Answers to the Review Quizzes

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1. **Why do we need a units-free measure of the responsiveness of the quantity demanded of a good or service to a change in its price?**

   The elasticity of demand is a units-free measure. Compare it as a measure of the responsiveness to some other candidate that depends on the units, such as the slope. The slope of the demand curve changes as the units measuring the same quantity of the good change (going from pounds to ounces, for example). The value of the elasticity is independent of the units used to measure the price and quantity of the product. As a result, the elasticity can be compared across the same good when quantity is measured in different units and/or the price is measured in different currencies. The elasticities of different goods also can be compared even though they are measured in different units.

2. **Define price elasticity of demand and show how it is calculated.**

   The price elasticity of demand is a units-free measure of the responsiveness of the quantity demanded of a good to a change in its price when all other influences on buying plans remain the same. It equals the absolute value (or magnitude) of the ratio of the percentage change in the quantity demanded to the percentage change in the price. The percentage change in quantity (price) is measured as the change in quantity (price) divided by the average quantity (price).

3. **Why, when we calculate the price elasticity of demand, do we express the change in price as a percentage of the average price and the change in quantity as a percentage of the average quantity?**

   Using the average of both price and quantity gives the elasticity at the midpoint between the original price and the new price. If we only used percentage change from the original price, we would have a larger value for the elasticity between two prices when calculating the elasticity for a price fall than when calculating it for a price rise. Using the average price and quantity measures avoids the value of elasticity being dependent upon whether a price change reflects a price increase or decrease.

4. **What is the total revenue test? Explain how it works.**

   The total revenue test is a method of estimating the price elasticity of demand by observing the change in total revenue, given a change in price, holding all other things constant. The total revenue test shows that a price cut increases total revenue if demand is elastic, decreases total revenue if demand is inelastic, and does not change total revenue if demand is unit elastic.

5. **What are the main influences on the elasticity of demand that make the demand for some goods elastic and the demand for other goods inelastic?**

   The magnitude of the price elasticity of demand for a good depends on three main influences:
   - **Closeness of substitutes.** The more easily people can substitute other items for a particular good, the larger is the price elasticity of demand for that good.
- The proportion of income spent on the good. The larger the portion of the consumer’s budget being spent on a good, the greater is the price elasticity of demand for that good.
- The time elapsed since a price change. Usually, the more time that has passed after a price change, the greater is the price elasticity of demand for a good.

6. Why is the demand for a luxury generally more elastic than the demand for a necessity?
   Demand for a necessity is generally less elastic than demand for a luxury because there are fewer substitutes for a necessity.

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1. What does the cross elasticity of demand measure?
   The cross elasticity of demand measures how the quantity demanded of one good responds to a change in the price of another good. The formula for the cross elasticity of demand is the percentage change in the quantity of the good demanded divided by the percentage change in the price of the related good.

2. What does the sign (positive versus negative) of the cross elasticity of demand tell us about the relationship between two goods?
   The sign of the cross elasticity of demand reveals whether two goods are substitutes or complements: The cross elasticity of demand is positive for substitutes and negative for complements.

3. What does the income elasticity of demand measure?
   The income elasticity of demand measures how the quantity demanded of a good responds to a change in income. The formula for the income elasticity of demand is the percentage change in the quantity of the good demanded divided by the percentage change in income.

4. What does the sign (positive versus negative) of the income elasticity of demand tell us about a good?
   The sign of the income elasticity of demand reveals whether a good is a normal good or an inferior good: The income elasticity of demand is positive for normal goods and negative for inferior goods.

5. Why does the level of income influence the magnitude of the income elasticity of demand?
   The level of a person’s income can influence the income elasticity of demand by changing how a good or service is perceived. Some goods, such as automobiles, might seem like a luxury when a person’s income is very low, but seem like a necessity when income is very high. Therefore, the income elasticity for some goods, like automobiles, might decrease (become less elastic) as incomes increase.

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1. Why do we need a units-free measure of the responsiveness of the quantity supplied of a good or service to a change in its price?
   The elasticity of supply is a units-free measure. We need a units-free measure of the elasticity of supply for the same reason we need a units-free measure of the elasticity of demand: Because the value of the elasticity of supply is independent of the units used to measure the price and quantity of the product, the elasticity of supply can be compared across the same good when quantity is measured in different units and/or the price is measured in different currencies. In addition, the elasticities of supply of different goods also can be compared even though they are measured in different units.

2. Define elasticity of supply and show how it is calculated.
   The elasticity of supply measures the responsiveness of the quantity supplied to a change in the price of a good when all other influences on selling plans remain the same. The elasticity of supply is calculated by the percentage change in the quantity supplied divided by the percentage change in the price.
3. What are the main influences on the elasticity of supply that make the supply of some goods elastic and the supply of other goods inelastic?

The main influences on the elasticity of supply are:

- **Resource substitution possibilities**: the greater the suppliers’ ability to substitute resources, the greater will be their ability to react to price changes and the greater the elasticity of supply.
- **Time frame for the supply decision**: the greater the amount of time available after the price change, the greater is the suppliers’ ability to adjust quantity supplied, and the greater the elasticity of supply.

4. Provide examples of goods or services whose elasticities of supply are (a) zero, (b) greater than zero but less than infinity, and (c) infinity.

Here are some examples:

a) The **momentary supply** of wheat is perfectly inelastic. Once farmers have brought their wheat to market, there is no other alternative use for it and they sell it all regardless of the going price.

b) The **short-run supply** of wheat. If the farmers already have a mature wheat crop but have not yet harvested it, farmers with both relatively high and low yield fields may choose to harvest both types of fields if the price for wheat is high. However, the farmers will not harvest their low yield fields when the price of wheat is relatively low to economize on added labor costs.

c) The **supply of wheat to an individual buyer**. Any one buyer can purchase as much wheat at the going price as he or she desires. However, no quantity of wheat will be supplied at a lower price.

5. How does the time frame over which a supply decision is made influence the elasticity of supply? Explain your answer.

The momentary supply, short-run supply, and long-run supply all illustrate the response of suppliers to changes in the price, but they differ according to how much time has elapsed after the price change.

- The **momentary supply** is frequently the least elastic and shows how suppliers cannot easily respond to a price change immediately after the price change occurs. Changing the quantity produced means changing the inputs into the production process, which takes time to complete. Sometimes the momentary supply is perfectly inelastic.

- The **short-run supply** shows suppliers’ response after enough time has elapsed for some, but not all, of the possible technological adjustments have occurred. Short-run supply generally is intermediate in elasticity between the momentary supply and the long-run supply.

- The **long-run supply** shows how suppliers react after enough time has passed that all possible adjustments to factors of production have been made to accommodate the price change. It usually is the most elastic of the three supplies.
Answers to the Problems and Applications

1. Rain spoils the strawberry crop. As a result, the price rises from $4 to $6 a box and the quantity demanded decreases from 1,000 to 600 boxes a week. Over this price range,

   a. What is the price elasticity of demand?

      The price elasticity of demand is 1.25. The price elasticity of demand equals the percentage change in the quantity demanded divided by the percentage change in the price. The price rises from $4 to $6 a box, a rise of $2 a box. The average price is $5 a box. So the percentage change in the price is $2 divided by $5 and then multiplied by 100, which equals 40 percent. The quantity decreases from 1,000 to 600 boxes, a decrease of 400 boxes. The average quantity is 800 boxes. So the percentage change in quantity is 400 divided by 800, which equals 50 percent. The price elasticity of demand for strawberries is 50 percent divided by 40 percent, which equals 1.25. \[(\frac{2}{5}) \times 100\]

   b. Describe the demand for strawberries.

      The price elasticity of demand exceeds 1, so the demand for strawberries is elastic.

2. If the quantity of dental services demanded increases by 10 percent when the price of dental services falls by 10 percent, is the demand for dental services inelastic, elastic, or unit elastic?

   The demand for dental services is unit elastic. The price elasticity of demand for dental services equals the percentage change in the quantity of dental services demanded divided by the percentage change in the price of dental services. The price elasticity of demand is 10 percent divided by 10 percent, which equals 1. The demand is unit elastic.

3. The demand schedule for hotel rooms is given in the table.

<table>
<thead>
<tr>
<th>Price (dollars per night)</th>
<th>Quantity demanded (millions of rooms per night)</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>100</td>
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<tr>
<td>250</td>
<td>80</td>
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<td>800</td>
<td>25</td>
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<td>1,000</td>
<td>20</td>
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</table>

   a. What happens to total revenue if the price falls from $400 to $250 a night?

      When the price is $400, the total revenue is equal to $400 × 50 million rooms, or $20 billion. When the price is $250, the total revenue is equal to $250 × 80 million rooms, or $20 billion. So the total revenue does not change when the price falls from $400 to $250 a night.

   b. What happens to total revenue if the price falls from $250 to $200 a night?

      When the price is $250, the total revenue is equal to $250 × 80 million rooms, or $20 billion. When the price is $200, the total revenue is equal to $200 × 100 million rooms, or $20 billion. So the total revenue does not change when the price falls from $400 to $250 a night.

   c. At what price is total revenue at a maximum? Explain and interpret your answer.

      The total revenue is the same at all prices, $20 billion. Because a change in price does not change the total revenue at any price, the demand is unit elastic at all prices.

   d. Is the demand for hotel rooms elastic, unit elastic, or inelastic?

      The demand for hotel rooms is unit elastic at all prices.

4. The Grip of Gas: Why You’ll Pay Through the Nose to Keep Driving

   Drivers in the United States consistently rank as the least sensitive to changes in gas prices. ... If prices rose from $3 per gallon to $4 per gallon and stayed there for a year... purchases of gasoline in the United States would fall only about 5 percent.  

   *Slate*, September 27, 2005

   a. Using the information provided, calculate the price elasticity of demand for gasoline.

      The price rises by $1.00 and the average price is $3.50. So the percentage change in the price is
b. Does this measurement indicate that the demand for gasoline is elastic, unit elastic, or inelastic? This measure indicates that the demand for gasoline is inelastic.

c. If the price of gasoline rises, will total revenue from gasoline sales increase or decrease? Explain. If the price of gasoline rises, because the demand is inelastic the total revenue test concludes that the total revenue from gasoline will increase.

5. In 2003, when music downloading first took off, Universal Music slashed the prices of a CD from an average of $21 to an average of $15. The company said that it expected the price cut to boost the quantity of CDs sold by 30 percent, other things remaining the same.

a. What was Universal Music’s estimate of the price elasticity of demand for CDs?

Using the data in the question, the price elasticity of demand is 0.90. The change in the price is $6 and the average of the two prices is $18, so the percentage change in the price is $(6/18) \times 100$, which equals 33.3 percent. The increase in the quantity demanded was estimated to be 30 percent. The price elasticity of demand equals $(30.0 \text{ percent})/(33.3 \text{ percent})$, or 0.90.

b. Given your answer in a, if you were making the pricing decision at Universal Music, would you cut the price, raise the price, or not change the price? Explain your decision.

The demand is inelastic, so if nothing else changes the price cut leads to a decrease in Universal Music’s total revenue. However, downloaded music and CDs are substitutes for each other and the quantity of downloaded music was forecast to rise substantially. Effectively, the price of downloading music fell as more people gained access to the Internet and download sites proliferated. The fall in the price of the substitute, downloaded music, decreases the demand for Universal Music’s CDs, so the price cut most likely was the result of the (forecasted) decrease in demand for CDs.

6. Why the Tepid Response to Rising Gasoline Prices

Estimates of the long-run response to past movements in [gasoline] prices imply that a 10 percent price rise causes 5 to 10 percent less consumption, other things being equal. ... The nationwide average price of gasoline surged 53 percent from 1998 to 2004, after adjusting for inflation. Yet consumption was up 10 percent in this period. Of course, many other things changed in this period. Perhaps most important, [incomes] grew by 19 percent. . . . This would ordinarily be expected to push gasoline sales up about 20 percent. . . .

The New York Times, October 13, 2005

a. What does the above information tell us about the responsiveness of the quantity of gasoline demanded to a change in the price a long time after the price change occurs?

The price of gasoline rose 53 percent and the quantity of gasoline consumed increased 10 percent. Taken on their face values, these data indicate that a higher price for gasoline increases the quantity demanded. However, as the question points out, factors other than the price and quantity consumed changed. In particular, people’s incomes rose over the time period. Therefore the data do not indicate a violation of the law of demand because the law of demand—the negative relationship between the price of a good and the quantity demanded—applies only when other factors remain the same. Indeed the news clip says that a 10 percent price rise leads to a 5 percent to 10 percent decrease in consumption, which means that the elasticity of demand of demand ranges from 0.5 to 1.0.

b. Calculate the income elasticity of demand for gasoline implied by the above information.

Using the data in the question, the income elasticity of demand is 1.05. According to the question, a 19 percent increase in income leads to a 20 percent increase in the quantity of gasoline demanded. The income elasticity of demand equals $20/19$, or 1.05.
c. If other things remained the same except for the increase in income and the rise in price, what would the data for 1998 to 2004 imply about the price elasticity of demand for gasoline?

Using the data in the question, the price elasticity of demand is 0.19. Assuming that the change in income affects the demand for gasoline equally at all prices for gasoline, then if the price of gasoline had not changed, the rise in income would have increased the quantity of gasoline demanded by 20 percent. But the quantity of gasoline increased only 10 percent. The higher price of gasoline reduced the net increase by 10 percent, that is, the higher price of gasoline lead to a −10 percent change in the quantity of gasoline demanded. Hence the 53 percent increase in the price of gasoline lead to a 10 percent decrease in the quantity demanded, so the price elasticity of demand is (10 percent)/(53 percent), or 0.19.

d. List all the factors you can think of that might bias the estimate of the price elasticity of demand for gasoline, using just the data for 1998 to 2004.

Any factor that affects the demand for gasoline and changed during the period under study would bias the estimate of the price elasticity of demand. Factors that might have changed were the number of demanders, the price of automobiles, and possibly the types of automobiles purchased. An increase in the number of demanders could have occurred because of population growth. Gasoline and automobiles are complements, so a change in the price of automobiles would affect the demand for gasoline. Finally, if people decided they preferred large, SUVs, minivans, and trucks over this time period, the demand for gasoline would have changed because of this change in people’s preferences. Most of these possible factors would have lead to an increase in the demand for gasoline, which would bias the estimated price elasticity of demand upward.

7. If a 12 percent rise in the price of orange juice decreases the quantity of orange juice demanded by 22 percent and increases the quantity of apple juice demanded by 14 percent, calculate the

a. Price elasticity of demand for orange juice.

The price elasticity of demand for orange juice is 1.83. The price elasticity of demand is the percentage change in the quantity demanded of the good divided by the percentage change in the price of the good. So the price elasticity of demand equals 22 percent divided by 12 percent, which is 1.83.

b. Cross elasticity of demand for apple juice with respect to the price of orange juice.

The cross elasticity of demand between orange juice and apple juice is 1.17. The cross elasticity of demand is the percentage change in the quantity demanded of one good divided by the percentage change in the price of another good. So the cross elasticity of demand is the percentage change in the quantity demanded of apple juice divided by the percentage change in the price of orange juice. The cross elasticity equals 14 percent divided by 12 percent, which is 1.17.

8. Swelling Textbook Costs Have College Students Saying 'Pass'

Textbook prices have been rising at double the rate of inflation for the past two decades… and nearly 60 percent of students nationwide choose not to buy all the course materials. ... For students working to pay for school or for those whose parents sweat every increase in tuition, book prices can be a nasty surprise. ... And plenty of students come up with their own strategies: Hunting down used copies and selling books back at the end of the semester; buying online, which is sometimes cheaper than the campus store; asking professors to put a copy in the library and waiting around till it’s free. Or borrowing, copying, taking careful notes in class—and gambling that the exam questions don’t come from the text. ...

Washington Post, January 23, 2006

Explain what this news clip implies about

a. The price elasticity of demand for college textbooks.

The news clip discusses ways students decrease the quantity of textbooks demanded when the price of
textbook rises. It is not possible to determine the precise elasticity of demand for textbooks, but there are substitutes for textbooks listed. In particular, a number of substitutes listed (borrowing, copying, taking careful notes in class) enable students to completely avoid buying textbooks. Additionally other substitutes listed (buying used books, selling books, buying on the Internet) enable students to pay less for their textbooks. The fairly long list of good substitutes indicates that the demand for textbooks might be elastic.

b. The income elasticity of demand for college textbooks.
Although the news clip does not directly give any information about changes in income, presumably the students working to pay for school and those whose parents sweat each price hike in tuition are the students who most frequently do not buy textbooks. So when income falls, the demand for textbooks decreases.

c. The cross elasticity of demand for college textbooks from the campus bookstore with respect to the online price of a textbook.
The cross elasticity of demand for textbooks from campus bookstores with respect to the online price of books is positive: the lower the price of online books, the lower the quantity of textbooks demanded from campus bookstores. This sign makes sense because textbooks from campus bookstores are substitutes for textbooks from online stores.

9. Home Depot Earnings Hammered
As home prices slump across the country, fewer people are spending money to renovate their homes, and the improvements that they are making are not as expensive. ... People are spending on small ticket types of repairs, ... not big ticket renovations ... With gas and food prices increasing ... people have less extra income to spend on major home improvements.

a. What does this news clip imply about the income elasticity of demand for big-ticket home-improvement items?
The news clip implies that the income elasticity of demand for big-ticket home-improvement items is positive. In particular "people have less extra income to spend" and, as a result, "fewer people are spending money to renovate their homes."

b. Would the income elasticity of demand for Spam be negative or positive? Explain.
If Spam is an inferior good, its income elasticity of demand is negative.

10. Spam Sales Rise as Food Costs Soar
Sales of Spam—that much maligned meat—are rising as consumers are turning more to lunch meats and other lower-cost foods to extend their already stretched food budgets. ... Consumers are quick to realize that meats like Spam and other processed foods can be substituted for costlier cuts as a way of controlling costs.

a. Is Spam a normal good or inferior good? Explain.
Based on the story, Spam is probably an inferior good. The idea of "stretched food budgets" implies that consumers’ incomes have fallen. And, as a result, the demand for Spam increased. The demand for Spam increased when income decreased, so Spam is an inferior good.

b. Would the income elasticity of demand for Spam be negative or positive? Explain.
If Spam is an inferior good, its income elasticity of demand is negative.

11. Study Ranks Honolulu Third Highest for ‘Unaffordable Housing’
[Study ranks] Honolulu number 3 in the world for the most unaffordable housing market in urban locations. Honolulu is listed only behind Los Angeles and San Diego and is deemed
“severely unaffordable.” ... Where there are significant constraints on the supply of land for residential development, housing inflation has occurred.

_Hawaii Reporter_, September 11, 2007

**a. Would the supply of housing in Honolulu be elastic or inelastic?**

The supply of housing is probably inelastic because it is limited by the amount of land, which is inelastically supplied. Indeed, the elasticity of supply for housing is probably close to 0.

**b. Explain how the elasticity of supply plays an important role in influencing how rapidly housing prices in Honolulu rise.**

The less elastic the supply, the more an increase in demand raises the price. Because the supply of housing is quite inelastic in Honolulu, increases in demand for housing have lead to large increases in the price of housing, that is, severe “housing inflation.”

12. The demand for illegal drugs is inelastic. Much of the expenditure on illegal drugs comes from crime. Assuming these statements to be correct,

**a. How will a successful campaign that decreases the supply of drugs influence the price of illegal drugs and the amount spent on them?**

By decreasing the supply, the price of illegal drugs will rise. Because the demand is inelastic, the total amount spent on them will increase.

**b. What will happen to the amount of crime?**

On the one hand, purchasing illegal drugs is a criminal activity so decreasing the amount of illegal drugs bought and sold decreases crime. On the other hand, many consumers of illegal drugs turn to criminal activities to raise the funds necessary to purchase the drugs. Because the total expenditure on these drugs would increase, the total amount of crime necessary to raise these funds would increase.

**c. What is the most effective way of decreasing the quantity of illegal drugs bought and decreasing the amount of drug-related crime?**

If the demand for illegal drugs decreased, then both the price and quantity of illegal drugs would fall. The total expenditure on illegal drugs also would fall. The decrease in the quantity of illegal drugs purchased would directly reduce the crime rate. Because the total expenditure spent on illegal drugs would fall, less crime would be necessary to raise these funds, so the crime rate also would fall indirectly.

13. Use the links on MyEconLab (Textbook Resources, Chapter 4, Web links) to find the number of gallons in a barrel of oil and the prices of crude oil and gasoline in the summer of 2007 and 2008.

**a. What are the other costs that make up the total cost of a gallon of gasoline?**

A barrel of oil has 42 gallons of oil. When refined, the barrel results in 44 gallons of petroleum products. (The number of gallons increases because there is a reduction in the density during the refining.) A barrel of crude oil, when refined, creates about 20 gallons of gasoline. All these data are from: http://www.eia.doe.gov/neic/infosheets/crudeproduction.htm

According to a Department of Energy brochure on the costs of a gallon of gasoline (available at http://www.eia.doe.gov/bookshelf/brochures/gasolinepricesprimer/eia1_2005primerM.html ) “The cost to produce and deliver gasoline to consumers includes the cost of crude oil to refiners, refinery processing costs, marketing and distribution costs, and finally the retail station costs and taxes. The prices paid by consumers at the pump reflect these costs, as well as the profits (and sometimes losses) of refiners, marketers, distributors, and retail station owners.”

**b. If the price of crude oil falls by 10 percent, by what percentage do you expect the price of gasoline change, other things remaining the same?**

Crude oil accounts for approximately 50 percent of the cost of a gallon of gasoline. So if the price of crude oil falls 10 percent and nothing else changes, the price of a gallon of gasoline falls by about 5 percent.
c. Which demand do you think is more elastic: that for crude oil or gasoline? Why?
   The demand for oil is probably more elastic than the demand for gasoline because there are more
   substitutes for oil than for gasoline. Crude oil is a source of energy but there are other sources of energy,
   such as coal, natural gas, nuclear power, wind power, and so forth. These other sources of energy are
   substitutes for crude oil. Gasoline is fuel primarily used for transportation and there are fewer substitutes,
   such as diesel and ethanol. Because there are more substitutes for oil, the elasticity of demand for crude oil,
   while probably inelastic, is likely larger than the elasticity of demand for gasoline.

d. Use the concepts of demand, supply, and elasticity to explain recent changes in the prices of
   crude oil and gasoline.
   Currently the price of oil is much higher than it was three or two or even one year ago. The price is higher
   because the demand for oil has increased due to higher incomes in developing nations such as India and
   China. In these rapidly growing nations, people have purchased more automobiles because cars are a
   normal good. Gasoline is a complement for cars so the demand for gasoline has increased. Because both
   the demand for and supply of gasoline and oil is inelastic, the increase in demand has resulted in sharply
   higher prices for oil and gasoline.

14. With higher fuel costs, airlines raise their fares. The average fare rises from 75¢ per passenger
   mile to $1.25 per passenger mile and the number of passenger miles decreases from 2.5 million
   a day to 1.5 million a day. Over this price range,
   a. What is the price elasticity of demand for air travel?
      The price elasticity of demand equals the absolute value of the percentage change in the quantity
      demanded divided by the percentage change in the price. The quantity demanded changes by 1.0 million
      passenger miles and the average passenger miles is 2.0 million. The percentage change in the quantity
      demanded is (1.0 million)/(2.0 million) × 100, which is 50 percent. The price changes by $0.50 and the
      average price is $1.00. The percentage change in the quantity demanded is ($0.50 /($1.00)
      × 100, which
      is 50 percent. So the price elasticity of demand is (50 percent)/(50 percent), or 1.00.
   b. Describe the demand for air travel.
      The demand for air travel between these two prices is unit elastic. The 50 percent price hike leads to a 50
      percent decrease in the quantity of air miles traveled.

15. The figure shows the demand for DVD rentals.
   a. Calculate the elasticity of demand when the
      price rises from $3 to $5 a DVD.
      The price elasticity of demand is 2. When the
      price of a DVD rental rises from $3 to $5, the
      quantity demanded of DVDs decreases from 75
      to 25 a day. The price elasticity of demand equals
      the percentage change in the quantity demanded
      divided by the percentage change in the price.
      The price increases from $3 to $5, an increase of
      $2 a DVD. The average price is $4 per DVD. So
      the percentage change in the price equals $2
      divided by $4 and then multiplied by 100, which
      equals 50 percent. The quantity decreases from
      75 to 25 DVDs, a decrease of 50 DVDs. The
      average quantity is 50 DVDs. So the percentage
      change in quantity equals 50 divided by 50 and
      then multiplied by 100, which equals 100
percent. The price elasticity of demand for DVD rentals equals 100 percent divided by 50 percent, which is 2.

b. **At what price is the elasticity of demand for DVDs equal to 1?**
The price elasticity of demand equals 1 at $3 a DVD. The price elasticity of demand equals 1 at the price halfway between the origin and the price at which the demand curve hits the y-axis. That price is $3 a DVD.

16. **The demand schedule for computer chips is given in the table.**
   a. **What happens to total revenue if the price falls from $400 to $350 a chip?**
      When the price of a chip is $400, 30 million chips are sold and total revenue equals $12,000 million. When the price of a chip falls to $350, 35 million chips are sold and total revenue is $12,250 million. The total revenue increases when the price falls.
   
   b. **What happens to total revenue if the price falls from $350 to $300 a chip?**
      When the price is $350 a chip, 35 million chips are sold and total revenue is $12,250 million. When the price of a chip is $300, 40 million chips are sold and total revenue decreases to $12,000 million. The total revenue decreases as the price falls.
   
   c. **At what price is total revenue at a maximum?**
      Total revenue is maximized at $350 a chip. When the price of a chip is $300, 40 million chips are sold and total revenue equals $12,000 million. When the price is $350 a chip, 35 million chips are sold and total revenue equals $12,250 million. Total revenue increases when the price rises from $300 to $350 a chip. When the price is $400 a chip, 30 million chips are sold and total revenue equals $12,000 million. Total revenue decreases when the price rises from $350 to $400 a chip. Total revenue is maximized when the price is $350 a chip.
   
   d. **At an average price of $350, is the demand for chips elastic, inelastic, or unit elastic? Use the total revenue test to answer this question.**
      The demand for chips is unit elastic. The total revenue test says that if the price changes and total revenue remains the same, the demand is unit elastic at the average price. For an average price of $350 a chip, cut the price from $400 to $300 a chip. When the price of a chip falls from $400 to $300, the total revenue remains at $12,000 million. So at the average price of $350 a chip, demand is unit elastic.

17. **In problem 16, at $250 a chip, is the demand for chips elastic or inelastic? Use the total revenue test to answer this question.**
    The demand for chips is inelastic. The total revenue test says that if the price falls and total revenue falls, the demand is inelastic. When the price falls from $300 to $200 a chip, total revenue decreases from $12,000 million to $10,000 million. So at an average price of $250 a chip, demand is inelastic.

18. **Your price elasticity of demand for bananas is 4. If the price of bananas rises by 5 percent, what is**
   a. **The percentage change in the quantity of bananas you buy?**
      The quantity of bananas you buy decreases by 20 percent. The price elasticity of demand equals the percentage change in the quantity demanded divided by the percentage change in the price. Rearranging this formula shows that the percentage change in the quantity demanded equals the price elasticity of demand multiplied by the percentage change in the price. In the case at hand, the percentage change in the quantity demanded equals $4 \times 5$ percent, which is 20 percent.
b. The change in your expenditure on bananas?
Your total expenditure decreases because your demand is elastic. The fall in expenditure is approximately 15 percent, the 5 percent rise in price offset by the 20 percent decrease in the quantity purchased.

19. Why Gasoline Follows Oil Up But Not Down
If it seems like gasoline prices are quick to skyrocket when the price of oil goes up, but then take their sweet ‘ol time coming back down when crude prices sink, the answer is simple: They do. “There is a rocket and feather aspect.”... The service stations are still selling the same amount of gasoline when wholesale prices fall... “so there’s no reason to drop. ...[Service stations] typically react [to a spike in oil prices] by pushing prices higher, even before they replace their inventories...” Eventually, the free market steps in and prices begin going down when other nearby stations reduce their price.

a. Explain the link between the elasticity of supply of gasoline and gas price fluctuations.
The short-run elasticity of supply is small and the supply of gasoline is inelastic. As a result, in the short run fluctuations in demand lead to large fluctuations in the price and small fluctuations in the quantity. In the longer run the elasticity of supply becomes larger, so in the longer run fluctuations in demand lead to smaller price swings and larger quantity changes.

b. Explain the connection between the elasticity of demand for gasoline and the “rocket and feather” tendency of price fluctuations.
The short-run elasticity of demand is quite small and the demand for gasoline is inelastic. As a result, in the short run fluctuations in supply lead to large fluctuations in the price and small fluctuations in the quantity. In the longer run the elasticity of demand becomes larger in magnitude (though demand remains inelastic) so in the longer run fluctuations in supply lead to smaller price changes and larger quantity changes. So the price will “rocket” up in the short run and then “feather” back down in the longer run.

20. As Gasoline Prices Soar, Americans Slowly Adapt
... in March, Americans drove 11 billion fewer miles than in March 2007... “People have recognized that prices are not going down and are adapting to higher energy cost.” ... Americans spend 3.7 percent of their disposable income on transportation fuels. At its lowest point, that share was 1.9 percent in 1998, and at its highest it reached 4.5 percent in 1981... “We actually have a lot of choices, based on what car we drive, where we live, how much time we choose to drive, and where we choose to go.” For many people, higher energy costs mean fewer restaurant meals, deferred weekend outings with the kids, less air travel and more time closer to home. ...

a. List and explain the elasticities of demand that are implicitly referred to in the news clip.
The elasticities to which the clip refers are the income elasticity of demand, the price elasticity of demand, and the cross elasticity of demand. The income elasticity of demand is reflected in the news clip’s discussion of the fraction of income spent on transportation fuels. More references are made to the factors that influence the price elasticity of demand. The article lists many substitutions households can make in response to higher fuel prices. In particular the type of car a family can drive, where the family lives, and where the family chooses to go reflect substitution methods that households can use to decrease the quantity of gasoline demanded. In addition, discussion of “fewer restaurant meals, deferred weekend outings with the kids, less air travel and more time closer to home” suggest that higher gasoline prices have an income effect that decreases the quantity demanded. It is the strength of these factors that determines the magnitude of the price elasticity of demand for fuel. Additionally these activities, such as smaller cars, more time closer to home, are also the substitutes that people use in place of gasoline. The news clips
suggests that these activities increase in response to the higher price of gasoline, indicating that they are substitutes for gasoline so that their cross elasticity of demand with respect to the price of gasoline is positive.

b. **Explain the factors identified in the news clip that may make the demand for gasoline inelastic.**

   One factor listed that helps make the demand for gasoline inelastic is the point that gasoline accounts for only a relatively small fraction of people's incomes. Another factor is more qualitative: none of the substitutions listed for gasoline—the type of car the family drives and so forth—are particularly close substitutes for gasoline. Hence the absence of close substitutes combined with the relatively small fraction of income spent on gasoline combine to make the demand for gasoline inelastic.

21. **When Alex’s income increased from $3,000 to $5,000, he increased his consumption of bagels from 4 to 8 a month and decreased his consumption of donuts from 12 to 6 a month. Calculate Alex’s income elasticity of demand for**

   a. **Bagels.**

      The income elasticity of demand equals the percentage change in the quantity demanded divided by the percentage change in income. The change in income is $2,000 and the average income is $4,000, so the percentage change in income equals 50 percent. The change in the quantity demanded is 4 bagels and the average quantity demanded is 6 bagels, so the percentage change in the quantity demanded equals 66.67 percent. The income elasticity of demand for bagels equals (66.67 percent)/(50 percent), which is 1.33.

   b. **Donuts.**

      From part a, the percentage change in income is 50 percent. The change in the quantity demanded is −6 donuts and the average quantity demanded is 9 donuts, so the percentage change in the quantity demanded is −66.67 percent. The income elasticity of demand for donuts equals (−66.67 percent)/(50 percent), which is −1.33.

22. **Wal-Mart’s Recession-Time Pet Project**

   Wal-Mart … is “redefining” the pets business in its stores, including repositioning pet food and supplies right in front of its other fast-growing business, baby products. There lies the connection, according to retail industry experts, who point out that kids and pets tend to be fairly recession-resistant businesses. Even in a recession, dogs will be fed and kids will get their toys…

   **CNN, May 13, 2008**

   a. **What does this news clip imply about the income elasticity of demand for pet food and baby products?**

      The news clip implies that both pet food and baby food are necessities. Their income elasticities of demand are positive but small (since they “tend to be fairly recession resistant businesses”).

   b. **Would the income elasticity of demand be greater or less than 1? Explain.**

      The income elasticities of demand are less than 1 because they are necessities.

23. **Netflix to Offer Online Movie Viewing**

   Online movie rental service Netflix introduced a new feature Tuesday to allow customers to watch movies and television series on their personal computers. ... Netflix has been competing with video rental retailer Blockbuster, which has added an online rental service to the in-store rental service.

   **CNN, January 16 2007**

   a. **How will the offering of online movie viewing influence the price elasticity of demand for in-store movie rentals?**

      The price elasticity of demand for store rental movies will increase because online movie viewing is another
substitute for renting movies.

b. **Would the cross elasticity of demand for online movies and in-store movie rentals be negative or positive? Explain.**
   
   Online movies and in-store rental movies are substitutes, so their cross elasticity of demand is positive.

c. **Would the cross elasticity of demand for online movies with respect to high-speed internet service be negative or positive? Explain.**
   
   Online movies and high-speed Internet service are complements, so their cross elasticity of demand is negative.

24. **To Love, Honor, and Save Money**

   Nearly half of caterers and event planners surveyed ... said they were seeing declines in wedding spending in response to the economic slowdown; 12% even reported wedding cancellations because of financial concerns.

   *Time*, June 2, 2008

   a. **Based upon this news clip, are wedding events a normal good or inferior good? Explain.**
   
   Based on the news clip, wedding events are a normal good. The economic slowdown means that people’s incomes are falling and, as a result, the demand for wedding events is decreasing.

   b. **Are wedding events more of a necessity or luxury? Explain.**
   
   Wedding events are a luxury. Wedding events are not necessities because couples can marry with plain weddings; indeed, couples can marry using a civil ceremony and with no wedding event at all.

   c. **Given your answer to b, would that make the income elasticity of demand greater than 1, less than 1, or equal to 1?**
   
   If wedding events are a luxury, their income elasticity of demand is greater than 1.

25. **The table gives the supply schedule of long distance phone calls. Calculate the elasticity of supply when**

   a. **The price falls from 40 cents to 30 cents a minute.**
   
   The elasticity of supply is 1. The elasticity of supply is the percentage change in the quantity supplied divided by the percentage change in the price. When the price falls from 40 cents to 30 cents, the change in the price is 10 cents and the average price is 35 cents. The percentage change in the price is 28.57 percent. When the price falls from 40 cents to 30 cents, the quantity supplied decreases from 800 to 600 calls. The change in the quantity supplied is 200 calls, and the average quantity is 700 calls, so the percentage change in the quantity supplied is 28.57 percent. The elasticity of supply equals (28.57 percent)/(28.57 percent), which is 1.

   b. **The average price is 20 cents a minute.**
   
   The elasticity of supply is 1. The formula for the elasticity of supply calculates the elasticity at the average price. So to find the elasticity at an average price of 20 cents a minute, change the price such that 20 cents is the average price—for example, a fall in the price from 30 cents to 10 cents a minute. When the price falls from 30 cents to 10 cents, the change in the price is 20 cents and the average price is 20 cents. The percentage change in the price is 100 percent. When the price falls from 30 cents to 10 cents, the quantity supplied decreases from 600 to 200 calls. The change in the quantity supplied is 400 calls and the average quantity is 400 calls. The percentage change in the quantity supplied is 100 percent. The elasticity of supply is the percentage change in the quantity supplied divided by the percentage change in the price. The elasticity of supply is 1.

26. **Study Reading Between the Lines on pp. 100–101 and then answer the following questions.**

   a. **What factors other than the price of gasoline would you expect to influence California**
motorists’ planned purchases of gasoline?
Income and the size of cars that people drive both influence motorists’ demand for gasoline.

b. In which directions would the factors that you identified in a change the demand for gasoline in California?
Income did not change much in the time period under consideration, so its effect was probably quite small. The fleet of cars that Californians drove became more fuel efficient over that time period, so this factor likely decreased the demand for gasoline.

c. How would the changes in the demand for gasoline have biased our estimate of the price elasticity of demand for gasoline?
If the demand for gasoline decreased, then the measured fall in the quantity of gasoline reflects both the effect from the higher price and the effect from the decrease in demand. The total decrease in the quantity is larger than the decrease that results from the higher price and so the price elasticity of demand calculated from the data would be larger than the true price elasticity of demand.

d. Given the influence of the price of gasoline on the demand for small vehicles and large vehicles, how would you expect the prices of small vehicles and large vehicles to have changed in 2008?
The prices of small vehicles rose and the prices of large vehicles fell.

e. What elasticities do you need to know to predict the magnitude of the changes in the prices of small vehicles and large vehicles?
To calculate the magnitude of the price change of small and large vehicles the cross elasticity of demand between the price of gasoline and the quantity demanded of small and large vehicles is needed. This elasticity will yield the change in the quantity. Then the price elasticity of supply for small and large vehicles is necessary to determine the effect of the change in quantity on the price of small and large vehicles.

f. If the prices of cars did change in 2008 in the directions that you have predicted in d, how would these changes impact our estimates of the cross elasticities of demand for small vehicles and large vehicles with respect to the price of gasoline?
If the price of small cars rose, then the change in the quantity demanded of small cars was the result of two factors: The higher price for small cars, which decreases the quantity demanded, and the higher price of gasoline, which increases the quantity demanded of small cars. Hence the total change in the quantity demanded is less than would occur if only the price of gasoline rose, so the cross elasticity of demand as calculated is for small vehicles is smaller than the “true” cross elasticity of demand. For large vehicles, the change in the quantity demanded is again the result of two factors: The lower price for large cars increases the quantity demanded and the higher price of gasoline decreases the quantity demanded. Hence the total change in the quantity demanded is larger than would occur if only the price of gasoline rose, so the cross elasticity of demand as calculated is for large vehicles is larger than the “true” cross elasticity of demand.

g. How would you expect the demand for vehicles to change in the long run in response to a permanent rise in the price of gasoline?
In the long run, the change in demand will be larger than in the short run. In the long run the increase in demand for small cars will be larger than in the short run and the decrease in demand for large cars will be larger than in the short run.
Additional Problems

1. Better-than-average weather brings a bumper tomato crop. The price of tomatoes falls from $6 to $4 a basket, and the quantity demanded increases from 200 to 400 baskets a day. Over this price range,
   a. What is the price elasticity of demand?
   b. Describe the demand for tomatoes.

2. The figure shows the demand for pens.
   a. Calculate the elasticity of demand for a rise in price from $2 to $4.
   b. At what prices is the elasticity of demand equal to 1, greater than 1, and less than 1?

3. If the quantity of fish demanded decreases by 5 percent when the price of fish rises by 10 percent, is the demand for fish elastic, inelastic, or unit elastic?

4. The table gives the demand schedule for coffee.
   a. What happens to total revenue if the price of coffee rises from $10 to $20 per pound?
   b. What happens to total revenue if the price rises to $15 to $25 per pound?
   c. What is the price when total revenue at a maximum?
   d. What quantity of coffee will be sold at the price that answers part c?
   e. At an average price of $15 a pound, is the demand for coffee elastic or inelastic? Use the total revenue test to answer this question.

5. If a 10 percent fall in the price of beef increases the quantity of beef demanded by 20 percent and decreases the quantity of chicken demanded by 15 percent, calculate the cross elasticity of demand between beef and chicken.

6. Judy’s income has increased from $10,000 to $12,000. Judy increased her demand for concert tickets by 10 percent and decreased her demand for bus rides by 5 percent. Calculate Judy’s income elasticity of demand for (a) concert tickets and (b) bus rides.
7. The table gives the supply schedule for shoes. Calculate the elasticity of supply when
   a. The price rises from $125 to $135 a pair.
   b. The price is $125 a pair.

<table>
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<th>Price (dollars per pair)</th>
<th>Quantity supplied (millions of pairs per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
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</tr>
<tr>
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<td>130</td>
<td>1,600</td>
</tr>
<tr>
<td>135</td>
<td>1,800</td>
</tr>
</tbody>
</table>
Solutions to Additional Problems

1. a. The price elasticity of demand is 1.67. The price elasticity of demand equals the percentage change in the quantity demanded divided by the percentage change in the price. The price falls from $6 to $4 a basket, a fall of $2 a basket. The average price is $5 a basket. So the percentage change in the price equals $2 divided by $5 and then multiplied by 100, which equals 40 percent. The quantity increases from 200 to 400 baskets, an increase of 200 baskets. The average quantity is 300 baskets. So the percentage change in quantity equals 200 divided by 300 and then multiplied by 100, which equals 66.7 percent. The price elasticity of demand for tomatoes equals 66.7 percent divided by 40 percent, which is 1.67.

b. The price elasticity of demand exceeds 1, so the demand for tomatoes is elastic.

2. a. The price elasticity of demand is 0.33. When the price of a pen rises from $2 to $4, the quantity demanded of pens decreases from 100 to 80 a day. The price elasticity of demand equals the percentage change in the quantity demanded divided by the percentage change in the price. The price increases from $2 to $4, an increase of $2 a pen. The average price is $3 a pen. So the percentage change in the price equals $2 divided by $3 and then multiplied by 100, which equals 66.7 percent. The quantity decreases from 100 to 80 pens, a decrease of 20 pens. The average quantity is 90 pens. So the percentage change in quantity equals 20 divided by 90 and then multiplied by 100, which equals 22 percent. The price elasticity of demand for pens equals 22 percent divided by 66.7 percent, which is 0.33.

b. The price elasticity of demand equals 1 at $6 a pen. The price elasticity of demand is greater than 1 at prices greater than $6 a pen. The price elasticity of demand is less than 1 at prices less than $6 a pen. The price elasticity of demand equals 1 at the price halfway between the origin and the price at which the demand curve hits the y-axis. That price is $6 a pen. The demand curve is linear. Along a linear demand curve, the price elasticity of demand is greater than 1 at points above the midpoint and less than 1 at points below the midpoint. The price elasticity of demand is greater than 1 at prices above $6 a pen and less than 1 at prices below $6 a pen.

3. The demand for fish is inelastic. The price elasticity of demand for fish equals the percentage change in the quantity of fish demanded divided by the percentage change in the price of fish. The price elasticity of demand equals 5 percent divided by 10 percent, which is 0.5. The demand is inelastic.

4. a. Total revenue increases. When the price of a pound of coffee is $10, 30 million pounds are sold and total revenue equals $300 million. When the price of a pound of coffee rises to $20, 20 million pounds are sold and total revenue is $400 million. Total revenue increases.

b. Total revenue does not change. When the price of a pound of coffee is $15, 25 million pounds are sold and total revenue is $375 million. When the price of a pound of coffee is $25, 15 million pounds are sold and total revenue is $375 million. Total revenue does not change.

c. Total revenue is maximized at $20 a pound. When the price of a pound of coffee is $20, 20 million pounds are sold and total revenue equals $400 million. When the price is $15 a pound, 25 million pounds are sold and total revenue equals $375 million. Total revenue increases as the price rises from $15 to $20 a pound. When the price is $25 a pound, 15 million pounds are sold and total revenue equals $375 million. Total revenue decreases as the price rises from $20 to $25 a pound. Total revenue is maximized when the price is $20 a pound.

d. The quantity will be 20 million pounds a year. The demand schedule tells us that when the price is $20 a pound, the quantity of coffee demanded is 20 million pounds a year.

e. The demand for coffee inelastic. The total revenue test says that if the price rises and total revenue increases, the demand is inelastic at the average price. For an average price of $15 a pound, raise the price from $10 to
$20 a pound. When the price of a pound rises from $10 to $20, total revenue increases from $300 million to $400 million. So at the average price of $15 a pound, demand is inelastic.

5. The cross elasticity of demand between beef and chicken is 2. The cross elasticity of demand is the percentage change in the quantity demanded of one good divided by the percentage change in the price of another good. The fall in the price of beef resulted in a decrease in the quantity demanded of chicken. So the cross elasticity of demand is the percentage change in the quantity demanded of chicken divided by the percentage change in the price of beef. The cross elasticity equals 20 percent divided by 10 percent, which is 2.

6. Income elasticity of demand for (a) concert tickets is 0.55 and (b) bus rides is −0.275. Income elasticity of demand equals the percentage change in the quantity demanded divided by the percentage change in income. The change in income is $2,000 and the average income is $11,000, so the percentage change in income equals 18.2 percent.
   a. The change in the quantity demanded of concert tickets is 10 percent. The income elasticity of demand for concert tickets equals 10/18.2, which is 0.55.
   b. The change in the quantity demanded of bus rides is −5 percent. The income elasticity of demand for bus rides equals −5/18.2, which is −0.275.

7. a. The elasticity of supply is 3.25. The elasticity of supply is the percentage change in the quantity supplied divided by the percentage change in the price. When the price rises from $125 to $135, the change in the price is $10 and the average price is $130. The percentage change in the price is 7.7 percent. When the price rises from $125 to $135, the quantity supplied increases from 1,400 million to 1,800 million pairs. The change in the quantity supplied is 400 million pairs, and the average quantity is 1,600 million pairs, so the percentage change in the quantity supplied is 25 percent. The elasticity of supply equals (25 percent)/(7.7 percent), which equals 3.25.
   b. The elasticity of supply is 3.57. The formula for the elasticity of supply calculates the elasticity at the average price. So to find the elasticity of supply at $125, change the price such that $125 is the average price—for example, a fall in the price from $130 to $120. When the price falls from $130 to $120, the change in the price is $10 and the average price is $125. The percentage change in the price is 8 percent. When the price falls from $130 to $120, the quantity supplied decreases from 1,600 million to 1,200 million pairs. The change in the quantity supplied is 400 millions pairs and the average quantity is 1,400 million pairs. The percentage change in the quantity supplied is 28.57 percent. The elasticity of supply is the percentage change in the quantity supplied divided by the percentage change in the price. The elasticity of supply is 3.57.