



# 1

## GRAPHS IN ECONOMICS

### Answers to the Review Quiz

#### Page 26

**1. Explain how we “read” the three graphs in Figs A1.1 and A1.2.**

The points in the graphs relate the quantity of the variable measured on the one axis to the quantity of the variable measured on the other axis. The quantity of the variable measured on the horizontal axis (the  $x$ -axis) is measured by the horizontal distance from the origin to the point. Similarly, the quantity of the variable measured on the vertical axis (the  $y$ -axis) is measured by the vertical distance from the origin to the point. The point relates these two quantities. For instance, in Figure A1.2a, point  $A$  shows that at a price of 99 cents per song, 8.3 million songs are downloaded.

**2. Explain what scatter diagrams show and why we use them.**

Scatter diagrams plot the value of one economic variable against the value of another variable for a number of different values of each variable. We use scatter diagrams because they quickly reveal if a relationship exists between the two variables. Moreover, if a relationship exists, scatter diagrams show whether increases in one variable are associated with increases or decreases in the other variable.

**3. Explain how we “read” the three scatter diagrams in Figs A1.3 and A1.4.**

The scatter diagram in Figure A1.3 shows the relationship between box office ticket sales and DVDs sold for 8 popular movies. The figure shows that higher box office sales are associated with a higher number of DVDs sold. But the figure shows that the relationship is weak because the points tend to be widespread.

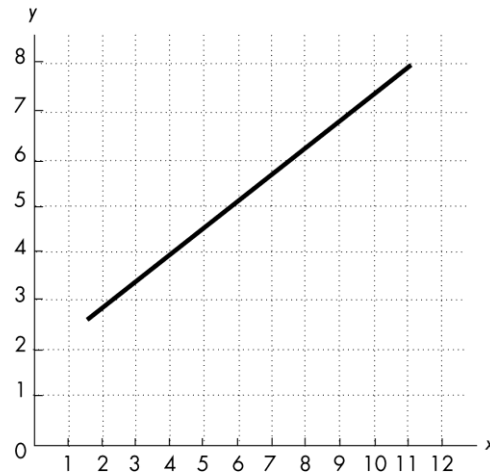
The scatter diagram in Figure A1.4a shows the relationship between income, in thousands of dollars per year, and expenditure, also in thousands of dollars per year, for the years 2000 to 2009. The scatter diagram shows that higher income leads to higher expenditure. The figure also shows that the relationship is relatively strong because the points tend to be narrowly clustered along the positive relationship.

The scatter diagram in Figure A1.4b shows the relationship between the inflation rate and the unemployment rate for the years 2000 to 2009. The figure shows that for most of the years, there was no relationship between these variables, although in 2009 the high unemployment rate brought a low inflation rate.

**4. Draw a graph to show the relationship between two variables that move in the same direction.**

A graph that shows the relationship between two variables that move in the same direction is shown by a line that slopes upward. Figure A1.1 illustrates such a relationship.

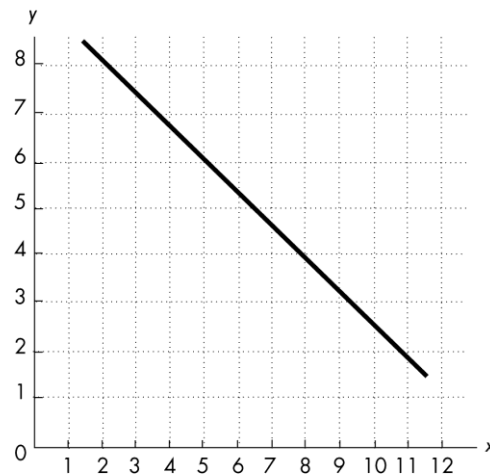
**FIGURE A1.1**  
**Review problem 4**



**5. Draw a graph to show the relationship between two variables that move in opposite directions.**

A graph that shows the relationship between two variables that move in the opposite directions is shown by a line that slopes downward. Figure A1.2 illustrates such a relationship.

**FIGURE A1.2**  
**Review problem 5**

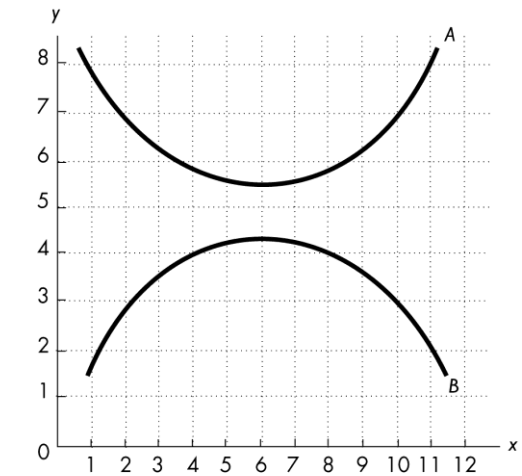


6. **Draw a graph to show the relationship between two variables that have a maximum and a minimum.**

A graph that shows the relationship between two variables that have a maximum is shown by a line that starts out sloping upward, reaches a maximum, and then slopes downward. Figure A1.3 illustrates such a relationship with curve *B*.

A graph that shows the relationship between two variables that have a minimum is shown by a line that starts out sloping downward, reaches a minimum, and then slopes upward. Figure A1.3 illustrates such a relationship with curve *A*.

**FIGURE A1.3**  
**Review problem 6**



7. **Which of the relationships in Questions 4 and 5 is a positive relationship and which is a negative relationship?**

The relationship in Question 4 between the two variables that move in the same direction is a positive relationship. The relationship in Question 5 between the two variables that move in the opposite directions is a negative relationship.

8. **What are the two ways of calculating the slope of a curved line?**

To calculate the slope of a curved line we can calculate the slope at a point or across an arc. The slope of a curved line at a point on the line is defined as the slope of the straight line tangent to the curved line at that point. The slope of a curved line across an arc—between two points on the curved line—equals the slope of the straight line between the two points.

9. **How do we graph a relationship among more than two variables?**

To graph a relationship among more than two variables, hold constant the values of all the variables except two. Then plot the value of one of the variables against the other variable.

10. **Explain what change will bring a *movement along a curve*.**

A movement along a curve occurs when the value of a variable on one of the axes changes while all of the other relevant variables not graphed on the axes do not change. The movement along the curve shows the effect of the variable that changes, *ceteris paribus* (holding all of the other non-graphed variables constant).

11. **Explain what change will bring a *shift of a curve*.**

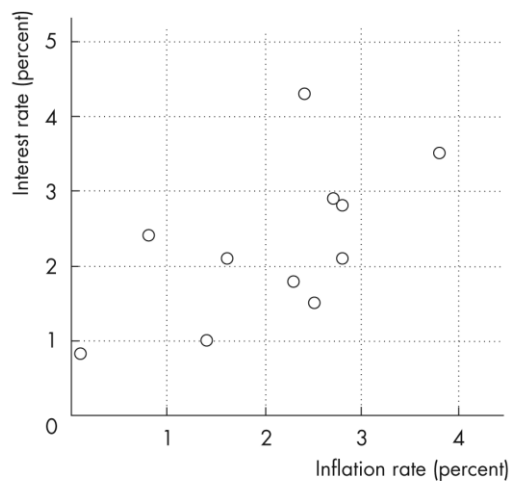
A curve shifts when there is a change in the value of a relevant variable that is not graphed on the axes. In this case the entire curve shifts.

## Answers to Study Plan Problems and Applications

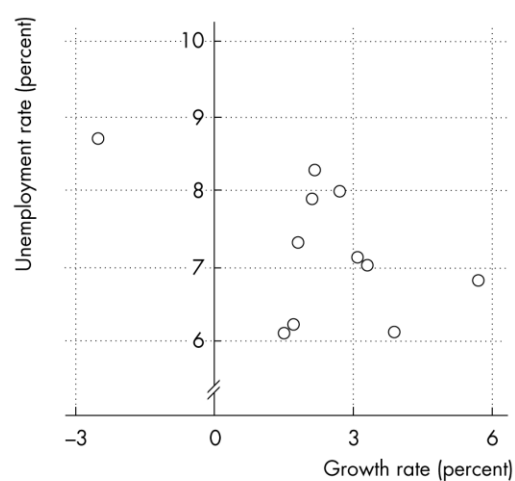
Use the spreadsheet to work Problems 1 to 3. The spreadsheet provides data on the U.S. economy: Column A is the year, column B is the inflation rate, column C is the interest rate, column D is the growth rate, and column E is the unemployment rate.

	A	B	C	D	E
1	2000	2.4	4.3	5.7	6.8
1	2001	3.8	3.5	3.1	7.1
2	2002	0.8	2.4	2.1	7.9
3	2003	2.5	1.5	2.7	8.0
4	2004	2.3	1.8	1.8	7.3
5	2005	1.6	2.1	3.3	7.0
6	2006	2.8	2.8	3.9	6.1
7	2007	2.7	2.9	1.5	6.1
8	2008	2.8	2.1	1.7	6.2
8	2009	0.1	0.82	-2.5	8.7
10	2010	1.4	1.0	2.2	8.3

1. Draw a scatter diagram of the inflation rate and the interest rate. Describe the relationship. **FIGURE A1.4 Problem 1**



2. Draw a scatter diagram of the growth rate and the unemployment rate. Describe the relationship. **FIGURE A1.5 Problem 2**



To make a scatter diagram of the inflation rate and the interest rate, plot the inflation rate on the  $x$ -axis and the interest rate on the  $y$ -axis. The graph will be a set of dots and is shown in Figure A1.4. The pattern made by the dots tells us that as the inflation rate increases, the interest rate usually increases so there is a positive relationship.

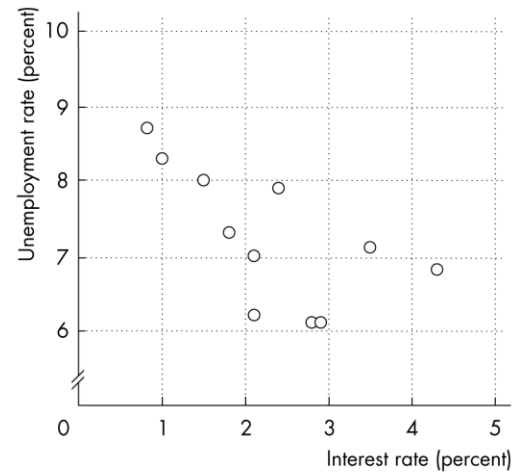
2. Draw a scatter diagram of the growth rate and the unemployment rate. Describe the relationship.

To make a scatter diagram of the growth rate and the unemployment rate, plot the growth rate on the  $x$ -axis and the unemployment rate on the  $y$ -axis. The graph will be a set of dots and is shown in Figure A1.5. The pattern made by the dots tells us that when the growth rate increases, the unemployment rate usually decreases so there is a negative relationship.

3. **Draw a scatter diagram of the interest rate and the unemployment rate. Describe the relationship.**

To make a scatter diagram of the interest rate and the unemployment rate, plot the interest rate on the  $x$ -axis and the unemployment rate on the  $y$ -axis. The graph will be a set of dots and is shown in Figure A1.6. The pattern made by the dots tells us that when the interest rate increases, the unemployment rate usually decreases so there is a negative relationship.

FIGURE A1.6  
Problem 3



Use the following news clip to work Problems 4 to 6.

***Clash of the Titans* Tops Box Office With Sales of \$61.2 Million:**

Source: Bloomberg.com, April 5, 2010

4. **Draw a graph of the relationship between the revenue per theatre on the  $y$ -axis and the number of theatres on the  $x$ -axis. Describe the relationship.**

Figure A1.7 shows the relationship. As the figure shows, there is perhaps a positive relationship. But this relationship is extremely inconsistent. In particular, the second largest revenue per theatre occurred in the smallest number of theatres while the largest revenue per theatre occurred in the second largest number of theatres.

Movie	Theatres (number)	Revenue (dollars per theatre)
<i>Clash of the Titans</i>	3,777	16,213
<i>Tyler Perry's Why</i>	2,155	13,591
<i>Did I Get Married</i>		
<i>How To Train Your Dragon</i>	4,060	7,145
<i>The Last Song</i>	2,673	5,989

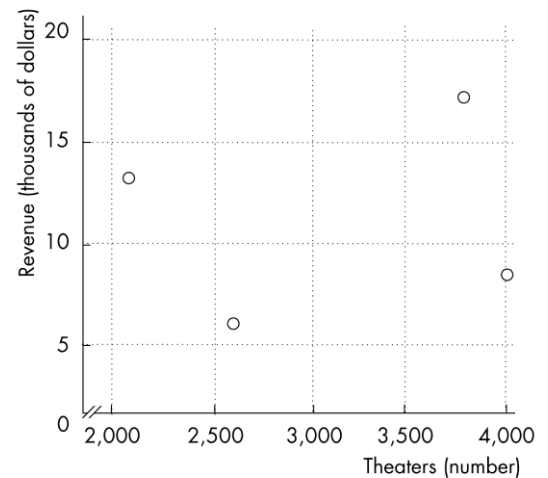
5. **Calculate the slope of the relationship between 4,060 and 2,673 theatres.**

The slope equals the change in revenue per theatre divided by the change in the number of theatres.  
The slope equals  $(\$7,145 - \$5,989)/(4,060 - 2,673)$  which equals \$0.83 per theatre.

6. **Calculate the slope of the relationship between 2,155 and 4,060 theatres.**

The slope equals the change in revenue per theatre divided by the change in the number of theatres.  
The slope equals  $(\$13,591 - \$7,145)/(2,155 - 4,060)$  which equals  $-\$3.38$  per theatre.

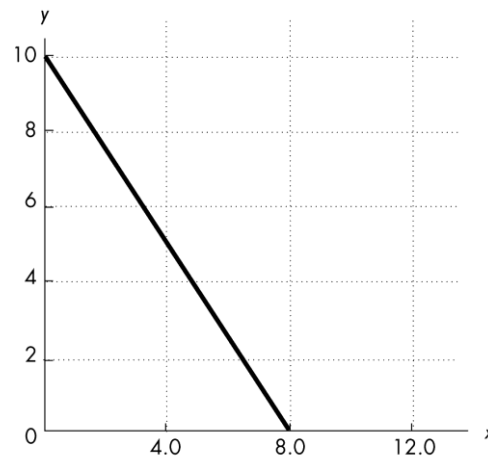
FIGURE A1.7  
Problem 4



7. **Calculate the slope of the relationship shown in Figure A1.8.**

The slope is  $-5/4$ . The curve is a straight line, so its slope is the same at all points on the curve. Slope equals the change in the variable on the  $y$ -axis divided by the change in the variable on the  $x$ -axis. To calculate the slope, you must select two points on the line. One point is at 10 on the  $y$ -axis and 0 on the  $x$ -axis, and another is at 8 on the  $x$ -axis and 0 on the  $y$ -axis. The change in  $y$  from 10 to 0 is associated with the change in  $x$  from 0 to 8. Therefore the slope of the curve equals  $-10/8$ , which equals  $-5/4$ .

FIGURE A1.8  
Problem 7



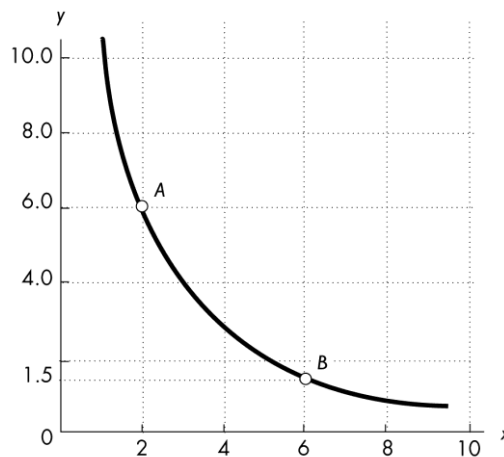
Use the relationship shown in Figure A1.9 to work Problems 8 and 9.

8. **Calculate the slope of the relationship at point A and at point B.**

The slope at point A is  $-2$ , and the slope at point B is  $-0.25$ . To calculate the slope at a point on a curved line, draw the tangent to the curved line at the point. Then find a second point on the tangent and calculate the slope of the tangent. The tangent at point A cuts the  $y$ -axis at 10. The slope of the tangent equals the change in  $y$  divided by the change in  $x$ . The change in  $y$  equals  $-4$  (6 minus 10) and the change in  $x$  equals 2 (2 minus 0). The slope at point A is  $-4/2$ , which equals  $-2$ .

Similarly, the slope at point B is  $-0.25$ . The tangent at point B goes through the point (4, 2). The change in  $y$  equals 0.5, and the change in  $x$  equals  $-2$ . The slope at point B is  $-0.25$ .

FIGURE A1.9  
Problems 8 and 9



9. **Calculate the slope across the arc AB.**

The slope across the arc AB is  $-1.125$ . The slope across an arc AB equals the change in  $y$ , which is 4.5 (6.0 minus 1.5) divided by the change in  $x$ , which equals  $-4$  (2 minus 6). The slope across the arc AB equals  $4.5/-4$ , which is  $-1.125$ .

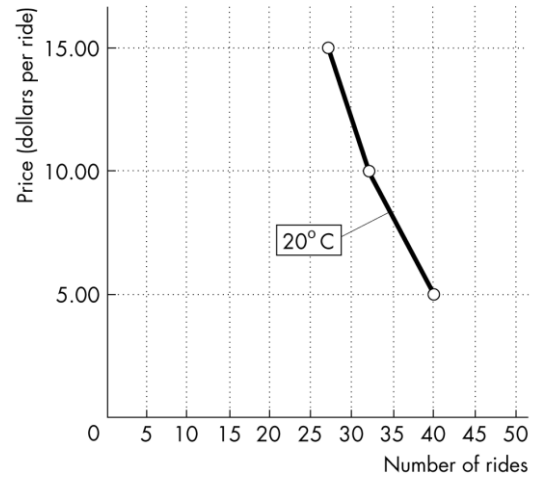
Use the table to work Problems 10 and 11. The table gives the price of a balloon ride, the temperature, and the number of rides a day.

10. Draw a graph to show the relationship between the price and the number of rides, when temperature is 20°C. Describe this relationship.

Figure A1.10 shows the relationship between the price and the number of balloon rides when the temperature is 20°C. The relationship between the price and the number of rides is an inverse relationship; that is, when the price rises, the number of rides decreases.

Price (dollars per ride)	Balloon rides (number per day)		
	10°C	20°C	30°C
5.00	32	40	50
10.00	27	32	40
15.00	18	27	32

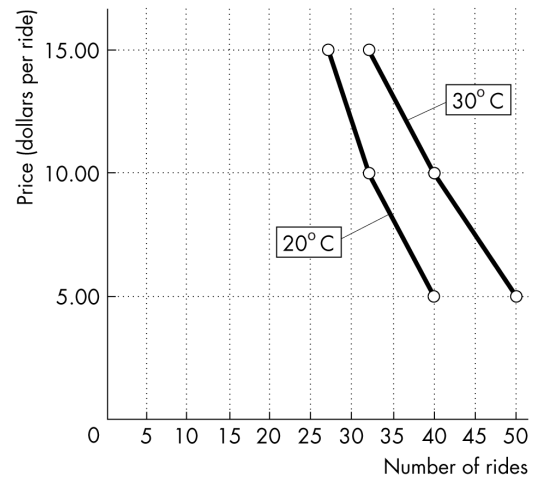
FIGURE A1.10  
Problem 10



11. What happens in the graph in Problem 10 if the temperature rises to 30°C?

If the temperature rises to 30°C, the curve shifts rightward. This shift is illustrated in Figure A1.11. In that figure, both the initial curve, which applies when the temperature is 20°C, and the new curve, which applies when the temperature is 30°C, are illustrated. The curve when the temperature is 30°C lies to the right of the curve when the temperature is 20°C indicating that at every price, more balloon rides are taken when the temperature is 30°C rather than 20°C.

FIGURE A1.11  
Problem 11



## Answers to Additional Problems and Applications

Use the spreadsheet to work Problems 12 to 14. The spreadsheet provides data on oil and gasoline: Column A is the year, column B is the price of oil (dollars per barrel), column C is the price of gasoline (cents per litre), column D is the quantity of crude oil produced, and column E is the quantity of gasoline refined (both in millions of barrels per day).

	A	B	C	D	E
1	1999	24	29	5.9	8.1
2	2000	30	38	5.8	8.2
3	2001	17	37	5.8	8.3
4	2002	24	35	5.7	8.4
5	2003	27	40	5.7	8.5
6	2004	37	47	5.4	8.7
7	2005	49	58	5.2	8.7
8	2006	56	65	5.1	8.9
9	2007	86	71	5.1	9.0
10	2008	43	82	5.0	8.9
11	2009	76	60	4.9	8.9

FIGURE A1.12

Problem 12

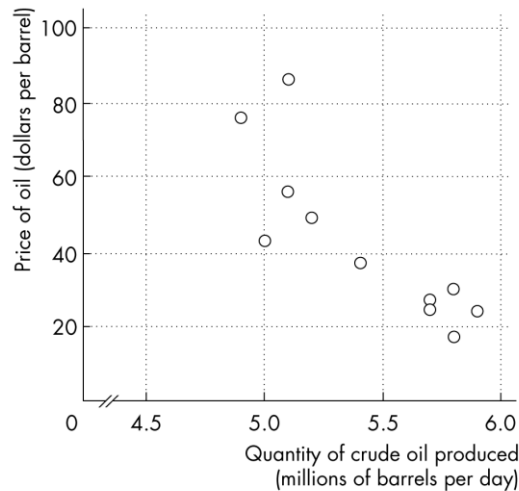
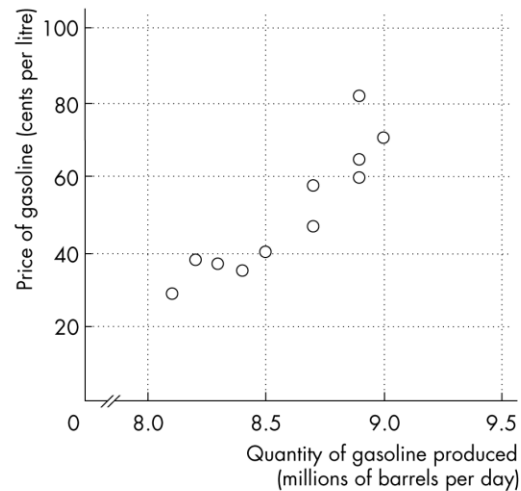


FIGURE A1.13

Problem 13



12. Draw a scatter diagram of the price of oil and the quantity of crude oil produced. Describe the relationship.

Figure A1.12 shows the scatter diagram between the price of a barrel of oil and the quantity of crude oil produced. It shows a negative relationship.

13. Draw a scatter diagram of the price of gasoline and the quantity of gasoline refined. Describe the relationship.

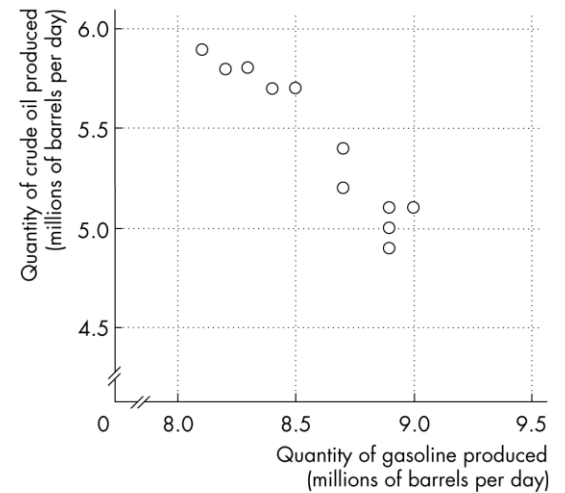
Figure A1.13 shows the scatter diagram between the price of a gallon of gasoline and the quantity of gasoline refined. It shows a positive relationship.



14. Draw a scatter diagram of the quantity of crude oil produced and the quantity of gasoline refined. Describe the relationship.

Figure A1.14 shows the scatter diagram between the quantity of crude oil produced and the quantity of gasoline refined. It shows a negative relationship.

FIGURE A1.14  
Problem 14

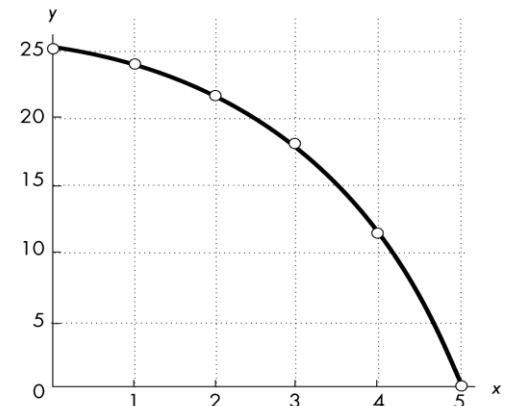


- Use the following data to work Problems 15 to 17.  
Draw a graph that shows the relationship between the two variables  $x$  and  $y$  in the table to the right.

To make a graph that shows the relationship between  $x$  and  $y$ , plot the  $x$  variable on the  $x$ -axis and the  $y$  variable on the  $y$ -axis. Figure A1.15 shows this graph.

$x$	0	1	2	3	4	5
$y$	25	24	22	18	12	0

FIGURE A1.15  
Problem 15



15. a. Is the relationship positive or negative?

The relationship is negative because  $x$  and  $y$  move in opposite directions: As  $x$  increases,  $y$  decreases.

- b. Does the slope of the relationship increase or decrease as the value of  $x$  increases?

The slope becomes steeper as  $x$  increases, so the absolute value of the slope increases as  $x$  increases. (The slope *itself* decreases as  $x$  increases because it becomes more negative.) Slope is equal to the change in  $y$  divided by the change in  $x$  as we move along the curve. When  $x$  increases from 1 to 2 (a change of 1),  $y$  decreases from 24 to 22 (a change of  $-2$ ), so the slope is  $-2$ . But when  $x$  increases from 4 to 5 (a change of 1),  $y$  decreases from 12 to 0 (a change of  $-12$ ), so the slope is  $-12$ .

- c. Think of some economic relationships that might be similar to this one.

The less expensive a good, the greater is the number of people who buy it. The higher the interest rate, the smaller is the number of people who take out home mortgages. The less expensive gasoline, the greater the miles car owners drive.

16. Calculate the slope of the relationship between  $x$  and  $y$  when  $x$  equals 3.

The slope equals  $-5$ . The slope of the curve at the point where  $x$  is 3 is equal to the slope of the tangent to the curve at that point. Plot the relationship and then draw the tangent line at the point where  $x$  is 3 and  $y$

is 18. Now calculate the slope of this tangent line by finding another point on the tangent. When  $x$  equals 5,  $y$  equals 10 on the tangent, so another point is  $x$  equals 5 and  $y$  equals 10. The slope equals the change in  $x$ ,  $-8$ , divided by the change in  $y$ ,  $2$ , so the slope is  $-4$ .

**17. Calculate the slope of the relationship across the arc as  $x$  increases from 4 to 5.**

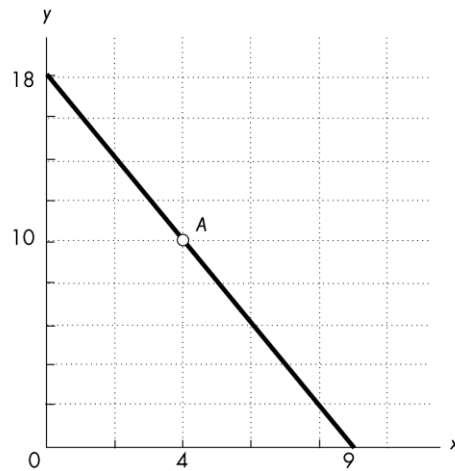
The slope is  $-12$ . The slope of the relationship across the arc when  $x$  increases from 4 to 5 is equal to the slope of the straight line joining the points on the curve at  $x$  equals 4 and  $x$  equals 5. When  $x$  increases from 4 to 5,  $y$  falls from 12 to 0. The slope equals the change in  $x$ ,  $-12$  (0 minus 12), divided by the change in  $y$ ,  $1$  (5 minus 4), so the slope across the arc is  $-12$ .

**18. Calculate the slope of the relationship shown at point A in figure A1.16.**

The slope is  $-2$ . The curve is a straight line, so its slope is the same at all points on the curve. Slope equals the change in the variable on the  $y$ -axis divided by the change in the variable on the  $x$ -axis. To calculate the slope, select two points on the line. One point is at 18 on the  $y$ -axis and 0 on the  $x$ -axis, and another is at 9 on the  $x$ -axis and 0 on the  $y$ -axis. The change in  $y$  from 18 to 0 is associated with the change in  $x$  from 0 to 9. Therefore the slope of the curve equals  $-18/9$ , which equals  $-2$ .

FIGURE A1.16

Problem 18



Use Figure A1.17 to work Problems 19 and 20.

**19. Calculate the slope at point A and at point B.**

The slope at point A is  $-4$ , and the slope at point B is  $-1$ . To calculate the slope at a point on a curved line, draw the tangent to the line at the point. Then find a second point on the tangent and calculate the slope of the tangent.

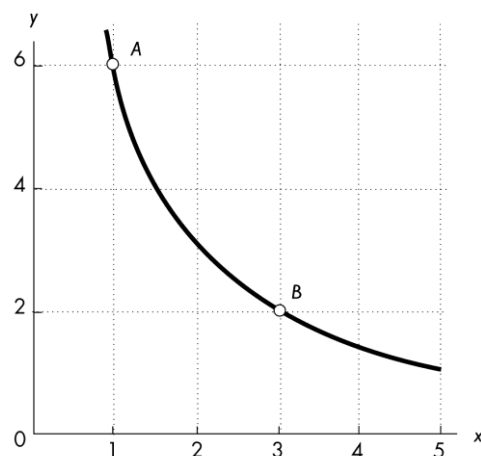
The tangent at point A cuts the  $x$ -axis at 2.5. The slope of the tangent equals the change in  $y$  divided by the change in  $x$ . The change in  $y$  equals 6 (6 minus 0) and the change in  $x$  equals  $-1.5$  (1 minus 2.5). The slope at point A is  $6/-1.5$ , which equals  $-4$ . Similarly, the slope at point B is  $-1$ . The tangent at point B cuts the  $y$ -axis at 5. The change in  $y$  equals 3, and the change in  $x$  equals  $-3$ . The slope at point B is  $-1$ .

**20. Calculate the slope across the arc AB.**

The slope across the arc AB is  $-2$ . The slope across the arc AB equals the change in  $y$ , which is 4 (6 minus 2) divided by the change in  $x$ , which equals  $-2$  (1 minus 3). The slope across the arc AB equals  $4/-2$ , which equals  $-2$ .

FIGURE A1.17

Problems 19 and 20



Use the following table to work Problems 21 to 23. The table gives information about umbrellas: price, the number purchased, and rainfall in millimetres.

21. Draw a graph to show the relationship between the price and the number of umbrellas purchased, holding the amount of rainfall constant at 1 inch. Describe this relationship.

Figure A1.18 shows the relationship. To draw a graph of the relationship between the price and the number of umbrellas when the rainfall equals 200 mm, keep the rainfall at 200 mm and plot the data in that column against the price. This curve is the relationship between price and number of umbrellas when the rainfall is 200 mm. The relationship between the price and the number of umbrellas is an inverse relationship; as the price rises, the number of umbrellas decreases.

22. What happens in the graph in Problem 21 if the price rises and rainfall is constant?

If the price rises, the number of umbrellas decreases. In Figure A1.18, there is a movement upward along the (unchanged) curve.

23. What happens in the graph in Problem 21 if the rainfall increases from 200mm to 2 inches?

As shown in Figure A1.19, the curve shifts rightward. In that figure, both the initial curve, which applies when the rainfall is 200 mm, and the new curve, which applies when the rainfall is 400 mm, are illustrated. The curve when the rainfall is 400 mm lies to the right of the curve when the rainfall is 200 mm indicating that at every price, more umbrellas are purchased when the rainfall is 400 mm than when the rainfall is 200 mm.

Price (dollars per umbrella)	Umbrellas (numbers per day)		
	0	200	400
	(mms of rainfall)		
20	4	7	8
30	2	4	7
40	1	2	4

FIGURE A1.18  
Problem 21

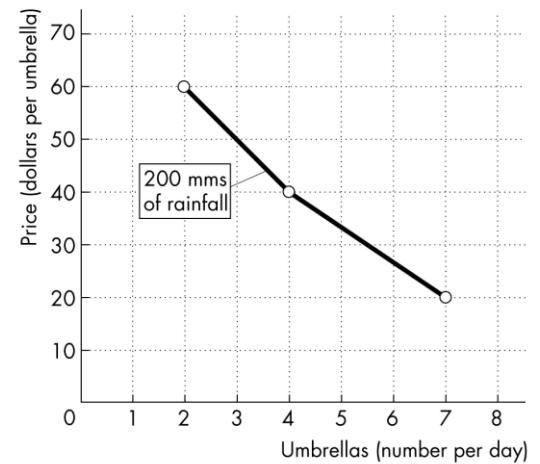


FIGURE A1.19  
Problem 23

