Scientific Investigations

1. Scientific inquiry attempts to search out, describe, explain, and predict things that happen in nature. Which of the following best describes how progress is made in scientific inquiry?

   A. by asking questions and collecting, analyzing, and interpreting data to answer them
   B. by asking questions and collecting, analyzing, and interpreting different people's opinions
   C. by asking questions and researching the answers in papers, books, and on the internet
   D. by researching the history of science and learning about scientific progress in the past

Scientific Investigations

2. The children in Ms. Murray's class have to perform an investigation. The question their study must answer is "How do various types of plants differ in their physical features?"

   What type of investigation must the children do?

   A. find several new species of plants
   B. observe and record physical characteristics of plants
   C. do an experiment on the chemical components of plants
   D. make a model of a plant, since they are hard to observe

Scientific Investigations

3. Jill hypothesizes that individual volcanoes produce igneous rocks with a certain chemical signature. She further hypothesizes that scientists could use an igneous rock's chemical signature to determine where the rock came from.

   What type of investigation should Jill perform to test her hypothesis?
A. perform a controlled experiment on a volcano
B. model the formation of an igneous rock
C. collect and test rock specimens
D. observe and describe a volcanic eruption

Scientific Investigations

4. Oscar placed a beaker of water on a hot plate and recorded the temperature of the water for four minutes. He recorded his observations in the data table below.

<table>
<thead>
<tr>
<th>Time (s)</th>
<th>Temperature (°C)</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>24</td>
<td>no activity</td>
</tr>
<tr>
<td>30</td>
<td>35</td>
<td>no activity</td>
</tr>
<tr>
<td>60</td>
<td>57</td>
<td>some steam rising</td>
</tr>
<tr>
<td>90</td>
<td>81</td>
<td>more steam rising; tiny bubbles forming</td>
</tr>
<tr>
<td>120</td>
<td>98</td>
<td>more steam rising; more bubbles</td>
</tr>
<tr>
<td>150</td>
<td>100</td>
<td>boiling</td>
</tr>
<tr>
<td>180</td>
<td>100</td>
<td>boiling</td>
</tr>
<tr>
<td>210</td>
<td>100</td>
<td>boiling</td>
</tr>
<tr>
<td>240</td>
<td>100</td>
<td>boiling</td>
</tr>
</tbody>
</table>

Based on Oscar's observations, what is the most appropriate scientific question to ask?
A. What causes the temperature of the water to decrease over time?
B. Why does the temperature of the water continue to rise while it boils?
C. Does water boil because the temperature is being observed?
D. Why does the temperature of the water remain constant while it boils?

Scientific Investigations

5. Which of the following is a good scientific question?
A. Why do crickets chirp?
B. Are dragons lizards or birds?
C. Does eating less fat increase a mouse's life span?
D. How do star fish fall in love?

Scientific Investigations

6. George is interested in insects and wants to do an experiment. Which of the following is a scientific question about insects that he could investigate with an experiment?

A. Do different food types affect the growth rate of beetles?
B. Do ants feel anxiety?
C. Are ladybugs prettier than beetles?
D. Why are there so many different kinds of insects in the world?

Scientific Investigations

7. Dr. Stevens observes that squirrels in the wild eat nuts, fruit, and insects. She wonders which of the food sources makes young squirrels grow the fastest. She separates thirty young squirrels into two equal groups. She feeds one of the groups nuts and she feeds the other group insects. The group of squirrels that eats the nuts grows faster than the group of squirrels that eats the insects.

What question could Dr. Stevens ask next if she wants to continue studying about squirrel growth rate?

A. Do squirrels that eat nuts grow faster than squirrels that eat fruit?
B. Are squirrels that eat nuts cuter than squirrels that eat fruit or insects?
C. Are squirrels that eat nuts happier than squirrels that eat fruit or insects?
D. Do squirrels like the taste of nuts more than they like the taste of fruit?

Scientific Investigations

8. After investigating many properties of gases, Darren hypothesized that the volume of a gas is related to its temperature. Which of the following observations led to his hypothesis?
A. All of the gases that were investigated were both odorless and colorless.

B. A balloon filled with air expanded when it was heated and shrank when it was cooled.

C. A syringe filled with air could be compressed when he applied pressure to the plunger.

D. all of these

Scientific Investigations

9. Which of the following statements is true regarding scientific hypotheses?

- A. A testable hypothesis is valuable only if all evidence supports it.
- B. There are no valuable hypotheses.
- C. Every hypothesis is valuable, whether or not it is testable.
- D. A testable hypothesis is valuable, even if evidence shows that it is false.

Scientific Investigations

10. Belinda is interested in dog behavior. She has formed a hypothesis that dogs are able to hear higher-frequency sounds than humans. What should Belinda do next?

- A. Form another hypothesis about dogs.
- B. Write a paper describing how she formed her hypothesis.
- C. Design an experiment to test her hypothesis.
- D. Make observations of other mammals.

Scientific Investigations

11. Ava observes that a certain species of bird follows behind a herd of cattle. The bird species primarily eats insects. The birds stay with the herd of cattle as they graze.

What is a scientific hypothesis that Ava could formulate based on her observations?

- A. Why does this species of bird follow herds of cattle?

- B. The birds follow the herd because the cows stir up insects for the birds to eat.
C. The birds are happier around big herds of cattle rather than small herds.

D. Do the birds get any benefit from following the herd of cattle?

Scientific Investigations

12. A scientific theory is a well-tested explanation for a wide range of observations or experimental results. A hypothesis is a possible answer to a question. When does a hypothesis become a scientific theory?

A. after the hypothesis is first formed by a scientist
B. after a hypothesis is shown to be correct in one experiment
C. after the hypothesis has been confirmed through extensive testing
D. after a competing hypothesis has failed testing

Scientific Investigations

13. What is the difference between a theory and an opinion?

A. A theory is a scientific fact, while an opinion is not.
B. An opinion is a scientific fact, while a theory is not.
C. An opinion is supported by scientific evidence, while a theory is not.
D. A theory is supported by scientific evidence, while an opinion is not.

Scientific Investigations

14. Major scientific theories include the cell theory, the big bang theory, and the theory of plate tectonics. How are scientific theories formed?

A. through meetings between scientists in which they discuss several possible answers to a scientific question
B. through the formation of several related hypotheses
C. through a single scientific discovery in which a scientist learns something new
D. through extensive testing and the accumulation of several lines of evidence
15. Isabella's next door neighbor has a theory that the best time to wash your car is late in the afternoon on Sunday. Is this a scientific theory?

- A. No, it is better to wash cars on Saturday.
- B. Yes, the car will stay clean for more of the week.
- C. Yes, the neighbor might be a scientist.
- D. No, it is an opinion and is not testable.

Laboratory Tools & Safety

16. Jackie has difficulty seeing the blackboard in class. Her teacher suggests that she start wearing ________.

- A. glasses
- B. eye makeup
- C. hearing aids
- D. headphones

Laboratory Tools & Safety

17. A person who has difficulty hearing can wear which of the following to improve his or her hearing?

- A. earmuffs
- B. a mouthguard
- C. a hearing aid
- D. contacts

Laboratory Tools & Safety

18. Mia has a glass of water. Which of the following tools could she use to measure the amount of time it takes her to drink the water in the glass?

- A. a thermometer
- B. a graduated cylinder
- C. a metric ruler
- D. a stopwatch
Laboratory Tools & Safety

19. A magnet can be used to _______.

○ A. measure the length of an object
○ B. measure the mass of an object
○ C. measure the temperature of an object
○ D. attract metal objects

Laboratory Tools & Safety

20. A triple beam balance is used to find the mass of an object. The balance has three beams with number scales and sliders that can be moved, a platform that holds the object, and a pointer that tells when the object and sliders are balanced.

In order to use the balance, an object is placed on the platform. Then, the sliders on the beams are moved to indicate the mass in hundreds, tens, and ones (and tenths) until

○ A. the pointer and the mass are at zero.
○ B. the pointer is at the bottom and the object is at the top.
○ C. the pointer lines up with the zero mark.
○ D. the pointer is at the top and the object is at the bottom.

Laboratory Tools & Safety

21. Juan wants to find out what the crystal structure of a salt grain looks like. What tool should he use in his investigation?

○ A. hand lens
○ B. meter stick
○ C. calipers
○ D. balance

Laboratory Tools & Safety

22.
Grady put water and a thermometer in a metal can. He added ice cubes one at a time and stirred the water carefully, as shown in the diagram above. When he noticed water droplets begin to form on the outside of the can, he recorded the temperature.

What did this experiment most directly measure?

- A. air temperature
- B. relative humidity
- C. dew point
- D. air pressure

Laboratory Tools & Safety

23. A barometer is used to measure air pressure or a change in pressure readings. In order to measure an air pressure change, the set pointer is placed _______ the reading pointer. Then, the difference in pressure can be read after a certain amount of time by determining how much the reading pointer has moved.

- A. to the right of
- B. directly opposite of
- C. to the left of
- D. on top of

Laboratory Tools & Safety

24.
Wendy wants to know which colors of light are emitted by her flashlight. Which tool could help her?

- A. a psychrometer
- B. a laser pointer
- C. a spectroscope
- D. an anemometer

Laboratory Tools & Safety

25. Which of the following tools is used to observe objects that are very far away?

- A. a microscope
- B. a anemometer
- C. a hand lens
- D. a telescope

Laboratory Tools & Safety

26. Which of these instruments sends its measurements directly to a computer?

- A. pH paper
- B. graduated cylinder
- C. stopwatch
- D. temperature probe

Laboratory Tools & Safety
27. Sachiko wants to measure the temperature of ice water in a beaker. The thermometer she will be using is at room temperature. After she places the thermometer in the beaker, what should she do to obtain the most accurate measurement?

   A. Take the reading on the thermometer immediately.
   B. Wait until the water warms to room temperature, then take the reading on the thermometer.
   C. Take the reading immediately after the mercury level in the thermometer becomes stable.
   D. Wait five seconds, then take the reading on the thermometer.

---

**Laboratory Tools & Safety**

28. Which of the following tasks should be performed before measuring the mass of any object on a triple-beam balance?

   A. Make sure that the balance is on a level surface.
   B. Make sure that all the counterweights are set to zero.
   C. Make sure that the balance pan is clean and free of debris.
   D. all of these

---

**Laboratory Tools & Safety**

29. Menthol is an organic compound that can be made synthetically or extracted from peppermint or other mint oils. Substances that contain menthol can often be distinguished by its unique smell.

What would be the safest way to smell unknown compounds to check for the presence of menthol?

   A. Waft the substance's fumes toward you with your hand.
   B. Freeze the substance and smell the solid form.
   C. Hold the substance under your nose and inhale.
   D. Pour the substance into a petri dish under a fume hood.
30. Jack was diluting a strong acid when he spilled some of the acid on his shirt.

What should Jack do?

- A. Notify the teacher.
- B. Proceed to the safety shower.
- C. Remove his shirt.
- D. all of these

---

Experimental Design

31. How do the independent and dependent variables in an experiment compare?

- A. The independent variable controls the dependent variables.
- B. The independent and dependent variables have no effect on each other.
- C. The dependent variable controls the independent variables.
- D. The independent and dependent variables are the exact same as each other.

---

Experimental Design

32. Janet learned in science class that the amount of salt that can dissolve in a certain amount of water depends on the temperature of the water. She decides to do an experiment to test this.

She carefully adds salt, 100 mg at a time, to a cup of water and stirs until all the salt dissolves. When she has added so much salt that it will not dissolve after 5 minutes, she measures the temperature of the water. She records the temperature and the final amount of salt. She does this with cold water, cool water, room-temperature water, warm water, and hot water.

What is the independent variable in this experiment?

- A. the amount of salt
- B. the temperature of the water
- C. how long it took the salt to dissolve
- D. the amount of water

---

Experimental Design

33. Eva is performing an experiment to determine which type of disinfectant kills the most bacteria. She has six plates of the same kind and amount of bacteria. She adds one of five
different kinds of disinfectant to each plate and leaves one plate without any disinfectant as a control.

What role does the independent variable play in this experiment?

- **A.** The amount of bacteria killed determines the type of bacteria used.
- **B.** The type of disinfectant used determines the type of bacteria used.
- **C.** The type of disinfectant determines the amount of bacteria killed.
- **D.** The amount of bacteria killed determines the type of disinfectant used.

---

**Experimental Design**

34. In a controlled scientific experiment, a scientist

- **A.** alters one dependent variable and observes the effects on other dependent variables.
- **B.** alters the dependent variable and observes the effects on the independent variable.
- **C.** alters one independent variable and observes the effects on other independent variables.
- **D.** alters the independent variable and observes the effects on the dependent variable.

---

**Experimental Design**

35. Omar wants to determine if the mass of a model rocket affects how long the rocket is able to stay up in the air. To do this, he constructs three identical rockets and then fills two of the rockets with varying amounts of sand to add mass. He then launches the rockets one at a time and times how long they are able to stay airborne.

What is the independent variable in Omar's experiment?

- **A.** the time the rockets remain airborne
- **B.** the masses of the model rockets
- **C.** the materials out of which the rockets were made
- **D.** the force with which each rocket is launched
36. Shawn is planning a scientific experiment. He wants to learn whether time of day has an effect on how far the roses in his mother's garden are open. He plans to measure the diameter of each flower on three rosebushes every hour during a week in the spring.

What is the independent variable in Shawn's experiment?

- [ ] A. the time of year
- [ ] B. the number of flowers
- [ ] C. the time of day
- [ ] D. the diameter of the flowers

Experimental Design

37. Which of the following should be done when designing an experiment for a controlled scientific investigation?

- [ ] A. list the procedures
- [ ] B. plan the variables
- [ ] C. list the needed materials
- [ ] D. all of these

Experimental Design

38. Scientists often repeat experiments multiple times. Why is this important?

- [ ] A. Repeating an experiment turns a hypothesis into a theory.
- [ ] B. Repeating an experiment gives scientists something to do while they think of new hypotheses.
- [ ] C. Repeating an experiment helps to verify the results.
- [ ] D. Repeating an experiment allows scientists to test different variables.

Experimental Design

39. Emilio's teacher told his class that a controlled experiment's results are valid only if one factor in the experiment is changed and all the other factors remain constant. Why is this statement true?
A. When only one factor is changed, you can be more certain that it caused the results.

B. Changing several different factors in an experiment takes too many controls.

C. When only one factor is changed, you don't need to use a control.

D. Changing several different factors in an experiment takes too much time.

---

**Experimental Design**

40. Olivia researched insects that destroy farmers’ crops. Based on this information, she discovered a way to keep the insects away from the plants, without adding any harmful chemicals to the crops. She recorded her conclusion, but did not write down any of the resources she used to learn about the insects. She also did not record information about any of the trials that did not work. Does she need to include this information?

A. Yes, because the information could be helpful to other scientists conducting similar research.

B. She should include the sources of the articles she read, but the trials that did not work are not important.

C. No, because she is the one who made the discovery. Listing the resources she used would give credit to other people.

D. No, because Olivia put a lot of time and effort into finding this information. Other people should have to do the same.

---

**Experimental Design**

41. Javier has found a beetle during a field study. He suspects that it might be a new species of beetle that no one has ever documented before. He takes the beetle back to his lab and examines it under a microscope.
What does Javier need to do so that he can accurately compare his beetle to known species of beetle?

- A. Javier must collect some of the beetle's tissue so it can be cloned.
- B. Javier must carefully record and describe the beetle's response to laser light.
- C. Javier must carefully record and describe all of the characteristics of his beetle.
- D. Javier must compare the beetle's foot speed to that of an ant.

**Experimental Design**

42. Nick hypothesizes that wax has a higher melting point than chocolate. How can Nick test his hypothesis?

- A. Heat samples of wax and chocolate and use a stopwatch to time how long it takes until they start to melt.
- B. Measure the volume and weight of samples of wax and chocolate and calculate their densities.
- C. Use Mohs Hardness Scale to test how easily wax and chocolate can be scratched.
- D. Heat equal masses of wax and chocolate and measure their temperatures when they start to melt.

**Experimental Design**

43. Jamal needs to know how fast a red oak sapling grows. What can he do to find this out?
A. Measure how fast the saplings of different kinds of oaks grow.
B. Ask his friends to find out if any of them have seen a sapling grow.
C. Grow a sapling from seed and measure its growth periodically.
D. Cut down an adult red oak and count its rings.

Experimental Design

44. A student would like to determine how heating a liquid changes its volume. The student hypothesizes that the liquid will increase in volume. The following list shows the steps taken by the student in order to test the hypothesis.

I. Select the liquid to test.
II. Place the liquid in a sealed container.
III. Use a Bunsen burner to heat the liquid by 10°C.
IV. Measure the volume of the liquid.
V. Record the results.

What is wrong with how the student conducted the investigation?
A. The student should have increased the temperature of the liquid by more than 10°C.
B. The hypothesis was not valid because it is impossible for liquids to change in volume.
C. The volume of the liquid should be measured before it is heated.
D. The length of time it took for the liquid to be heated should be measured.

Collecting Data

45. When scientists use one of their five senses to gather information, they are

A. making an observation.
B. making an inference.
C. drawing a conclusion.
D. predicting a relationship.

Collecting Data

46. Tony recorded data from his chemistry experiment in the following table.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Color</th>
<th>Volume</th>
<th>Temperature</th>
<th>Mass</th>
</tr>
</thead>
</table>
A | yellow | 150 mL | 20°C | 40.1 g  
B | red | 125 mL | 20°C | 15.2 g  
C | clear | 175 mL | 20°C | 26.3 g  
D | green | 150 mL | 20°C | 81.4 g  

Which of the categories from Tony's data table includes qualitative observations?

- A. temperature  
- B. color  
- C. volume  
- D. mass  

**Collecting Data**

47. The mass of a block was measured in grams using a triple beam balance. Using the picture, determine the mass of the block.

A. 94.71 g  
B. 709.4 g  
C. 1793.9 g  
D. 179.39 g  

**Collecting Data**

48. The image below is a stopwatch whose small hand keeps track of minutes to the nearest half minute. Its large hand keeps track of seconds.

- A. 94.71 g  
- B. 709.4 g  
- C. 1793.9 g  
- D. 179.39 g
How much time does the stopwatch show has passed?

- **A.** 12.5 minutes, 37.3 seconds
- **B.** 12 minutes, 7.3 seconds
- **C.** 12.37 minutes
- **D.** 12 minutes, 37.3 seconds

**Collecting Data**

49.

What is the volume of the liquid in the graduated cylinder shown above?
Collecting Data

50. Ramon uses a metric tape measure to find the circumference of a model globe, as shown below.

What is the circumference of this globe?
- A. 15.27 cm
- B. 16 cm
- C. 15.54 cm
- D. 15.24 cm

Collecting Data

51.
The picture above shows a scale being used to measure the mass of a tomato. How much mass does the tomato have?

○ A. 52 g  
○ B. 62 g  
○ C. 57 g  
○ D. 67 g  

**Collecting Data**

**52.** The temperature outside is 25°C. Which of the following thermometers shows that the temperature is 25°C?
Collecting Data

53. Abby timed how long she ran using a stopwatch. She started the timer when she started running and stopped it when she had finished running. The stopwatch is shown below after Abby stopped it.

- [ ] A. X
- [ ] B. Z
- [ ] C. W
- [ ] D. Y
How long did Abby run?

- A. 54 sec
- B. 59 sec
- C. 57 sec
- D. 51 sec

**Collecting Data**

54. Jessica poured a liquid into the graduated cylinder below.

What is the volume of the liquid?

- A. 16.9 mL
- B. 17.5 mL
- C. 15.2 mL
- D. 10.7 mL

**Collecting Data**
55. The gram is a metric unit for _______.

- A. length
- B. volume
- C. temperature
- D. mass

Collecting Data

56. Which of the following correctly lists the prefixes in order from smallest to biggest?

- A. centi-, milli-, micro-, deca-, kilo-
- B. micro-, milli-, deca-, centi-, kilo-
- C. micro-, milli-, centi-, deca-, kilo-
- D. milli-, micro-, centi-, kilo-, deca-

Collecting Data

57. The level of closeness between multiple measurements of the same quantity is called _________.

- A. precision
- B. congruence
- C. similarity
- D. accuracy

Collecting Data

58. The target above can be best described as an example of
A. low accuracy and high precision.
B. low accuracy and low precision.
C. high accuracy and low precision.
D. high accuracy and high precision.

Analyze, Interpret & Communicate Data

59. Inferences are

A. conclusions or predictions that are made by studying observations.
B. exactly the same as observations.
C. questions that are made by studying conclusions or predictions.
D. never made by scientists.

Analyze, Interpret & Communicate Data

60. Fran wanted to find out how adding salt changes the boiling point of water. She placed 100 ml of water in each of 4 beakers. She then added a different amount of salt to each beaker. Finally, using a hot plate, Fran heated the beakers of water.

When the water began to boil, she measured the temperature using a thermometer. Her results are in the table below.

<table>
<thead>
<tr>
<th>Solution #</th>
<th>Dissolved Salt (g)</th>
<th>Boiling Point (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>100.0</td>
</tr>
<tr>
<td>2</td>
<td>5.6</td>
<td>100.5</td>
</tr>
<tr>
<td>3</td>
<td>11.2</td>
<td>101.0</td>
</tr>
<tr>
<td>4</td>
<td>16.8</td>
<td>101.5</td>
</tr>
<tr>
<td>5</td>
<td>22.4</td>
<td>102.0</td>
</tr>
</tbody>
</table>

How much salt does it take to raise the boiling point of water by a half of a degree?

A. 16.8 g
B. 22.4 g
C. 11.2 g
61. Mr. Swanson's science class used a thermometer to measure the outside temperature each day throughout the school year. They used their results to make the graph below.

Which month had an average daily temperature of around 41 degrees?

- A. May
- B. April
- C. March
- D. December

62. The graph below shows the growth of a tree with time, but some data are missing. What was the most likely height of the tree in meters (m) at 10 days?
Harry put 20 mL of water in a beaker and wanted to track how the water evaporated each day. What would be the best estimate as to the amount of water left in the beaker at the start of day 5?

- A. 6 mL
- B. 4 mL
- C. 8 mL
- D. 5 mL

63. Harry put 20 mL of water in a beaker and wanted to track how the water evaporated each day. What would be the best estimate as to the amount of water left in the beaker at the start of day 5?
64. Mrs. Strunk's Earth Science class used an erosion model to investigate the relationship between the slope of a hill, or incline, and the amount of soil that washes off of the incline.

The class increased the slope of the incline from 1 to 5. Then, they poured 100 ml of water down the incline. Finally, they collected the soil from a tray at the bottom of the incline, dried the soil in an oven, and used a balance to find the mass of the soil. The data from their study is shown below.

Based on the graph, more soil is washed away when
- A. the soil is made mostly of sand.
- B. there are fewer rocks in the soil.
- C. the slope of the incline is steeper.
- D. the slope of the incline is less steep.

65. The pictures below show a field that is being studied over time. In the field, there are rabbits (red circles) and foxes (blue circles). What conclusion can be drawn from these observations?
A. The number of foxes increases while the number of rabbits decreases.
B. The number of foxes remains constant while the number of rabbits decreases.
C. The number of rabbits and foxes remains constant over time.
D. The number of foxes decreases as the number of rabbits increases.

Analyze, Interpret & Communicate Data

66. Charity wants to be a biologist some day. To prepare for her career, she decides to study her pet rabbit's behavior.

Every evening for a month, she places half a carrot, half a leaf of lettuce, and a short stalk of celery in the rabbit's food dish. She then records which item the rabbit eats first. The chart below shows the results of Charity's multiple trials.

<table>
<thead>
<tr>
<th>Food Item</th>
<th>Number of Days Item was Eaten First</th>
</tr>
</thead>
<tbody>
<tr>
<td>carrot</td>
<td>5</td>
</tr>
<tr>
<td>lettuce</td>
<td>7</td>
</tr>
<tr>
<td>celery</td>
<td>19</td>
</tr>
</tbody>
</table>

Based on these results, Charity can conclude that

A. her pet rabbit will likely eat celery first over carrots and lettuce.
B. all rabbits prefer celery over carrots and lettuce.
C. her pet rabbit will likely eat lettuce first over carrots and celery.
D. all rabbits prefer lettuce over carrots and celery.

Analyze, Interpret & Communicate Data

67. The average monthly rainfall during the summer months in Boulder, Colorado and in Madison, Wisconsin are shown in the graph below.
Average Monthly Rainfall

Which of the following conclusions could be made from this data?

A. It is hotter in Madison than in Boulder during the winter.

B. It is hotter in Madison than in Boulder during the summer.

C. Madison's summer climate is wetter than Boulder's.

D. Madison's summer climate is drier than Boulder's.

Analyze, Interpret & Communicate Data

68. Which statements about scientific explanations are true?

I. Scientific explanations must prove that a hypothesis is true.

II. Scientific explanations should be based on evidence or data.

III. Scientific explanations must have logical and consistent arguments.

IV. Scientific explanations should use scientific principles, models, and theories.

A. II, III and IV only

B. I, II and III only
Dr. Peterson does an experiment to research the growth rate of mice. He has two groups of mice. He feeds one group a type of food and adds chemical A, which is supposed to increase growth rate. The other group he feeds the same food without chemical A added. His research shows that chemical A increases growth rate by 30%. He does the experiment 4 times and comes up with the same result each time.

Dr. Peterson concludes that chemical A does increase the growth rate of mice. Is Dr. Peterson’s conclusion supported by scientific knowledge?

A. No; scientific knowledge never comes from research or experiments.
B. No; science cannot be used to research small animals such as mice.
C. Yes; any study that involves a percentage is based on scientific knowledge.
D. Yes; his conclusion is supported by evidence from his experiment.

Dr. Burke performs an experiment to determine how plants grow in a variety of temperature and moisture conditions. He runs five trials with five different groups of the same species of plant. The table below shows the results from his experiment.

<table>
<thead>
<tr>
<th>Plant Group</th>
<th>Temperature</th>
<th>Moisture</th>
<th>Average Plant Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>high</td>
<td>high</td>
<td>2 in</td>
</tr>
<tr>
<td>Group 2</td>
<td>moderate</td>
<td>moderate</td>
<td>6 in</td>
</tr>
<tr>
<td>Group 3</td>
<td>low</td>
<td>low</td>
<td>0 in</td>
</tr>
<tr>
<td>Group 4</td>
<td>high</td>
<td>moderate</td>
<td>3 in</td>
</tr>
<tr>
<td>Group 5</td>
<td>moderate</td>
<td>high</td>
<td>4 in</td>
</tr>
</tbody>
</table>
After finishing the experiment, Dr. Burke explains that heat and moisture have no effect on plant growth. Based on the evidence shown in the table, is his explanation valid?

A. No, he did not test plants in moderate moisture and moderate temperature conditions.
B. Yes, his experiment is well designed so his results do not need to support his explanation.
C. No, the evidence shown in the table does not support his explanation.
D. Yes, the evidence shown in the table supports his explanation.

Analyze, Interpret & Communicate Data

71. A scientist is observing a rare monkey in the jungle, and the monkey begins exhibiting an odd behavior. The scientist thinks this behavior may not have been observed in this species before, but he is not certain. The scientist records video of the behavior and takes many detailed notes.

The scientist becomes very excited about his finding and plans to share it with other scientists. The best way for him to communicate and defend his finding would be to

A. confirm that the behavior has not been observed before, and then present his finding in a report.
B. defend his finding as a new discovery, even if another scientist has already published a report about the behavior.
C. immediately write a report claiming a newly discovered behavior, and then check later to see if others have observed it before.
D. wait until other scientists ask him about his trip to the jungle, and then tell them about his finding.

Analyze, Interpret & Communicate Data

72. Which of the following can be used to communicate ideas?

A. oral and written reports
B. charts and spreadsheets
C. symbols and illustrations
D. all of these

Systems & Patterns

73. Which of the following is the best example of the parts of a system working together?
   A. The heart pumps blood to the blood vessels, and the vessels transport the blood throughout the human body.
   B. John uses a microwave to heat up his food and then puts his leftovers in the refrigerator to keep them cold.
   C. A bowling ball, a tennis ball, and a basketball are sitting next to one another on top of a computer desk.
   D. Kayla uses a computer to type up an essay, whereas James uses a pen and paper to do the same assignment.

Systems & Patterns

74. A system is a group of related parts with specific roles that work together to achieve an observed result. Which of the following are the main parts of the circulatory system?
   A. red blood cells and white blood cells
   B. heart, blood, and blood vessels
   C. the brain and spinal cord
   D. the human body and its organ systems

Systems & Patterns

75. What is system input?
   A. Material that has been changed by a system
   B. Feedback from scientists about the results of a system
   C. The ordered processes that the system uses to change raw material
   D. Raw material that must be put into a system for processing
There are five elements of a universal systems model: goal, inputs, processes, outputs, and feedback. Which of the following describes the "processes" portion of this model?

- A. information collected from the outputs
- B. the results of the system
- C. what is done to the inputs
- D. the money, time, and resources used on the model

Which of the steps in the system are examples of processes?

- A. I, III, and V only
- B. I, II, III, IV and V
- C. I, II, III, and IV only
- D. II and IV only

The raw material that is added to a system for processing is known as _______.

- A. negative feedback
- B. the output
- C. positive feedback
- D. the input
79. The flowchart below represents a system.

[Flowchart image]

What is the input in this system?
- A. sweat gland activity
- B. body temperature
- C. the brain
- D. blood vessel diameter

80. The diagram below shows the carbon cycle.
Which of the following descriptions of the carbon cycle is most accurate?

A. It is a closed system because the amount of carbon in the system is variable.

B. It is an open system because the amount of carbon in the system stays constant.

C. It is a closed system because the amount of carbon in the system stays constant.

D. It is an open system because the amount of carbon in the system is variable.

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**Systems & Patterns**

81. What is a closed-loop system?

A. A group of related parts that work together in order to transport material

B. A model of something that helps us to understand it better

C. A group of related objects that do not send out or receive feedback and cannot modify themselves

D. A group of related objects that send out and receive feedback and can modify themselves

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**Systems & Patterns**
82. What would be an immediate effect of the final part of an assembly line system shutting down?

- A. inputs would stop
- B. the system would not be affected
- C. outputs would stop
- D. the assembly line would speed up

83. A subway system for a large city owns 40 subway trains that run on five different colored routes. What difference will it make to the system as a whole if a train breaks down blocking the yellow line route near Downtown and East Side?

- A. Only the people riding the broken train will be affected.
- B. No one will be affected because there are 39 other trains.
- C. Only people that ride on the blue and yellow train routes might be affected.
- D. Everyone whose train connects with the yellow route may be affected.

84. What do the lunar cycle, bird migration, and cell mitosis have in common?

- A. They are all natural events that occur in a pattern.
Systems & Patterns

85. What does the motion of a hurricane have in common with the seasons of the year?

- A. Both of them follow a pattern.
- B. Both of them can only be observed through a telescope.
- C. Neither of them is studied anymore.
- D. Neither of them is predictable.

Systems & Patterns

86. A cycle is a series of events that repeats in a regular pattern. Which of these is a cycle?

- A. a major flood
- B. a basketball game
- C. the seasons of the year
- D. the hatching of an egg

Models & Technological Design

87. Science and technology are closely related, but not the same. Which of the following is most likely a result of science, not technology?

- A. a theory
- B. an invention
- C. a design
- D. a process

Models & Technological Design

88. The Large Hadron Collider (LHC) is a huge piece of equipment designed and built in order to make new scientific discoveries. The Large Hadron Collider is a product of _______ and is used for _______.
A. scientific investigations, technological development
B. technological development, scientific investigations
C. technological development, technological development
D. scientific investigation, scientific investigations

Models & Technological Design

89. Trey was asked to build a working model of a landform for a science project. He chose to build a model of a volcano.

Trey formed a base out of clay and then painted the model so it resembled a cinder cone volcano. Finally, Trey mixed baking soda, vinegar, and red food coloring in the base, so it mimicked lava flowing out of the volcano. Once he was finished with his project, Trey's teacher asked how useful his model was.

What factor best determines the usefulness of the model?

A. how closely the model's color matches the real world
B. how closely the model's composition matches the real world
C. how closely the model's size matches the real world
D. how closely the model's behavior matches the real world

Models & Technological Design

90. Dr. Ray has developed a new way to remove oil from wetlands in the event of an oil spill. To test his new process, Dr. Ray builds a scale model of a wetland in his lab and pours a small amount of oil into it. He then observes the rate at which his process is able to remove the oil from the model.
Why did Dr. Ray use a model?

- A. Because his model makes the process more complicated.
- B. Because real wetlands are too complicated for his process to work.
- C. Because dumping oil in a real wetland would be dangerous.
- D. Because real wetlands are too large to be affected by oil.

Models & Technological Design

91. Part of a bird's digestive tract, called a gizzard, is able to break up large chunks of food at an extremely fast rate. It is difficult for scientists to watch a gizzard functioning in a live bird. How would building a model of a gizzard help a scientist?

- A. to analyze how a gizzard works
- B. to determine what type of tissues a real gizzard is made of
- C. to study bird behavior
- D. to watch a gizzard functioning in life

Models & Technological Design

92. Doug has filled a long tray with an even layer of sand. Doug then uses two bricks to prop up one side of the tray. Next, Doug uses a watering can to pour water onto the high side of the tray. What natural process is Doug most likely modeling?

- A. the rock cycle
- B. a volcanic eruption
- C. erosion
- D. an earthquake

Models & Technological Design

93. Newton's Third Law of Motion states that for every action there is an equal and opposite reaction. Science teachers often model this law by showing what happens when two floating balls collide in a pool of water.
What is the most likely reason that science teachers explain this law by modeling it?

- A. The law does not apply to any objects found on Earth.
- B. The law is an abstract idea that may be difficult to understand without seeing how it works.
- C. The objects governed by the law are too dangerous to be observed directly.
- D. The objects governed by the law are too small to be easily observed directly.

Models & Technological Design

94. Sariah's science teacher asked everyone in the class to bring a model of the park near their school so that they could add labels to them in class. To which kind of model would it be easiest to add labels?

- A. a scale drawing, looking down on the park
- B. a scale-model diorama made of dirt and sticks
- C. a scale-model sculpture out of clay
- D. a scale drawing of a cross-section of the park

Models & Technological Design

95. Kelly is giving her friend directions to a nearby park. Which model would be most appropriate for her to use?

- A. a detailed road map of the whole city
- B. a photograph of the playground
- C. a hand drawn outline of the route
- D. a globe

Models & Technological Design

96. A company is developing a new type of airplane that can take off like a helicopter. Before they begin manufacturing the airplanes on a large scale, they first build a prototype. What is the main purpose of building a prototype?
A. to find a market in which to sell the product
B. to train factory workers about how to make the product on a large scale
C. to make sure the design works as expected
D. to show future customers what the product will look like

Models & Technological Design

97. What do engineers use to test their designs of new technologies?

A. polls
B. reference materials
C. models
D. pie charts

Models & Technological Design

98. Stuart designed and built a water filter in class. He wants to know if it will make water from lakes or streams safe to drink. Which of the following would it be best for Stuart to measure in an experiment in order to test his design and answer this question?

A. the diameter of the largest grain of dust, dirt, or sand that can pass through his filter
B. the amount of time required for different volumes of water to pass through his filter
C. the amount of bacteria and impurities in water both before and after it passes through his filter
D. the maximum force that can be applied to his filter without breaking it

Models & Technological Design

99. Many companies are making permanent coffee filters like the one below.
How is this an improvement on the traditional, paper coffee filters?

- A. The coffee brewed using permanent filters does not taste as good.
- B. A permanent filter is more expensive than a traditional filter.
- C. They contain plastic which does not break down as easily as paper.
- D. They are less wasteful and more cost effective because they last longer.

Models & Technological Design

100. Abigail just completed a report on plastics, which are manufactured using petroleum. She concluded that the price of plastic will likely rise significantly in the years to come as petroleum reserves are depleted. She recommends that manufacturers begin making less plastic from petroleum reserves to prevent extreme price increases in the future.

Abigail's younger brother Henry just completed a report on waste management. Henry concluded that plastic products are a major component of garbage that ends up in landfills. He recommends that humans reduce the amount of plastic they put in landfills.

Which of the following would help implement both Abigail's and Henry's recommendations?

- A. Reuse more plastic products.
- B. Use alternatives to plastic products.
- C. Recycle more plastic products.
- D. all of these

Answers

1. A
2. B
3. C
4. D
5. C
6. A
7. A
8. B
9. D
10. C
11. B
12. C
13. D
14. D
15. D
16. A
17. C
18. D
19. D
20. C
21. A
22. C
23. D
24. C
25. D
26. D
27. C
28. D
29. A
30. D
31. A
32. B
33. C
34. D
35. B
36. C
37. D
38. C
39. A
40. A
41. C
42. D
43. C
44. C
45. A
46. B
47. D
48. D
49. A
50. C
51. C
52. C
53. A
54. A
55. D
56. C
57. A
58. C
59. A
60. D
61. C
62. C
63. B
64. C
65. A
66. A
67. C
68. A
69. D
70. C
71. A
72. D
73. A
74. B
75. D
76. C
77. D
78. D
79. B
80. C
81. D
82. C
83. D
84. A
85. A
86. C
87. A
88. B
89. D
90. C
91. A
92. C
93. B
94. A
95. C
Explanations

1. Scientific inquiry progresses by constantly asking questions and collecting, analyzing, and interpreting data in order to answer them. Researching something in books, articles, and on the internet is a good way to learn, but it can only teach what someone else has already figured out. To make new discoveries, new questions must be asked and answered with objective data.

2. An investigation dealing with differences in the physical features of plants could be studied by observing and recording the physical characteristics of plants.

Plants are easy to grow and observe in nature, so a model would not be necessary.

Finding new plant species is not needed, since most physical features of plants are shared among species (leaves, roots, flowers, etc.).

Also, experimenting on the chemical components of a plant would not tell anything about the physical features.

3. Different scientific questions and hypotheses require different types of scientific investigations. Some questions can be answered through controlled experiments. Other questions can be answered through collecting specimens, building models, and/or making observations.

Jill's hypothesis could best be tested by collecting and testing rock specimens from multiple volcanoes in various locations.

4. Based on Oscar's data, the temperature of the water continued to rise until the water began to boil. As the water boiled, the temperature remained constant at 100°C.

Therefore, the best question to ask is, "Why does the temperature of the water remain constant while it boils?"

5. A scientific question cannot be asked about something that does not exist, so the question about dragons is out. Similarly, starfish do not fall in love as far as we know, nor would we have a reliable way of measuring how they did. The cricket question asks only "why?" and lists no variables. The only question left is "Does eating less fat increase a mouse's life span?" This question can be answered by giving different mice various diets and seeing how long they live.

6. Good scientific questions must be testable, and they can be answered using data and facts obtained from research, observations, or experiments. Good scientific questions do not ask about
opinions (e.g., Are ladybugs prettier than beetles?) or emotions (e.g., Do ants feel anxiety?), and they typically do not begin with "why" (e.g., Why are there so many different kinds of insects in the world?).

"Do different food types affect the growth rate of beetles?" is a good scientific question because George could design an experiment to test it.

7. A scientific question must be testable and based on observations, investigations, or research. It cannot be used to ask about opinions or emotions. "Do squirrels that eat nuts grow faster than squirrels that eat fruit?" is a testable scientific question.

8. Darren hypothesized that the volume of a gas is related to its temperature. The observation from which he based his hypothesis was that a balloon filled with air expanded when it was heated and shrunk when it was cooled. This observation shows a direct relationship between the volume of a gas and its temperature.

It is always important for an investigator to be able to identify observations which support a hypothesis or prediction. Equally, it important to acknowledge any observations which do not support a hypothesis or prediction.

9. All testable hypotheses are valuable because their corresponding scientific investigations produce evidence, data, and information from which scientists can develop other theories, ideas, and investigations.

It doesn't matter if a hypothesis is proven to be correct or incorrect as long as the hypothesis is valid (i.e., clear, measureable, testable).

10. Scientists form hypotheses about subjects they are interested in studying. A hypothesis helps a scientist design a scientific experiment. Experiments are designed to test whether a hypothesis is correct. Belinda's next step is to design an experiment to test her hypothesis.

11. A scientific hypothesis must be testable and it must be written as a statement, not as a question. "The birds follow the herd because the cows stir up insects for the birds to eat" is a testable hypothesis.

12. Most scientific theories start as hypotheses. After many repeated experiments and different lines of evidence all indicate that a hypothesis is correct, the hypothesis may be adopted by the scientific community as a theory.

13. A theory is a statement meant to explain something in nature. Although a theory has not been proven as fact, it is supported by scientific evidence. An opinion is not supported by scientific evidence.

14. In science, a theory is a unifying explanation for a broad range of hypotheses and observations that have been supported by testing. The gathering of evidence and the peer review of that evidence are hallmarks of scientific thought.
15. Many times people will use the word *theory* when they are really just stating an opinion or speculating. These opinions and speculations cannot be proven right or wrong.

A *scientific theory*, on the other hand, is a well-supported explanation of nature. It is based on scientific knowledge and has been tested through experimentation.

In this case, the best time to wash a car is really a **matter of opinion and not a testable explanation of nature**.

16. If Jackie is having difficulty seeing the blackboard, her teacher would likely suggest that she wear **glasses** or contacts. These pieces of technology enhance the sense of sight.

17. **A hearing aid** is a piece of technology that expands the sense of hearing.

18. A **stopwatch** is used to measure the amount of time that has passed from one point to another. This would be the best tool for Mia to use to measure the amount of time it takes her to drink the water in the glass.

19. A magnet can be used to **attract metal objects**. Certain kinds of metal, including iron, cobalt, and nickel, are attracted by magnets.

20. In order to use the balance, an object is placed on the platform. Then, the sliders on the beams are moved to indicate the mass in hundreds, tens, and ones (and tenths) until **the pointer lines up with the zero mark**. Finally, the mass is read from the beams.

21. **Hand lenses are tools that magnify small objects**. They can be used in an experiment that is investigating properties of small objects or details on larger objects that are too small to see clearly with the naked eye.

22. The ice-water can experiment is similar to an instrument used by meteorologists called a chilled mirror. The chilled mirror can detect the exact temperature at which water begins to condense out of the air, which is known as the **dew point**.

23. When using a barometer to measure a change in air pressure, the set pointer is placed on top of the reading pointer. Then, if the reading pointer changes position, the change in pressure can be determined.

24. **A spectroscope** is a tool that divides light into the different colors that make it up. Most light sources—including light bulbs, flashlights, and the Sun—emit many different colors, but not all colors. A spectroscope can help an observer determine which colors are released by the light source and which colors are not.

25. **A telescope** makes objects that are very far away appear larger. This makes them easier to observe. Objects like stars and planets are often observed through telescopes.
26. A **temperature probe** can monitor the temperature of a solution continuously and sends the data directly to a computer. The data from the other tools must be interpreted and recorded by person.

27. After Sachiko places the room-temperature thermometer in the beaker of ice water, the mercury level will immediately begin to drop. It will take several seconds for the thermometer to adjust to the new temperature. To obtain the most accurate reading, she should watch the mercury level closely and take the reading immediately after the mercury level has become stable.

28. Before using a triple-beam balance, it is necessary to

- make sure that the pan is clean and free of debris. If something is left on the balance, it could contaminate whatever you are trying to measure and cause you to make an incorrect measurement.

- make sure that the balance is on a level surface. If the balance is not level, the readings will be inaccurate.

- make sure that all of the counterweights are set to zero (and the balanced is zeroed). If the balance is not properly zeroed, all the measurements will be inaccurate.

29. If you are asked to note the odor of a substance, the safest way to do so is to **waft the fumes toward you with your hand**.

30. Strong acids and strong bases are extremely dangerous and corrosive. When a strong acid or a strong base is spilled onto an article of clothing, it is very important to remove that article of clothing as quickly as possible to prevent prolonged exposure to the skin. Then, the skin should be rinsed thoroughly with water. Finally, the teacher should be notified of the exposure.

Strong acids and strong bases are capable of dissolving flesh all the way down to the bone. Extreme precaution should be taken when using these chemicals (i.e., goggles, aprons, and gloves should be worn).

31. In an experiment, the **independent variable controls the dependent variables**.

For example, if a student wants to determine how the amount of water a plant is given affects the growth of a plant, the independent variable (the amount of water) controls the dependent variable (the growth of the plant).

32. The independent variable is the one that is changed to see what effect changing it has. In this experiment, the independent variable is the **temperature of the water**.

The amount of salt is the dependent variable. The amount of water and the amount of time the salt is given to dissolve are both constants.
33. In this experiment, the independent variable is the type of disinfectant used and the dependent variable is the amount of bacteria killed. The **type of disinfectant determines the amount of bacteria killed**.

34. **Variables** are the factors that can be changed in an experiment. Independent variables are those factors that are manipulated or changed by the scientist. Dependent variables are those factors that respond to the independent variables.

In a controlled scientific experiment, a scientist **alters the independent variable and observes the effects on the dependent variable**. All other conditions in the experiment are kept constant.

35. Variables are the parts in an experiment which change. Independent variables determine the values of the dependent variables.

In Omar's experiment, the independent variable is **the mass of the model rocket**. This variable is controlled by Omar and ultimately determines the values of the dependent variable (the amount of time that the rockets remain airborne).

36. Shawn is investigating how the **time of day** affects the diameter of a flower. The time of day is the independent variable.

37. When designing an experiment for a controlled scientific investigation, the designer should:

   - **plan the variables** (manipulated and responding)
   - plan for controlled variables
   - **list the needed materials**
   - **list the procedures**
   - plan for recording, organizing and analyzing data from the experiment

38. Scientists repeat experiments in order to verify that the results from their first experiment are accurate. Repeating experiments helps scientists make sure there are no errors in the evidence they collect.

39. There are several ways to make sure the results of an investigation are valid. First, you and others can try to repeat the experiment. In addition, if it is a controlled experiment, you can make sure you have a control, only one independent variable, at least one dependent variable, and constants.

   It is especially important to use only one independent variable because **when only one factor is changed, you can be more certain that it caused the results**. If you change multiple factors, you won't know which one was responsible for the change.

40. It is important to include all information, including resources and unsuccessful trials. This information could be beneficial to other scientists. They could use this information to further benefit the farmers and the consumers who buy the food from the crops.
41. **Javier must carefully record and describe all of the characteristics of his beetle.**

Javier might have found a new species of beetle. But he will only be able to figure this out if he has carefully recorded all of the details of the beetle. So Javier must closely observe it, and take careful notes. After he has done this, he can compare his description to that of known species.

42. **To test his hypothesis, Nick should heat equal masses of wax and chocolate and measure their temperatures when they start to melt.**

43. **To find the answer to a question about nature, it is best to plan an experiment in which the natural event in question can be directly observed and measured.**

44. During an experiment to test how a variable changes a substance, it is important to first observe and record the characteristics of the substance before the variable is introduced. In this case, the variable is heat energy. The student must first record the liquid’s volume, before attempting to change the volume by introducing heat energy.

45. When scientists use one of their five senses to gather information, they are **making an observation.**

Much of scientific knowledge has been gained through observation. By using the senses of sight, smell, touch, taste, and hearing, there are many things about the world that can be learned.

46. An observation that includes only words in the description is **qualitative** because it describes the quality of an object. **Color** is an example of a qualitative observation.

Temperature, volume, and mass are all examples of **quantitative** data because they involve quantities, or numbers.

47. The rider on the back beam is at 70 g. The rider on the middle beam is at 100 g. The rider on the front beam is past the 9.3 g mark and very close to the 9.4 g mark; so a reasonable estimate is 9.39 g.

The total mass of the block is equal to the sum of these numbers.

\[100 \text{ g} + 70 \text{ g} + 9.39 \text{ g} = 179.39 \text{ g}\]

So, the total mass of the block is 179.39 g.

Triple beam balances measure mass. Common units of mass include grams or kilograms.

48. The small hand is on 12.5 minutes, and the large hand is on 7.3 seconds. This indicates that the amount of time that has passed is 12 min + .5 min + 7.3 s = 12 min + 30 s + 7.3 s = 12 minutes, 37.3 seconds.
There is a second way to read this stopwatch. A total of twelve minutes and more than 30 seconds has passed. Since the number of seconds is greater than 30, it is indicated by the red numbers on the inside of the dial instead of the black numbers on the outside of the dial. The large hand is pointing to 37.3 seconds. This gives a total of **12 minutes, 37.3 seconds**.

49. The correct volume is read from the *bottom* of the meniscus. In this image, the meniscus appears as a curved white area. The bottom of the meniscus is between the lines marking 25 mL and 26 mL. It appears to be slightly above the halfway mark, so **25.6 mL** is a good answer.

50. A tape measure is read by seeing where the end of the tape measure crosses the rest of the tape. In this case, the end of the tape that would be labeled "0" does not quite reach the 15.5 cm mark, so **15.54 cm** is a reasonable measurement.

51. The measurement on the scale shows that the mass of the tomato is **57 g**.

52. Thermometer **W** shows that the temperature outside is 25°C.

53. The stopwatch shows that Abby ran for **54 sec**.

Time is usually measured using a stopwatch. Time is commonly recorded in units of hours, minutes, and/or seconds.

54. When using analog tools, measurements should not be rounded to the smallest unit. Instead, measure how many complete smallest units there are, then estimate the fraction of the last smallest unit.

   The volume of a liquid should be read where the bottom of the curve or *meniscus* rests. Since each unit on the graduated cylinder is equal to 1 mL, the measurement should be estimated to the nearest tenth of a milliliter. **16.9 mL** is a good estimation of the liquid's volume.

55. The gram is a metric unit for **mass**. Mass is also typically measured in kilograms.

56. The prefix micro- represents $10^{-6}$. The prefix milli- represents $10^{-3}$. The prefix centi-represents $10^{-1}$. The prefix deca- represents $10^1$, and the prefix kilo- represents $10^3$.

   So, from smallest to biggest, the prefixes should be listed as follows:
   
   micro-, milli-, centi-, deca-, kilo-

57. The level of closeness between multiple measurements of the same quantity is called **precision**.

58. Accuracy is the level of closeness between a measured quantity and the actual or standard value. Precision is the level of closeness between multiple measurements of the same quantity. On the target, the marks are near the bulls-eye but relatively far apart. This represents **high accuracy and low precision**.
59. Inferences are **conclusions or predictions that are made by studying observations**.

Although much of scientific knowledge has been gained from using the senses to make observations, much has also been learned from analyzing those observations. These analyses often result in important conclusions or predictions that lead to new scientific experiments.

60. The boiling point of pure water at standard atmospheric pressure is 100°C. The more salt, or any solid, that is dissolved in the water, the more the water's boiling point will be elevated.

It takes **5.6 g** of salt to raise the boiling point of water by a half of a degree.

61. The month of **March** had an average daily temperature of 41 degrees.

62. The growth of the tree from zero to 20 days is linear. By drawing a straight-line through the data points from zero to 20 days, you can tell that the height of the tree at 10 days was about 2 meters.

63. Each day the volume decreased 4 mL. So, at the start of day 5, there would be approximately **4 mL** left.

64. Although increasing the amount of sand in soil or decreasing the number of rocks on an incline can increase the amount of soil that is washed away, the graph did not have any data about rocks or soil type.

The data in the graph shows that more soil is washed away when **the slope of the incline is steeper**.

65. The plots show that the number of rabbits decreases from six on day 1 to two on day 21, while the number of foxes increases from two on day 1 to six on day 21. Therefore, over time, **the number of foxes increases, while the number of rabbits decreases**.

66. Charity's rabbit ate celery first on many more days than it ate lettuce or carrots first. So, the results of her scientific investigation suggest that **her rabbit will likely eat celery first, given the three choices**.

To find out if all rabbits generally prefer celery over carrots and lettuce, Charity would need to run similar trials for many other rabbits.

67. The graph shows that Madison receives more rainfall than Boulder during each of the summer months. Because Madison gets more rain in the summer, **Madison's summer climate is wetter than Boulder's**.

Climate is defined by the temperature, humidity, air pressure, wind, and amount of precipitation in an area averaged over a long period of time. The Earth has a variety of climates.
68. Only statements II, III and IV are true.

Scientific explanations should

- be based on and emphasize evidence or data;
- have logical and consistent arguments;
- use scientific principles, models, and theories.

Scientific explanations do not have to prove that a scientific hypothesis is true.

69. Scientific knowledge is based on observation and evidence from research and experiments. Dr. Peterson based his conclusion on the results of his experiment. His conclusion is supported by scientific knowledge because his conclusion is supported by evidence from his experiment.

A study that involves percentages is not necessarily scientific.

70. Dr. Burke's explanation is not valid because the evidence shown in the table does not support the explanation.

According to the table, plants that receive low heat and moisture do not grow at all. Plants that are grown in moderate temperature and moisture conditions grow the most.

71. Before claiming a new discovery, the scientist needs to confirm that the behavior has not been observed before. This is done by checking to see if other scientists have published reports about the behavior.

If it turns out no one else has documented the behavior, then the scientist can claim the discovery and present his finding in a report. In science, it's always best to communicate and defend one's findings in writing.

72. All of these can be used to communicate ideas. People use words, drawings, figures, and speech to communicate ideas to each other.

73. A system is made up of interrelated parts that work together to perform a single task. There are thousands of systems at work every day in society, in machines, and in our own bodies.

An example of a system is the circulatory system. In the circulatory system, the heart pumps blood to the blood vessels, and the vessels transport the blood throughout the human body. This provides the human body with nutrients and oxygen. All of the parts of the circulatory system work together to perform this task.

74. Systems are made of many parts that work together. For example, the circulatory system is made up of a heart that pumps blood through blood vessels.

Each of the parts in a system may be a smaller subsystem, which is also composed of parts. For
example, the circulatory system's blood is composed of plasma, platelets, red blood cells, and white blood cells.

The components of a system play different roles in the system.

75. System input is the raw material that is put into a system for processing. In the case of the digestive system, food is the input. The output is energy and waste. The system process is the digestion itself, including chewing, chemical breakdown of the food in the stomach, and nutrient absorption in the intestines.

76. A universal systems model is a tool used to try to simply and understand complex systems. Inputs, such as capital and materials, are used to run a process. The results, or outputs, are analyzed and feedback is produced.

77. Systems can include processes as well as things. In the system that produces mp3 players, only steps II and IV are examples of processes. The production process builds the case and the electronics while the assembly process puts the parts together into a product.

The materials used are inputs to the system. The parts are both an output and an input, and the product is the final output for the system.

78. The raw material that is added to a system for processing is known as the input. For example, the input for the digestive system is food that is eaten.

The finished product or waste that forms as a result of a process is known as the output. For example, the output of the digestive system is energy and wastes.

When the output of a system comes back to influence the subsequent functioning of that system, feedback occurs. If the output amplifies subsequent outputs, positive feedback occurs. If the output causes subsequent outputs to decrease, negative feedback occurs.

79. An input is the information entering a system. In this system, body temperature is the information that can cause a response by the brain.

80. In an open system, matter and energy can enter or exit the system. An organism is an example of an open system.

In a closed system, however, only energy can move into or out of a system. The carbon cycle is a closed system because the amount of carbon stays constant.

81. A closed-loop system is a system with feedback that can change its processes based on the feedback. It is the opposite of an open-loop system.

82. Outputs, or the product of the assembly line, would stop coming out of the system if the final part of the system shut down. Inputs could continue, at least for awhile. But no matter how many
inputs go into the system, outputs cannot be created again until all parts of the system are working.

83. Having only one out of 40 trains malfunction seems like a small change in the overall system. However, this small change has large effects on the system as a whole.

Many people ride trains that connect to the yellow line. Many people will be stranded at these stations, and some people may try to take different trains than usual in order to get to their destination.

84. All of the natural events in the list have a predictable recurring pattern.

In fact, most natural events occur in patterns. Scientists often look for patterns when studying a new phenomenon.

85. Meteorologists study the weather. They have found that hurricanes occur most often in the summer months and that they move in a predictable way across the Atlantic Ocean. This means that, like the seasons of the year, hurricanes follow a pattern.

In fact, most natural event occur in patterns.

86. The seasons of the year repeat in a predictable pattern of winter, spring, summer, and fall.

The other answer choices are individual events. Parts of these events may repeat. For example, a team may perform the same play several times during a basketball game. Also, each of these events may be one step of a larger cycle (e.g., an individual basketball game is one of many games in a basketball season that repeats every year). But these individual events are not cycles themselves.

87. Science is the pure pursuit to gain knowledge about the natural world. Theories, laws, and facts are examples of items produced by science. The goal of technology is to develop new processes or products for human use. Design, inventions, and processes are examples of items produced by technology.

88. Technology produces designs and equipment, so the Large Hadron Collider is a product of technological development. It happens to be an invention that is used for the purpose of scientific investigations, like many other technological tools. Just as technology benefits from new scientific discoveries, science benefits from technological advances that make complicated equipment like the Large Hadron Collider possible.

89. Models are often created to represent objects, events, and processes in the real world that

- occur too slowly or too quickly;
- are too small or too large;
- are too complicated or too dangerous.
Although a model's appearance may be similar to the object that is being modeled, the usefulness of a model is best determined by **how closely its behavior matches the real world.**

Models are often used to get a better idea of how an object works or how an event or process occurs. However, if a model is used as the only source of data, there is no guarantee that hypotheses or conclusions made about the real world object will be correct.

90. Models are often used to think about processes that are too vast to be changed deliberately, or that are potentially dangerous.

**Intentionally dumping oil in a real wetland would be dangerous.** So Dr. Ray most likely chose to build a model so that he could test his cleanup system without harming a real ecosystem.

91. Models represent objects, events, and processes in the real world.

Models are often used when an object, event, or process

- occurs too slowly or too quickly;
- is too small or too large;
- is too complicated or too dangerous.

Scientists often use models of organs to analyze how that organ works and what would happen should that organ fail. Models of organs are useful because it is very difficult to observe a working organ in a living organism.

92. Models are representations of objects, events, and processes in the real world. But, different models can be used to represent the same thing. The purpose of the model must be considered when choosing which type of model to use.

Doug is modeling how erosion by water can occur on a slope, such as the side of a hill. In his experiment, Doug can change the slope of the hill to model how different degrees of slope affect how much material is eroded.

93. Models represent objects, events, and processes in the real world.

Models are often used when an object, event, or process

- occurs too slowly or too quickly;
- is too small or too large;
- is too complicated or too dangerous.

Newton's laws of motions are **abstract ideas.** It is sometimes easier to understand abstract ideas when they are applied to objects in the real world.
94. Different models can be used to represent the same thing. The type of model chosen depends upon the purpose of the model.

Sariah's teacher wants the students to be able to add labels to their models. A **scale-drawing of the park, looking down on it**, would make that easiest.

95. Models are frequently used to represent objects, events, and processes in the real world. But, different models can often be used to represent the same thing. The purpose of the model must be considered when choosing which type of model to use.

Since the park is nearby, the friend will be traveling in a familiar area and only a short distance. A detailed road map or a globe would provide too much information, but a photograph of the playground would not give enough information.

**A hand drawn outline of the route** would be best.

96. An engineer starts the product design process by making drawings and notes about his or her idea. Next, models are built of the design. Once the model is satisfactory, a prototype is built. The prototype is a key opportunity for the engineer to identify and solve any design problems before the product is commercially produced.

97. Engineers use **models** when developing new or improved technologies. Models allow engineers to test a design to see how it will perform in the real world. The advantage of a model is that flaws or ways to improve a technological design can be discovered before the technology is fully developed.

98. Although each of these properties of Stuart's filter may be worth testing, the one that will tell him whether his filter can make lake water safe to drink is **the amount of bacteria, parasites, and impurities in water both before and after it passes through his filter**. Some filters are good at removing impurities, but not bacteria. Other ways of purifying water may kill bacteria but not remove impurities.

99. Permanent coffee filters are becoming more popular because they are **less wasteful and more cost effective because they last longer**. Traditional, paper filters can only be used once, whereas a permanent filter can last years. However, paper filters break down easily in the environment. Permanent filters are made from plastic and metal. The plastic takes years to break down in a landfill.

100. **All of these** solutions would help implement both Abigail's and Henry's recommendations.

By recycling and reusing plastic products, or by using products made of alternative materials, there will be less demand for new plastic products to be manufactured. Carrying reusable canvas shopping bags also reduces the amount of disposable items made of plastic.

All of these practices will also reduce the amount of plastic waste going into landfills.