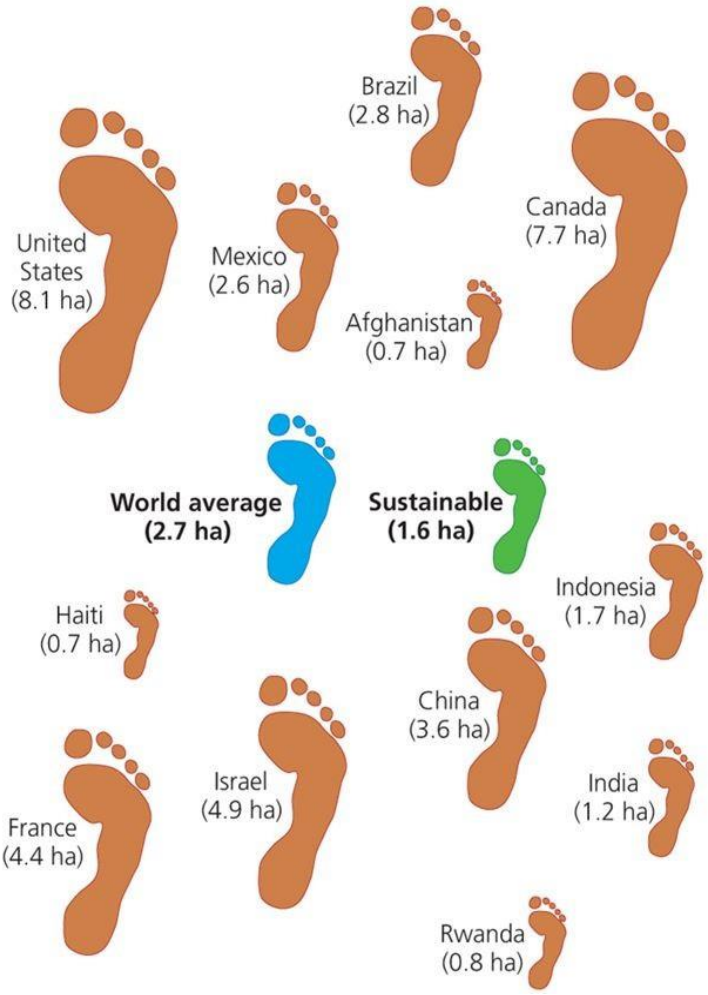
Environment: The Science Behind the Stories, 7e **(Withgott)**
Chapter 1 Science and Sustainability: An Introduction to Environmental Science

1.1 Graph and Figure Interpretation Questions



Use the accompanying figure to answer the following questions.

1) How many citizens of Haiti does it take to equal the ecological footprint of the average citizen of the United States?
A) They are essentially equal.
B) Ten citizens of Haiti equal the ecological footprint of the average U.S. citizen.
C) Six citizens of Haiti equal the ecological footprint of the average U.S. citizen.
D) Twelve citizens of Haiti equal the ecological footprint of the average U.S. citizen.
E) It takes over 100 Haitian citizens to equal the ecological footprint of the average U.S. citizen.
Answer: D
Section: 1.4
Bloom's Taxonomy: Application/Analysis

2) Nearly 50% of the land on our planet is currently used for agriculture; very little more agriculturally usable land is available. If everyone on the planet had an ecological footprint the size of the average citizen of the United States, then _____.
A) we would have 50% more food to go around
B) we would be able to provide for everyone without much difficulty, using the 50% of the land currently not being used
C) we would need at least two more planet Earths to feed and support everyone
D) we could support 50% more people on our planet
E) about 50% of the people would starve
Answer: C
Section: 1.4
Bloom's Taxonomy: Application/Analysis

3) The U.S. average footprint is _____ times larger than the world average footprint.
A) 2
B) 2.7
C) 3.3
D) 5
E) 6.7
Answer: B
Section: 1.4
Bloom's Taxonomy: Application/Analysis

4) The global average footprint per person has increased from 2.2 to 2.7 hectares since 2008, including the footprints of many developing nations such as India and China. This means that _____.
A) our collective lifestyle is even more unsustainable than before
B) our collective lifestyle is slightly more sustainable than before
C) the ability of the planet to sustain human beings has increased
D) some nations no longer have a measurable footprint
E) the populations of both India and China have decreased since 2008
Answer: A
Section: 1.4
Bloom's Taxonomy: Application/Analysis

1.2 Matching Questions

Match the following.

A) ecology
B) environmentalism
C) qualitative data
D) prediction
E) hypothesis
F) independent variable
G) paradigm
H) interdisciplinary science
I) quantitative data
J) dependent variable
K) social science
L) theory

1) One of many scientific fields of study within the broad scope of environmental science
Section: 1.2, 1.3
Bloom's Taxonomy: Knowledge/Comprehension

2) Information expressed with numbers
Section: 1.2, 1.3
Bloom's Taxonomy: Knowledge/Comprehension

3) The variable that is manipulated
Section: 1.2, 1.3
Bloom's Taxonomy: Knowledge/Comprehension

4) Expectation of experimental outcome
Section: 1.2, 1.3
Bloom's Taxonomy: Knowledge/Comprehension

5) Widely accepted, well-tested explanation of one or more cause-and-effect relationships
Section: 1.2, 1.3
Bloom's Taxonomy: Knowledge/Comprehension

6) Statement that attempts to explain a phenomenon or answer a scientific question
Section: 1.2, 1.3
Bloom's Taxonomy: Knowledge/Comprehension

7) The study of human interactions and institutions
Section: 1.2, 1.3
Bloom's Taxonomy: Knowledge/Comprehension

Answers: 1) A 2) I 3) F 4) D 5) L 6) E 7) K

1.3 Multiple Choice Questions

1) Which of the following discoveries would be most likely to cause a scientific paradigm shift?
A) the discovery that excess heat is radiating from the center of Earth and causing global climate change
B) the discovery of a new species of salamander in the Amazon rainforest
C) the discovery of more rings around Uranus
D) the discovery of a new pathogenic virus transmitted by mosquitoes
E) the discovery that a dormant volcano is showing signs of activity
Answer: A
Section: 1.3
Bloom's Taxonomy: Synthesis/Evaluation

2) The global population is projected to be about _____ in 2050.
A) 7 billion
B) 8 billion
C) 9 billion
D) 11 billion
E) 13 billion
Answer: C
Section: 1.1
Bloom's Taxonomy: Knowledge/Comprehension

3) The scientific method _____.
A) results in conclusions based on speculation
B) cannot prove a hypothesis to be true
C) results in the proving of a theory
D) has been replaced by a widely accepted shortcut that is less time-consuming and less expensive
E) if done correctly does not require replication
Answer: B
Section: 1.3
Bloom's Taxonomy: Knowledge/Comprehension

4) To determine your specific impacts on the environment, you can _____.
A) measure local air pollution and its impacts on your health
B) calculate the biodiversity of your local community
C) determine your community's impact on water quality in a nearby river
D) calculate your ecological footprint
E) determine your environmental handprint
Answer: D
Section: 1.4
Bloom's Taxonomy: Knowledge/Comprehension

5) A hypothesis is _____.
A) a prediction about something that has not yet been observed
B) a statement that explains an observed phenomenon or answers a scientific question
C) an instrument that is used to examine environmental conditions
D) the design of an experiment that can be used in scientific inquiry
E) a proven scientific fact
Answer: B
Section: 1.3
Bloom's Taxonomy: Knowledge/Comprehension

6) Roberto lives near a wind farm and is wondering about the environmental effects of the wind turbines. He _____ that the turbines make a sound like faint airplane engines and also that there are far fewer meadowlarks living near the wind farm than lived there before the wind farm was built.
A) hypothesizes
B) predicts
C) observes
D) theorizes
E) guesses
Answer: C
Section: 1.3
Bloom's Taxonomy: Application/Analysis

7) Roberto lives near a wind farm and is wondering about the environmental effects of the wind turbines. He _____ that the turbines, which sound like faint airplane engines, are scaring off meadowlarks that used to nest in the area.
A) hypothesizes
B) predicts
C) observes
D) theorizes
E) hopes
Answer: A
Section: 1.3
Bloom's Taxonomy: Application/Analysis

8) In a manipulative experiment, _____.
A) researchers manipulate the independent variable
B) researchers manipulate as many variables as possible
C) replication of the experiment is not necessary
D) a scientist has been caught manipulating the data for economic gain
E) the peer review process is bypassed
Answer: A
Section: 1.3
Bloom's Taxonomy: Knowledge/Comprehension

9) An environmental scientist is least likely to be involved with which of the following?
A) determining the best fuel to generate electricity for a growing city in Arizona
B) helping a rancher determine the best ways to rotate herds of cattle to reduce erosion
C) studying X-ray emissions for evidence of black holes
D) launching NASA satellites that monitor changes in carbon dioxide production on Earth
E) studying the relationship between soil fungi and aspen trees in areas that are being restored after oil sand mining
Answer: C
Section: 1.2
Bloom's Taxonomy: Application/Analysis

10) Which of the following terms *best* describes the practice of environmental science?
A) highly specialized and narrowly focused
B) integrative and interdisciplinary
C) abstract and theoretical
D) theoretical and controversial
E) elitist and unnecessary
Answer: B
Section: 1.1
Bloom's Taxonomy: Knowledge/Comprehension

11) The substances and energy sources that we take from the environment are _____.
A) ecosystem services
B) natural resources
C) sustainable resources
D) green infrastructure
E) variables
Answer: B
Section: 1.1
Bloom's Taxonomy: Knowledge/Comprehension

12) Solutions to environmental problems _____.
A) can be implemented only by scientists
B) should be designed with the goal of sustaining Earth's natural capital
C) must work on a global scale
D) must focus on short-term fixes because long-term solutions are generally unattainable
E) must always be designed and discussed in the political arena before implementation
Answer: B
Section: 1.1, 1.4
Bloom's Taxonomy: Knowledge/Comprehension

13) Ruben has a new puppy named Paddington and wants to feed him the best possible food. He decides on an experiment in which he will feed Paddington the very best canned food plus a dietary supplement of vitamins recommended by a veterinarian. Which of the following best describes Ruben's project?
A) This is an example of an excellent, controlled experiment as it is written.
B) Ruben needs to take careful measurements of Paddington's weight and height at least once a week for it to be a good experiment.
C) Ruben needs to control for the amount of exercise, sunshine, water, and care that Paddington gets each week so that they are equal from week to week.
D) Ruben needs to feed his mother's 6-year-old chocolate Shar-Pei named SallyJo a standard diet so that he can compare Paddington to a control.
E) This is a poorly designed experiment because there are no control dogs and no treatment replicates.
Answer: E
Section: 1.3
Bloom's Taxonomy: Application/Analysis

14) The process by which several researchers review another researcher's manuscript prior to publication to ensure research quality is referred to as _____.
A) overkill
B) investigative inquiry
C) peer review
D) quality control
E) critical analysis
Answer: C
Section: 1.3
Bloom's Taxonomy: Knowledge/Comprehension

15) Geothermal energy, wind energy, and solar radiation are all examples of _____.
A) nonrenewable resources
B) renewable environmental resources
C) biotic environmental factors
D) biodiversity
E) biodegradable materials
Answer: B
Section: 1.1
Bloom's Taxonomy: Knowledge/Comprehension

16) Which of the following statements *best* embodies the qualities of a scientific theory?
A) Squirrels in central Illinois prefer to build their nests in oak trees instead of hickory trees.
B) All gases, liquids, and solids consist of atoms.
C) Prairies that have large herds of bison show greater plant diversity than prairies without bison.
D) Dangerous wildfires in California could be avoided by better fire prevention strategies.
E) Students who study for their environmental science exams will perform better on those exams than those who do not.
Answer: B
Section: 1.3
Bloom's Taxonomy: Application/Analysis

17) Ecosystem services _____.
A) contribute to keeping ecosystems productive
B) are actions humans must take in order to protect and serve ecological systems
C) are economically valuable services provided by natural systems
D) are valuable to natural systems but not to human-created systems
E) are required to rebalance natural systems that we have disturbed
Answer: C
Section: 1.1
Bloom's Taxonomy: Knowledge/Comprehension

18) The concept of sustainable development includes _____.
A) the needs of future generations
B) growth in profits from international trade
C) the importance of developing the arts
D) each nation being sovereign over its own resources, to be used as its citizens deem appropriate
E) convenience and global economic improvements
Answer: A
Section: 1.4
Bloom's Taxonomy: Knowledge/Comprehension

19) You have read about the mistakes made on Easter Island. On Tikopia, a small island in the Solomon Islands, the people acted in other ways. When they realized that the pigs they had imported were damaging the environment, they killed them all. They had to have permission from a chief to fish, which prevented overfishing. They also practiced contraception. These actions all indicate that _____.
A) they believed in full resource utilization
B) they felt that everything was a nonrenewable resource
C) they felt that everything was a renewable resource
D) they were concerned with only one year at a time
E) they were attempting to enact sustainability
Answer: E
Section: 1.4
Bloom's Taxonomy: Application/Analysis

20) Which of the following actions would increase the size of a person's ecological footprint?
A) taking public transportation instead of driving
B) planting a vegetable garden
C) moving out of mom and dad's basement into one's own house
D) installing a photovoltaic solar panel on one's roof
E) turning down the thermostat in the winter
Answer: C
Section: 1.4
Bloom's Taxonomy: Application/Analysis

21) What type of graph would be best for showing the relationship between two quantitative variables?
A) pie chart
B) bar graph
C) scatter plot
D) data table
E) statistics table
Answer: C
Section: 1.3
Bloom's Taxonomy: Application/Analysis

22) In a controlled experiment, _____.
A) the researcher has several hypotheses, one of which will be proven correct
B) the researcher knows the outcome before beginning the experiment
C) the researcher controls for the effects of all variables except one
D) the researcher controls for the effects of only one variable
E) you need only a single experimental organism that is tested again and again
Answer: C
Section: 1.3
Bloom's Taxonomy: Knowledge/Comprehension

23) All of the following are examples of quantitative data *except* _____.
A) the number of siblings that students have
B) the gender of the students in a class
C) the cholesterol levels of the students in a class
D) the amount of sleep normally gotten by the students in a class
E) the exam scores for the students in a class
Answer: B
Section: 1.3
Bloom's Taxonomy: Application/Analysis

24) When during the scientific process does peer review occur?
A) during the research phase of a project
B) during the statistical analysis of the data collected
C) after the research is complete and before the paper (manuscript) is written
D) after the paper (manuscript) is written and before it is published
E) after the paper (manuscript) is published
Answer: D
Section: 1.3
Bloom's Taxonomy: Knowledge/Comprehension

25) A study's results are deemed worthy of acceptance into the body of scientific knowledge if they are published in journals that _____.
A) use the peer review process
B) charge a high fee for acceptance
C) are funded by corporations financing the research
D) meet guidelines advocated by environmentalists or consumer groups
E) conform to current political and religious views
Answer: A
Section: 1.3
Bloom's Taxonomy: Knowledge/Comprehension

26) What type of graph would be best for showing means for several different treatments?
A) pie chart
B) bar graph
C) scatter plot
D) data table
E) line graph
Answer: B
Section: 1.3
Bloom's Taxonomy: Application/Analysis

27) Which of the following lists the steps of the scientific method in the correct order?
A) hypothesis → prediction → questions → test → observations → results
B) questions → prediction → hypothesis → observations → test → results
C) hypothesis → prediction → questions → observations → test → results
D) observations → questions → hypothesis → prediction → test → results
E) questions → observations → prediction → hypothesis → test → results
Answer: D
Section: 1.3
Bloom's Taxonomy: Knowledge/Comprehension

28) What is a key "take-home message" about Easter Island?
A) Making and placing large stone statues are a waste of time.
B) Tropical soils are insufficient for growing enough crops for a population to be self-sustaining.
C) An island population must live as responsible stewards of its resources.
D) Humans who live in tropical areas will not die of exposure to extremely low temperatures.
E) The invasive brown tree snake can wipe out an entire population of humans in a short amount of time.
Answer: C
Section: 1.3
Bloom's Taxonomy: Knowledge/Comprehension

29) Proper peer review requires _____.
A) approval from industry leaders
B) sufficient funding
C) reviewers who specialize in the manuscript's subject area
D) conference presentation
E) government funding and approval
Answer: C
Section: 1.3
Bloom's Taxonomy: Knowledge/Comprehension

30) A major change in scientific thought or the dominant view is known as a(n) _____.
A) theory founding
B) peer review
C) paradigm shift
D) primary source
E) environmental discovery
Answer: C
Section: 1.3
Bloom's Taxonomy: Knowledge/Comprehension

31) The first event that began a remarkable increase in human population was the _____ revolution.
A) agricultural
B) industrial
C) chemical
D) informational
E) green
Answer: A
Section: 1.1
Bloom's Taxonomy: Knowledge/Comprehension

32) Minerals and fossil fuels are examples of _____.
A) ecosystem services
B) industrial resources
C) renewable resources
D) non-renewable resources
E) ecological footprints
Answer: D
Section: 1.1
Bloom's Taxonomy: Knowledge/Comprehension

33) Which of the following is not a strategy for campus sustainability?
A) increasing energy efficiency
B) water conservation
C) fossil fuel investment
D) improving transportation options
E) reducing waste
Answer: C
Section: 1.4
Bloom's Taxonomy: Knowledge/Comprehension

34) A _____ is a statistical association among variables.
A) treatment
B) correlation
C) hypothesis
D) theory
E) prediction
Answer: B
Section: 1.3
Bloom's Taxonomy: Knowledge/Comprehension

1.4 Essay Questions

1) Why is it important to understand our interactions with the environment? What will studying environmental science enable you to do?
Answer: We depend on the environment for air, water, food, shelter, and everything else. We are capable of modifying and harming the environment whether we intend to or not. Understanding our interactions with the environment is the essential first step toward devising positive, sustainable solutions that will allow future generations to enjoy a rich and full world. Studying environmental science will give us the tools we need to evaluate information on environmental change and to think critically and creatively about possible actions to take in response.
Section: 1.2
Bloom's Taxonomy: Application/Analysis

2) Use the assessment tool at www.ecologicalfootprint.com or some other website that calculates your ecological footprint to calculate your ecological footprint. Once you determine the factors that evaluate your use of water, energy, waste disposal, transportation, and food consumption, use the results of your specific ecological footprint to determine three *specific* actions you can take to *reduce the size* of your ecological footprint. Make sure that your specific actions each fit into a different category (water, energy, waste, transportation, and food). Summarize your assessment.
Answer: The answers will vary based on individual student lifestyle. Students can reflect on their results and could then consider making lifestyle adjustments that support a greater environmental sustainability.
Section: 1.4
Bloom's Taxonomy: Knowledge/Comprehension

3) Differentiate between environmental science and environmentalism. Define each term and explain how they are similar and how they differ.
Answer: Environmental science is the pursuit of knowledge about the workings of the environment and our interactions with it. Environmentalism is a social concern focused on protecting the natural environment and, by extension, humans from undesirable changes brought about by certain human choices. Environmental scientists and environmentalists study the same issues, but environmental scientists use an objective scientific approach to understanding environmental problems. Environmentalists, on the other hand, may use dramatic and often emotional approaches to alter the political and social understanding or to educate the public about environmental problems.
Section: 1.2
Bloom's Taxonomy: Knowledge/Comprehension

4) Compare and contrast the types of knowledge gained and the research methods of natural and social sciences when considering environmental problems. Why do both types of disciplines need to be a part of environmental science?
Answer: The natural sciences are made up of disciplines that study the physical and biological facets of the natural world and their interactions with each other. These disciplines rely on all types of studies that generate mainly quantitative data, allowing scientists to acquire and interpret information about the natural world. The social sciences are made up of disciplines that study human behaviors, interactions, and institutions. The scientists in these disciplines mainly collect qualitative data using a variety of research techniques that are similar to those used by natural scientists. Studies that examine how cultures perceive an environmental concept may be used to implement environmental policy. Because environmental problems involve accurate assessment of the scope of the problem by which policy that affects humans is devised, both types of sciences are needed to be a part of environmental science.
Section: 1.2
Bloom's Taxonomy: Application/Analysis

5) What qualities are present in an endeavor that is sustainable?
Answer: A sustainable endeavor is one that allows future generations to carry it on at the same level of productivity that we do at present. Whatever natural capital is required will remain equally available in the future as it is now. The environmental effects of the enterprise will not damage, degrade, or deplete the systems with which it interfaces. Materials and energy will be used efficiently, wastes will be minimal and nontoxic, and the ecological footprint of the enterprise will remain unchanged or may diminish as better technology becomes available.
Section: 1.4
Bloom's Taxonomy: Knowledge/Comprehension

6) Discuss the differences between a manipulative experiment and a natural experiment.
Answer: In a manipulative experiment, the researcher chooses and manipulates the independent variable while controlling for the effects of other variables, but in a natural experiment the researcher records differences in variables as they are expressed in the natural environment, such as the mean weight of tomatoes grown in dry versus wet climates. In such experiments, the independent variable varies naturally, and effects of other variables are not necessarily controllable.
Section: 1.3
Bloom's Taxonomy: Knowledge/Comprehension

7) You are hired by a pesticide company to determine whether its new pesticide ("Zap-em") is effective at controlling soybean aphids, an invasive species that costs American farmers millions of dollars a year in crop damage and control costs. Describe an experiment you would perform to test the effectiveness of Zap-em.
Answer: Students' answers will vary but should include all of the following components:
A. replicate plots (It would be inappropriate to test Zap-em on a single field.)
B. treatment and control plots, assigned randomly (Zap-em plots need to be compared to plots not sprayed with Zap-em.)
C. dependent variables to be measured (e.g., crop yield, amount of crop damage, and density of soybean aphids in plots)
D. use of statistical analysis to analyze the data
Section: 1.3
Bloom's Taxonomy: Application/Analysis

1.5 Scenario-Based Questions

Read the following scenario and answer the questions below.

Pablo and Johanna must complete a yearlong study for their biology course. After some discussion, they decide to compare dog diets. To test their hypothesis that the local veterinarian's special dog food mix will enhance growth and development, each student adopts a puppy from the local pound. Pablo plans to feed his goldendoodle the special diet, while Johanna plans to use generic dry kibble from the supermarket for her bulldog.

1) The independent variable in this study will be _____.
A) the age of the dogs
B) the sex of the dogs
C) the type of food the dogs receive
D) how much the dogs grow
E) the breed of the dogs
Answer: C
Section: 1.3
Bloom's Taxonomy: Application/Analysis

2) One dependent variable in this study will be _____.
A) the age of the dogs
B) the sex of the dogs
C) the type of food the dogs receive
D) how much the dogs grow
E) the breed of the dogs
Answer: D
Section: 1.3
Bloom's Taxonomy: Application/Analysis

3) When Pablo and Johanna write up their initial proposal, their instructor will probably _____.
A) give them an A for thoroughness and allow them to proceed with the experiment
B) tell them that they need at least 100 dogs to do the study
C) tell them that the proposal is impossible and that such a study cannot be done at all
D) give them an F and tell them to start over–it would take many years to do such a study
E) tell them that there are some serious problems with their proposal, but they are fixable if the students are willing to find more dogs for their study
Answer: E
Section: 1.3
Bloom's Taxonomy: Application/Analysis

4) Pablo and Johanna have too many _____.
A) variables that they didn't control and not enough replicates
B) replicates and not enough variables
C) controlled variables and not enough uncontrolled variables
D) dependent variables and not enough independent variables
E) independent variables and not enough dependent variables
Answer: A
Section: 1.3
Bloom's Taxonomy: Application/Analysis

5) Pablo and Johanna appear not to have considered the importance of controlling for _____.
A) the age of the dogs
B) the food that the dogs are being fed
C) possible differences resulting from using two different breeds of dog
D) the possibility that one dog food is healthier than the other dog food
E) the source of the dog food
Answer: C
Section: 1.3
Bloom's Taxonomy: Synthesis/Evaluation

Read the following scenario and answer the questions below.

After meeting with their instructor, Pablo and Johanna know that they need to change their experimental design. They contact a local dog breeder and arrange to do their study with 3-month-old pups from four Irish setters, for a total of 24 puppies consisting of 12 females and 12 males.

6) In order to have two groups of puppies (control and experimental), Pablo and Johanna should _____.
A) put the 12 females in one group and the 12 males in the other group
B) flip a coin for each dog to see which group it will be in
C) randomly choose one dog for the control group and use the other 23 in the experimental group
D) put 6 males and 6 females in each group, with some from each mother in each group
E) put all the puppies from two of the litters in one group and all the puppies from the other two litters in the other group
Answer: D
Section: 1.3
Bloom's Taxonomy: Application/Analysis

7) Pablo and Johanna should probably run the experiment _____.
A) for 1 month, weighing and measuring the pups before and after
B) for several months, weighing and measuring the pups before and after
C) for several months, weighing and measuring the pups twice every day
D) for several months, weighing and measuring the pups every week
E) for at least 3 years, weighing and measuring the pups every week
Answer: D
Section: 1.3
Bloom's Taxonomy: Application/Analysis

8) If the puppies in the experimental group gain, on average, 3 pounds more than those in the control group over a 4-month period and seem healthier and more energetic, then _____.
A) they have proven the veterinary diet is best for all dogs
B) there is a high probability that the veterinary diet is better than kibble for puppies
C) there is a high probability that the veterinary diet is better than kibble for all dogs
D) there is a high probability that the kibble is better for puppies
E) they have proven that the kibble diet is best for female dogs
Answer: B
Section: 1.3
Bloom's Taxonomy: Application/Analysis