QUICK QUIZ

Choose the best answer to each of the following questions. Explain your reasoning with one or more complete sentences.

1. If X is correlated with Y,

   a. X causes Y.

   b. increasing values of X go with increasing values of Y.

   c. increasing values of X go with either increasing or decreasing values of Y.

2. Consider Figure 5.46. According to this diagram, life expectancy in Russia is about

   a. 22 years. b. 63 years. c. 58 years.

3. If the points on a scatter diagram fall on a nearly straight line sloping upward, the two variables have

   a. a strong positive correlation.

   b. a weak negative correlation. c. no correlation.

4. If the points on a scatter diagram fall into a broad swath that slopes downward, the two variables have

   a. a strong positive correlation.

   b. a weak negative correlation. c. no correlation.

5. When can you rule out the possibility that changes to variable X *cause* changes to variable Y?

   a. when there is no correlation between X and Y

   b. when there is a negative correlation between X and Y

   c. when a scatter diagram of the two variables shows points lying in a straight line

6. What type of correlation would you expect between wages and the unemployment rate?

   a. none

   b. positive: higher wages would go with higher unemployment

   c. negative: higher wages would go with lower unemployment

7. You have found a higher rate of birth defects among babies born to women exposed to second-hand smoke. To support a claim that the second-hand smoke caused the birth defects, what else should you expect to find?

   a. evidence that higher rates of defects are correlated with exposure to greater amounts of smoke

   b. evidence that these types of birth defects occur only in babies whose mothers were exposed to smoke, and never to any other babies

   c. evidence that the types of birth defects in these babies are more debilitating than other types of birth defects

8. Consider Figure 5.49. According to this graph, how does the CO_2 concentration today compare to the highest CO_2 concentrations during the 400,000 years before humans began industry?

   a. The values are about the same.

   b. Today's value is about 10% higher.

   c. Today's value is about 30% higher.

9. Based on the trend shown in Figure 5.49, predict the CO_2 concentration in the year 2040.

   a. 390 ppm

   b. 420 ppm

   c. 600 ppm

10. A finding by a jury that a person is guilty "beyond reasonable doubt" is supposed to mean that

    a. the person is definitely guilty.

    b. all 12 members of the jury believed that there was more than a 50% chance that the person was guilty.

    c. any reasonable person would conclude that the evidence was sufficient to establish guilt.

Exercises

REVIEW QUESTIONS

1. What is a correlation? Give three examples of pairs of variables that are correlated.
2. What is a scatter diagram, and how is one made? How can we use a scatter diagram to look for a correlation?
3. Define and distinguish among positive correlation, negative correlation, and no correlation. How do we determine the strength of a correlation?
4. Describe the three general categories of explanation for a correlation. Give an example of each.
5. Briefly describe each of the six guidelines presented in this unit for establishing causality. Give an example of the application of each guideline.
6. Briefly describe three levels of confidence in causality and how they can be useful when we do not have absolute proof of causality.

DOES IT MAKE SENSE?

Decide whether each of the following statements makes sense (or is clearly true) or does not make sense (or is clearly false). Explain your reasoning.

7. There is a strong negative correlation between the price of tickets and the number of tickets sold. This suggests that if we want to sell a lot of tickets, we should lower the price.
8. There is a strong positive correlation between the amount of time spent studying and grades in mathematics classes.

This suggests that if you want to get a good grade, you should spend more time studying.

9. I found a nearly perfect positive correlation between variable A and variable B, and therefore was able to conclude that an increase in variable A causes an increase in variable B.

10. I found a nearly perfect negative correlation between variable C and variable D, and therefore was able to conclude that an increase in variable C causes a decrease in variable D.

11. I had originally suspected that an increase in variable E would cause a decrease in variable F, but I no longer believe this because I found no correlation between the two variables.

12. I agree that we should require kids to wear bicycle helmets if helmets really lower injury rates, but it makes no sense to start this requirement until we have absolute proof that helmets cause the lower injury rate.

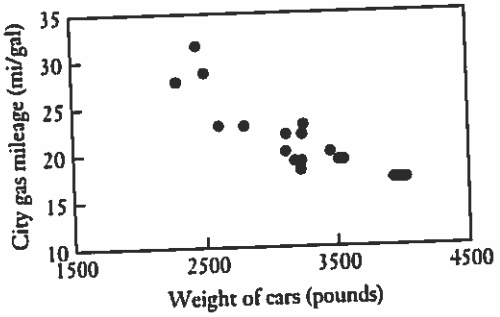
BASIC SKILLS & CONCEPTS

13–16: Interpreting Scatter Diagrams. Consider the following scatter diagrams.

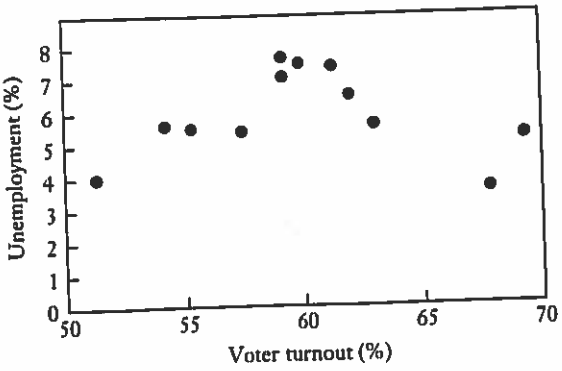
a. State whether the diagram shows a positive correlation, a negative correlation, or no correlation. If there is a positive or negative correlation, is it strong or weak?

b. Summarize any conclusions that you can draw from the diagram.

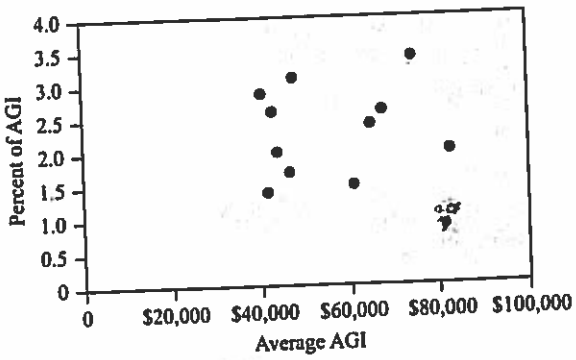
13. **2010 Model Cars**



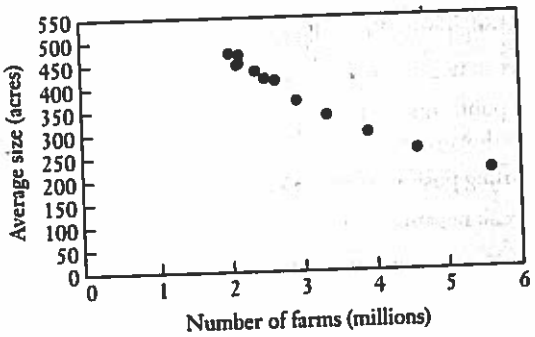
14. **U.S. Presidential Elections, 1964–2008**



15. **Charitable Giving (11 states) as Percentage of Adjusted Gross Income (AGI)**



16. **U.S. Farms 1950–2005**



17–24: Types of Correlation. For the following pairs of variables, state the units that might be used to measure each variable. Then state whether you believe that the two variables are correlated. If you believe they are correlated, state whether the correlation is positive or negative. Explain your reasoning.

17. Latitude north of the equator and average high temperature in June

18. Height of person and how frequently he or she attends religious services

19. Age of person and time spent on social networking sites

20. Altitude on a mountain hike and air pressure

21. The year in which a state joined the Union and the area of the state

22. Weight of a person and shoe size

23. Fertility rate of women and life expectancy in a country

24. Average property tax in a school district and average salary of high school teachers

FURTHER APPLICATIONS

25–30: Making Scatter Diagrams. Consider the following data sets.

a. Make a scatter diagram for the data.

b. State whether the two variables appear to be correlated, and if so, state whether the correlation is positive, negative, strong, or weak.

c. Suggest a reason for the correlation or lack of correlation. If you suspect causality, discuss what further evidence you need to establish it.

25. The table below gives the per capita gross national product and the per capita expenditure on defense for eight developed countries. Gross domestic product (GDP) is a measure of the total economic output of a country in monetary terms. Per capita GDP is the GDP averaged over every person in the country.

Country	Per Capita GDP ($)	Per Capita Defense ($)
Australia	36,300	947
France	33,200	807
Germany	34,200	524
Israel	25,800	1331
Japan	33,600	342
Norway	53,000	1241
United Kingdom	35,100	1001
United States	45,800	1974

26. The following table gives number of home runs and batting average for baseball's Most Valuable Players, 1998–2008 (NL = National League and AL = American League).

Player	Home Runs	Batting Average
Sammy Sosa (1998 NL)	66	.308
Juan Gonzalez (1998 AL)	45	.318
Chipper Jones (1999 NL)	45	.319
Ivan Rodriguez (1999 AL)	35	.332
Jeff Kent (2000 NL)	33	.334
Jason Giambi (2000 AL)	43	.333
Barry Bonds (2001 NL)	73	.328
Ichiro Suzuki (2001 AL)	8	.350
Barry Bonds (2002 NL)	46	.370
Miguel Tejada (2002 AL)	34	.308
Barry Bonds (2003 NL)	45	.341
Alex Rodriguez (2003 AL)	47	.298
Barry Bonds (2004 NL)	45	.362
Vladimir Guerrero (2004 AL)	39	.337
Albert Pujols (2005 NL)	41	.330
Alex Rodriguez (2005 AL)	48	.321
Ryan Howard (2006 NL)	58	.313
Justin Morneau (2006 AL)	34	.321
Jimmy Rollins (2007 NL)	30	.296
Alex Rodriguez (2007 AL)	54	.314
Albert Pujols (2008 NL)	37	.357
Dustin Pedroia (2008 AL)	17	.326

27. The following table gives per capita personal income and percent of the population below the poverty level for ten states in 2008.

State	Per Capita Personal Income ($)	Percent of Population Below Poverty Level
California	41,571	12.5
Colorado	41,042	9.8
Illinois	40,322	10.3
Iowa	35,023	9.6
Minnesota	41,034	8.7
Montana	32,458	13.2
Nevada	40,480	9.6
New Hampshire	41,512	5.6
Utah	31,189	9.4
West Virginia	29,537	15.0

28. The following table gives the average hours of television watched in households in five categories of annual income. (*Hint:* For the first and last categories of the household income data, place the dot at the position corresponding to $25,000 and $65,000, respectively. For other categories, place the dot at the center of each bin.)

Household Income	Weekly TV Hours
Less than $30,000	56.3
$30,000–$40,000	51.0
$40,000–$50,000	50.5
$50,000–$60,000	49.7
More than $60,000	48.7

Source: Nielsen Media Research.

29. The following table gives the average teacher salary and the expenditure on public education per pupil for ten states in 2007.

State	Average Teacher Salary ($)	Per Pupil Expenditure ($)
Alabama	43,389	7672
Alaska	54,658	10,392
Arizona	45,941	5696
Connecticut	60,822	13,005
Massachusetts	58,624	13,294
North Dakota	38,822	8228
Oregon	50,911	8989
Texas	44,899	8048
Utah	40,566	5551
Wyoming	50,692	13,328