Price elasticity of supply
  - b. Price elasticity of demand
  - c. Income elasticity
  - d. Cross-price elasticity
  
4. Who benefits from the concept of elasticity?
  - a. Business managers
  - b. Policy makers
  - c. Both business managers and policy makers
  - d. Neither business managers nor policy makers; only economists benefit from it
  
5. How is the responsiveness of the quantity demanded to a change in price measured?
  - a. By dividing the percentage change in the product's price by the percentage change in the quantity demanded of a product
  - b. By multiplying the percentage change in the product's price by the percentage change in the quantity demanded of a product
  - c. By dividing the percentage change in the quantity demanded of a product by the percentage change in the product's price
  - d. By multiplying the percentage change in the quantity demanded of a product by the percentage change in the product's price

6. Which of the following measures is more sensitive to the units chosen for quantity and price?
  - a. Price elasticity of demand
  - b. Price elasticity of supply
  - c. The slope of a demand or supply curve
  - d. The eventual equilibrium in the market
7. How do economists avoid confusion over units in the computation of elasticity?
  - a. By using index numbers rather than whole numbers
  - b. By using percentage changes rather than simple differences
  - c. By using aggregate values rather than single values
  - d. By using the same number as the value of the slope of the curve
8. Which of the following statements about the slope and the price elasticity of demand is/are correct?
  - a. The slope is calculated using percentage changes in quantity and price, whereas elasticity is calculated using simple numerical changes.
  - b. The slope is calculated using changes in quantity and price, whereas elasticity is calculated using percentage changes.
  - c. Both the slope and elasticity must be calculated using percentage changes.
  - d. Neither the slope nor the value of elasticity can be calculated using simple numerical changes.
9. Which of the following is true about the value of price elasticity of demand?
  - a. The value is always negative
  - b. The value is always positive
  - c. The value may be positive or negative depending on the value of the slope of the demand curve
  - d. The value is positive when the slope is negative and vice versa
10. In comparing price elasticities of demand, we are usually interested in their relative size. What is the best way to make these comparisons?
  - a. To drop the minus sign and compare absolute values
  - b. To compare the signs (positive or negative) of various elasticity values, regardless of absolute value
  - c. To avoid comparing absolute values, regardless of the sign (positive or negative)
  - d. To compare demand elasticities to supply elasticities
11. What happens when the quantity demanded is very responsive to changes in price?
  - a. The percentage change in quantity demanded will be greater than the percentage change in price.
  - b. The percentage change in quantity demanded will be less than the percentage change in price.
  - c. The percentage change in quantity demanded will be equal to the percentage change in price.
  - d. The percentage change in quantity demanded will be unrelated to the percentage change in price.
12. What happens when the quantity demanded is very responsive to changes in price?
  - a. The price elasticity of demand will be greater than 1 in absolute value.
  - b. Demand is inelastic.
  - c. There are few substitutes for the good in question.
  - d. All of the above
13. Which of the following is true if quantity demanded is not very responsive to price?
  - a. The percentage change in quantity demanded will be less than the percentage change in price.
  - b. The price elasticity of demand will be less than 1 in absolute value.
  - c. Demand is inelastic.
  - d. All of the above

14. Refer to the graph below. If the demand is elastic and you start at point *A*, what is the result of a cut in the price from \$30 to \$20?



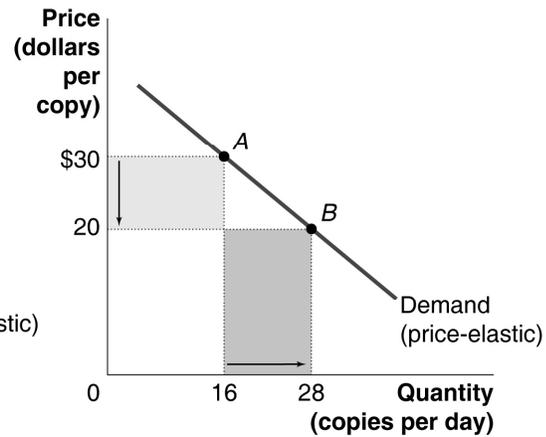
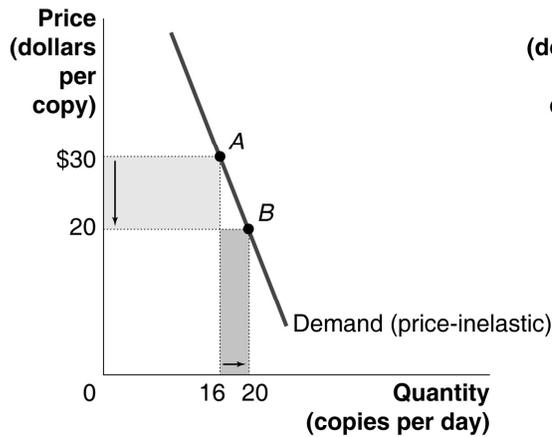
- A move to point *B*
  - A move to point *C*
  - A move to either point *B* or point *C*
  - No move at all
15. Refer to the graph below. If the demand is inelastic and you start at point *A*, what is the result of a cut in the price from \$30 to \$20?



- A move to point *B*
- A move to point *C*
- A move to either point *B* or point *C*
- No move at all

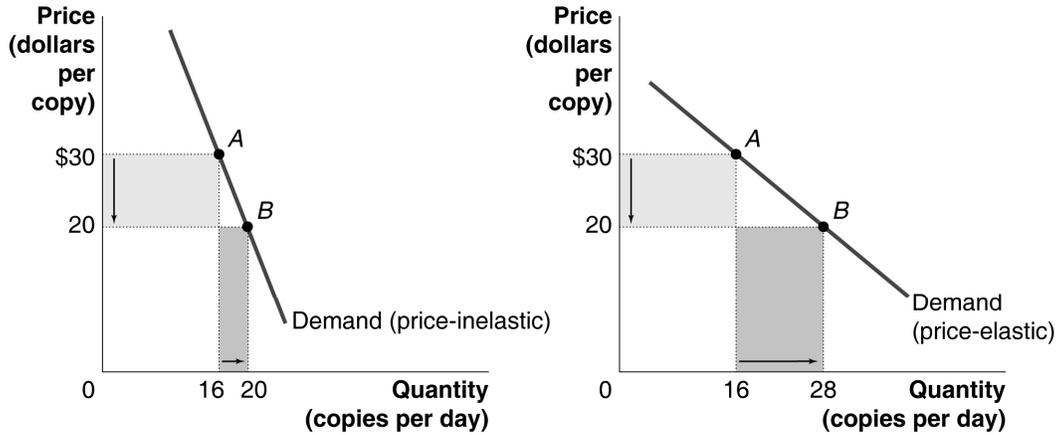
16. Which of the following would occur when calculating price elasticity between two points on a demand curve if we are not using the midpoint formula?
- The value of elasticity we get is the same whether we apply it to price increases or to price decreases.
  - We would get a different value for price increases than for price decreases.
  - The values we get are the same if the demand curve is downward sloping.
  - The values always coincide with the value of the slope of the demand curve, especially if the demand curve is linear.
17. Which of the following does the midpoint formula use to compute elasticity?
- The averages of the initial and final quantity and the initial and final price.
  - The differences between initial and final prices and quantities.
  - The sums of the initial and final prices and quantities.
  - The product of the initial and final prices and quantities.
18. When quantity demanded is completely unresponsive to price, what is the value of price elasticity of demand?
- Zero
  - 1
  - A number between zero and 1
  - A negative number
19. If demand is perfectly elastic, then what is the impact of an increase in price?
- A decrease in quantity demanded to zero.
  - No change in quantity demanded.
  - A change in quantity demanded exactly equal to the change in price.
  - A very small change in quantity demanded.
20. Which of the following is the most important determinant of price elasticity of demand?
- The availability of substitutes
  - The passage of time
  - The difference between necessities and luxuries
  - The definition of the market
21. Which of the following is a true statement?
- The more substitutes available for a product, the greater the price elasticity of demand.
  - The more time that passes, the more elastic the demand for a product becomes.
  - The demand curve for a luxury is more elastic than the demand curve for a necessity.
  - All of the above
22. Which of the following is a true statement?
- The fewer substitutes available for a product, the greater the price elasticity of demand.
  - The more time that passes, the more inelastic the demand for a product becomes.
  - The demand curve for a luxury is less elastic than the demand curve for a necessity.
  - The more narrowly defined a product is, the larger the price elasticity of demand.
23. The price elasticity for a particular brand of raisin bran is, in absolute value,
- larger than the elasticity for all family cereals.
  - the same as the elasticity for all family cereals.
  - smaller than the elasticity for all types of breakfast cereals.
  - neither larger nor smaller than the elasticity for any other type of cereal.

24. What is true about elasticity for a good that comprises a smaller fraction of the average consumer's budget?
- The price elasticity of demand for that good is smaller.
  - The price elasticity of demand for that good is larger.
  - Changes in the price of that good are insignificant.
  - The quantity of that good consumed is larger relative to the quantity of other goods.
25. What is total revenue?
- The total amount of funds a firm receives from selling a good or service.
  - An amount calculated by multiplying price per unit by the number of units sold.
  - An amount that increases when price increases if demand is inelastic.
  - All of the above
26. When demand is price-inelastic, what is the relationship between price and total revenue?
- They move together.
  - They move in inversely.
  - They always remain unchanged.
  - They are entirely unrelated.
27. When demand is price-elastic, what is the relationship between price and total revenue?
- They move together.
  - They move inversely.
  - They move in unpredictable directions.
  - They don't move at all.
28. Refer to the graphs below. In which of the graphs does a price decrease lead to an increase in total revenue?



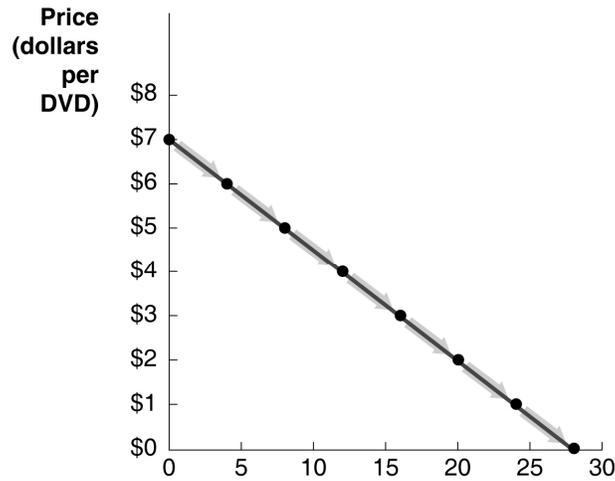
- In the graph on the left
- In the graph on the right
- In both graphs
- In neither graph

29. When an increase in the quantity demanded is not large enough to make up for a decrease in price, total revenue falls. Which graph is more applicable to this statement?



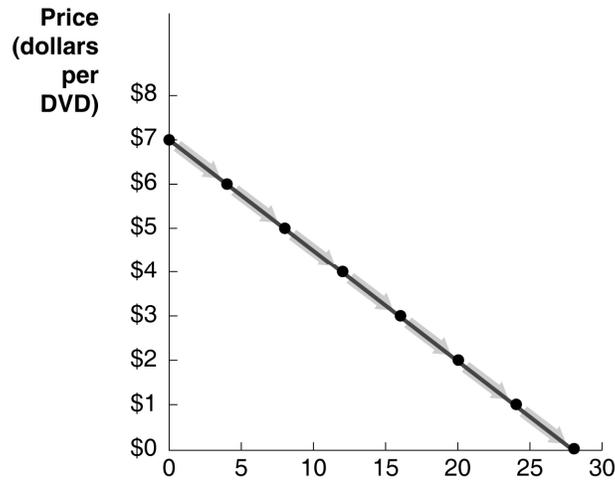
- a. The graph on the left
  - b. The graph on the right
  - c. Both graphs
  - d. Neither graph
30. What is the effect of a cut in price when demand is inelastic?
- a. An increase in total revenue
  - b. A decrease in total revenue
  - c. No effect on total revenue
  - d. A change in total revenue by an amount equal to the cut in price.
31. When is a change in price exactly offset by a proportional change in quantity demanded, leaving revenue unaffected?
- a. Never
  - b. When demand is elastic
  - c. When demand is inelastic
  - d. When demand is unitary elastic

32. Refer to the graph below. What happens to price elasticity as we move down the demand curve?



- a. It rises.
- b. It falls.
- c. It remains the same.
- d. It rises up to the midpoint, and then it falls.

33. Refer to the graph below. What happens to total revenue as we move down the demand curve?



- a. It rises.
- b. It falls.
- c. It remains the same.
- d. It rises up to the midpoint, and then it falls.

34. Fill in the blanks: An increase in the price of a substitute for iPods will lead to \_\_\_\_\_ in quantity demanded of iPods, so the cross-price elasticity of demand will be \_\_\_\_\_.
- an increase; positive
  - an increase; negative
  - a decrease; positive
  - a decrease; negative
35. Fill in the blanks: An increase in the price of a complement for DVDs will lead to \_\_\_\_\_ in the quantity demanded of DVDs, so the cross-price elasticity of demand will be \_\_\_\_\_.
- an increase; positive
  - an increase; negative
  - a decrease; positive
  - a decrease; negative
36. What is the cross-price elasticity of demand for the two products that are unrelated?
- Zero
  - 1
  - Infinite
  - Negative
37. If Amazon.com raises its prices by 10 percent and, as a result, the quantity of books demanded on BarnesandNoble.com increases by 35 percent, what do consumers consider the two Web sites to be?
- Close substitutes
  - Close complements
  - Unrelated
  - Identical
38. If the quantity demanded of a good increases as income increases, what can we say with certainty about the good?
- It is a necessity.
  - It is a luxury.
  - It is a normal good.
  - It is an inferior good.
39. If the quantity demanded of a normal good is very responsive to changes in income, what is the good considered?
- A necessity.
  - A luxury.
  - A substitute good.
  - An inferior good.
40. What is true about quantity demanded if a good is considered a *necessity*?
- It is very responsive to changes in income.
  - It is not very responsive to changes in income.
  - It is unrelated to changes in income.
  - It is always the same regardless of price changes.

41. Which of the following is true about what happens to the quantity demanded of an *inferior* good?
  - a. It rises when income rises.
  - b. It falls when income increases.
  - c. It does not change with changes in price.
  - d. It does not change with changes in income.
  
42. Suppose that an innovation in harvesting technology increases the supply of corn. Corn farmers will experience an increase in total revenue when
  - a. the supply of corn is inelastic.
  - b. the supply of corn is elastic.
  - c. the demand for corn is inelastic.
  - d. the demand for corn is elastic.

**Short Answer Questions**

1. From the chapter opener: "...there is no difference between \$22 and \$23...If you want a book in translation from a Czech writer, you are going to buy the book – price is not a factor if you really want it." If the price of a book is unimportant, what does this imply about the price elasticity of demand for the book?

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2. Phil Sanders, an economics major who recently graduated from a local college, was hired as a consultant by the Middletown City Council. A member of the Council proposed lowering fares for public transportation (buses and trolleys). He reasoned that the lower price would increase both the number of people using public transportation and revenue from fares. The increased revenue would be used to buy new buses. When he estimated price elasticities of demand, Sanders found that the price elasticity of demand for both bus and trolley service was  $-0.6$ . What advice should Sanders give the City Council?

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3. Assume that economic growth causes incomes to rise in the United States by 5 percent. Use the income elasticities of demand from *Making the Connection* "Price Elasticity, Cross-Price Elasticity, and Income Elasticity in the Market for Alcoholic Beverages" on page 188 in the textbook to estimate the change in the quantities demanded for beer, wine, and spirits.

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4. The Los Angeles Lakers basketball team and the Los Angeles Kings hockey team play their home games in the Staples Arena. The seating capacity of the Arena is just under 19,000. Although Lakers games are often sold out, the number of tickets sold to Kings games, some concerts, and other non-sports events is often less than 14,000. What is the price elasticity of supply for the Staples Arena?

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5. A low income elasticity of demand for wheat is one of the reasons given in the textbook for the reduction in the number of family farms in the United States. Why is the income elasticity for wheat low? Is wheat an inferior good?

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### True/False Questions

- T F 1. The price elasticity of demand measures the responsiveness of demand for a product to a change in the product's price.
- T F 2. The demand for all breakfast cereals is more elastic than the demand for a specific brand of cereal.
- T F 3. If the demand for a product is elastic, a decrease in price results in an increase in revenue.
- T F 4. The cross-price elasticity of demand for two complements is positive.
- T F 5. The mid-point formula is used to ensure that there is only one value of the price elasticity of demand between two points on the same demand curve.
- T F 6. One reason for the decline in wheat prices from 1950 to 2006 (measured in terms of prices in 2006) is a price elasticity of demand that is less than 1 in absolute value.
- T F 7. During recessions, the demand for inferior goods will rise.
- T F 8. If the supply for a product is inelastic, an increase in price will increase total revenue.
- T F 9. A supply curve that is a horizontal line is perfectly elastic.
- T F 10. If a product has a unit elastic demand curve, an increase in income does not affect revenue.
- T F 11. The demand for a good will be more elastic, the larger the share of a good in the average consumer's budget.
- T F 12. A perfectly elastic demand curve will be a horizontal line.
- T F 13. A perfectly inelastic demand curve will have a price elasticity equal to 1 in absolute value.
- T F 14. A good with an income elasticity of demand equal to 1.2 is a normal good.
- T F 15. A good with an income elasticity of demand equal to 1.2 is a luxury good.

## Answers to the Self-Test

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### Multiple-Choice Questions

Question	Answer	Comment
1	b	Economists use the concept of elasticity to measure how one economic variable responds to changes in another economic variable.
2	a	For this reason, elasticity is an important concept for managers and policy makers.
3	a	The responsiveness of the quantity supplied of a good to changes in its price is called price elasticity of supply.
4	c	Elasticity is an important concept not just for business managers but for policy makers as well.
5	c	The responsiveness of the quantity demanded to a change in price, measured by dividing the percentage change in the quantity demanded of a product by the percentage change in the product's price.
6	c	The measurement of slope is sensitive to the units chosen for quantity and price. For this reason we use percentage changes to compute responsiveness.
7	b	Percentage changes are not dependent on units of measurement.
8	b	The value we compute for the slope can change dramatically depending on the units we use for quantity and price. To avoid this confusion over units, economists use percentage changes when measuring the price elasticity of demand.
9	a	If we calculate the price elasticity of demand for a price cut, the percentage change in price will be negative and the percentage change in quantity demanded will be positive. Similarly, if we calculate the price elasticity of demand for a price increase, the percentage change in price will be positive and the percentage change in quantity will be negative. Therefore, the price elasticity of demand is always negative.
10	a	In comparing elasticities, we are usually interested in their relative size. So, we often drop the minus sign and compare their absolute values.
11	a	In other words, the value of elasticity will be greater than one, so the numerator will be greater than the denominator in the elasticity formula.
12	a	If the quantity demanded is responsive to changes in price, the percentage change in quantity demanded will be greater than the percentage change in price, and the price elasticity of demand will be greater than 1 in absolute value. In this case, demand is elastic.
13	d	When the quantity demanded is not very responsive to price, however, the percentage change in quantity demanded will be less than the percentage change in price, and the price elasticity of demand will be less than 1 in absolute value. In this case, demand is inelastic.
14	a	An elastic demand curve is relatively flat. Therefore, the drop in price will cause a move along the flatter (or elastic) demand curve.
15	b	An inelastic demand curve is relatively steep. Therefore, the drop in price will cause a move along the steeper (or inelastic) demand curve.
16	b	We could run into a problem because we get a different value for the price elasticity of demand for price increases than for price decreases. To avoid this problem, we use the midpoint formula to compute elasticity.
17	a	The midpoint formula uses the average of the initial and final quantity and the initial and final price to compute elasticity.
18	a	If a demand curve is perfectly inelastic, an increase in price causes the quantity demanded to remain the same, so there is no (or zero) response in quantity demanded.

- 19 a Refer to table 6-1 on page 179 in the textbook.
- 20 a The textbook asserts that the availability of substitutes is the most important determinant of the price elasticity of demand.
- 21 d All of these statements are correct. Read pages 180-181 in the textbook.
- 22 d The price elasticity of demand for a narrowly defined market (e.g., *Tide* has many substitutes) will be greater than the price elasticity of demand for a broadly defined market (laundry detergent).
- 23 a The more substitutes available for a product, the greater the price elasticity of demand. Also, the more narrowly defined a product is, the larger the price elasticity of demand.
- 24 a Goods that take only a small fraction of a consumer's budget tend to have inelastic demand. For example, the share of the average consumer's budget that is spent on salt is very low. As a result, even a doubling of the price of salt is likely to result in only a small decline in the quantity of salt demanded.
- 25 d Total revenue is the total amount of funds a firm receives from selling a good or service. Total revenue is calculated by multiplying price per unit by the number of units sold.
- 26 a An increase in price raises total revenue, and a decrease in price reduces total revenue.
- 27 b An increase in price reduces total revenue, and a decrease in price raises total revenue.
- 28 b In the graph on the right the increase in revenue from decreasing price equals 12 copies ( $28 - 12$ ) multiplied by \$20, or \$240. This is greater than the decrease in revenue from decreasing price ( $(\$30 - \$20) \times 16 = \$160$ ).
- 29 a This demand curve is inelastic. Refer to Figure 6-2 on page 183 in the textbook.
- 30 b When demand is inelastic, a cut in price will decrease total revenue.
- 31 d When demand is unit-elastic, a change in price is exactly offset by a proportional change in quantity demanded, leaving revenue unaffected. Therefore, when demand is unit elastic, neither a decrease in price nor an increase in price affects revenue.
- 32 b At higher prices, demand is more elastic, and at lower prices, demand is less elastic and eventually becomes inelastic.
- 33 d Total revenue is highest at the midpoint of the demand curve and decreases as the price moves away from the midpoint price.
- 34 a An increase in the price of a substitute will lead to an increase in demand for the substitute product, so the cross-price elasticity of demand will be positive.
- 35 d An increase in the price of a complement will lead to a decrease in demand for the complementary product, so the cross-price elasticity of demand will be negative.
- 36 a If the two products are unrelated, the cross-price elasticity of demand will be zero.
- 37 a If the percentage change in demand for books from BarnesandNoble.com is greater than the percentage change in the price of books from Amazon.com, then the two websites are considered by consumers to be close substitutes.
- 38 c If the demand for a good increases as income increases, then the good is a normal good. Normal goods are often further subdivided into luxury goods and necessity goods.
- 39 b A good is a luxury if demand is very responsive to changes in income, so that a 10 percent increase in income results in more than a 10 percent increase in demand. Expensive jewelry or vacation homes are examples of luxuries.
- 40 b A good is a necessity if demand is not very responsive to changes in income, so that a 10 percent increase in income results in less than a 10 percent increase in demand. Food and clothing are examples of necessities.

- 41 b A good is inferior if demand falls when income increases. Ground beef with a high fat content is an example of an inferior good.
- 42 d An increase in supply will cause a decrease in the equilibrium price and an increase in the equilibrium quantity. In order of total revenue to increase the equilibrium quantity must go up by more than the equilibrium price as we move along the demand; i.e. demand must be elastic.

### Short Answer Responses

1. If the price of a book really makes no difference to consumers, then the demand curve for the book would be perfectly inelastic and would be drawn as a vertical line at the quantity demanded. However, this type of demand curve is rare. Not only would there be no decrease in quantity demanded if the price rose above \$22, but there would be no increase in quantity demanded if the price decreased below \$22. Although price may not matter to some book buyers it is likely that other buyers would respond to price changes.
2. Sanders should advise the City Council members to not lower price, as this would result in lower revenue from fares. In fact, if the Council wishes to increase revenue the proper course would be to raise fares since demand is inelastic. However, Council members may wish to forego the fare increase for other reasons. It is likely that many lower income residents of Middletown use public transportation and Council members may not wish to place the financial burden of paying for new buses on them.
3. To determine the changes in quantity demanded it is necessary to multiply the income elasticity for these three goods by the percentage change in income. The income elasticities are: beer (-0.09), wine (5.03) and spirits (1.21). Multiplying these values by 5% (0.05) yields the following changes in quantity demanded: beer (-0.5%), wine (+25.2%) and spirits (+6.1%).
4. Assuming that temporary seating is not added to or removed from the Staples Arena for different events, the price elasticity of supply is zero. This means that the supply curve is a vertical line at the quantity supplied of 19,000. The number of tickets sold for different events reflects quantity demanded, not quantity supplied.
5. Wheat has a low income elasticity because there is a small increase in the demand for goods made from wheat as incomes rise. Wheat would be an inferior good only if demand decreased as incomes rose. This was not the case from 1950 through 2006. The income elasticity of demand for wheat was positive but less than 1.

### True/False Answers

1. F The price elasticity of demand measures the responsiveness of quantity demanded to price changes.
2. F The more narrow the market, the more elastic the demand for the product.
3. T With an elastic demand, the price and total revenue move in the opposite direction of one another.
4. F Cross-price elasticity of demand is negative for complements.
5. T See page 176.
6. T See Figure 6-4 on page 189.
7. T As income falls, the demand for inferior goods increases.

8. F If demand, not supply, is inelastic, then an increase in price will increase total revenue.
9. T See Table 6-5 on page 195.
10. F A product has a unit elastic demand curve if changes in price, not income, do not affect revenue.
11. T If the good is a large share of the budget and the price increases, we consume a lot less of the good; i.e. the income demand is elastic.
12. T See Table 6-1 on page 179.
13. F A perfectly inelastic demand curve will have a price elasticity equal to zero.
14. T If income elasticity is positive, then the good is a normal good.
15. T A luxury good has an income elasticity of more than 1.