Understanding Science

Directions: Answer each question or respond to each statement on the lines provided using a complete sentence. You must include the terms below in your answers.

- biology
- critical thinking
- ethics
- hypothesis
- inference
- observation
- prediction
- scientific law
- scientific theory
- technology

1. What are three examples of technology?

2. What is observation? Why is it important to scientists?

3. What role does critical thinking play in evaluating scientific evidence?

4. How is a scientific law different from a scientific theory?

5. How do you make an inference?

6. Contrast a hypothesis and a prediction.

7. Why are ethics particularly important in specific types of scientific investigation?

8. Define biology. Name two other branches of science.
Directions: Complete the crossword puzzle with the correct terms from the word bank.

Across
1. a statement about what will happen next in a sequence of events
2. a logical explanation of an observation that is drawn from prior knowledge or experience
3. an explanation of observations or events based on knowledge gained from many observations and investigations
4. describes a pattern or an event in nature that is always true
5. the practical use of scientific knowledge, especially for industrial or commercial use
6. using one or more senses to gather information and notice what occurs
7. a possible explanation about an observation that can be tested by scientific investigations

Down
1. hypothesis
2. inference
3. observation
4. prediction
5. scientific law
6. scientific theory
7. technology

Scientific Explanations
Understanding Science

Key Concept What is scientific inquiry?

Directions: On each line, write the term from the word bank that correctly completes each sentence. Each term is used only once.

analyze communicate conclusion
hypothesis observation prediction
science scientific inquiry scientific investigations

(1.) ________________________ is the investigation and exploration of natural events and of the new information that results from those investigations. Scientists use a set of skills called (2.) ___________ to find answers to their questions. (3.) ______________ is a scientific skill that involves using your senses to gather information and take note of what occurs. After making an observation, a scientist might form a(n) (4.) ________________________, which is a possible explanation about an observation that can be tested by (5.) ________________________.

When a scientist forms a hypothesis, he or she usually makes a(n) (6.) ________________________, or a statement about what will happen next in a sequence of events. After a hypothesis is tested, a scientist must (7.) ________________________ the results. A scientist might then draw a(n) (8.) ______________________ based on the results. Scientists write articles or speak at conferences to (9.) ______________________ their results to other scientists and to the public.

10. What does a scientist do if a hypothesis is supported? What does he or she do if a hypothesis is not supported?

________________________________________________________________________

________________________________________________________________________

Directions: On the line before each question, write L if the question might be asked by a life scientist, E if the question might be asked by an Earth scientist, or P if the question might be asked by a physical scientist.

1. _______ How do rocks form?

2. _______ How does an object’s motion change?

3. _______ What substances are in soil?

4. _______ Why does a liquid change to a solid?

5. _______ How do plants produce their own food?

6. _______ Why do some animals give birth to live young and others lay eggs?

7. _______ How are force and motion related?

8. _______ How are reptiles and birds related?

9. _______ What causes earthquakes?
Science and Pseudoscience

Pseudoscience is a method, belief, or practice that might appear to be scientific but does not follow appropriate scientific protocol. Its most important flaw is the lack of controlled, thoughtful, peer-reviewed experiments that are the foundation of the natural sciences.

Legitimate Science v. Junk Science

Legitimate science has its weaknesses and bumps in the road. Many experiments are done incorrectly or interpreted wrongly. Occasionally, a scientist is so enthusiastic about his or her results that the studies are made public before they can be reviewed. But genuine science has a backup plan—repetition and peer review. Genuine science has the support and critical review of the science community at large, and this makes problems generally self-correcting.

Junk science, on the other hand, is seldom peer reviewed. It nearly always has an element of politics or sales marketing behind it. For example, a certain claim was recently circulated around the Internet that the oil companies were suppressing the discovery of water as a fuel. This is junk. On the Internet, don’t believe claims that someone lost 9 kg per week due to one fantastic discovery. It’s junk, and it is pseudoscience.

Here are some ways to tell the difference between real science and pseudoscience.

1. Science attempts to achieve a better understanding of the natural world. Pseudoscience is more often driven by political or commercial goals.

2. Science expands knowledge through disciplined investigation. Pseudoscience attempts to justify an existing belief.

3. Science meets contradictions of established theory with further experimentation. Pseudoscience ignores or suppresses contradictions.

4. Science constantly tests its own principles and alters theories in the search for truth. Pseudoscience cannot be falsified or verified and, therefore, can’t be tested or disproved.

If you recognize pseudoscience, you might be able to avoid it. But those who have less ability for critical thinking or who don’t have the tools or information are more likely to become targets for health or commercial scams. Stay informed. Look for the real thing.

<table>
<thead>
<tr>
<th>Science</th>
<th>Pseudoscience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Here are the facts. What conclusions can we draw from them?</td>
<td>Here is the conclusion. What facts can we find to support it?</td>
</tr>
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Applying Critical-Thinking Skills

Directions: Answer each question or respond to each statement.

1. **Compare** How does the graphic clearly illustrate the difference between science and pseudoscience?

2. **Point out** What are two subject areas in which pseudoscience is likely to be found? What might it look or sound like when it is encountered?
Lesson Quiz B

Matching
Directions: On the line before each definition, write the letter of the term that matches it correctly. Not all terms are used.

| _____ | 1. a possible explanation of an observation that can be tested by scientific investigations | A. scientific theory |
| _____ | 2. an explanation of observations or events based on knowledge gained from many observations and investigations | B. observation |
| _____ | 3. a description of a pattern or an event in nature that is always true | C. inference |
| _____ | 4. using one or more of your senses to gather information and take note of what occurs | D. critical thinking |
| _____ | 5. a statement about what will happen next in a sequence of events | E. hypothesis |
| _____ | 6. a logical explanation of an observation that is drawn from prior knowledge or experience | F. scientific law |
| _____ | G. prediction |

Multiple Choice
Directions: On the line before each question, write the letter of the correct answer.

| _____ | 7. Which question would most likely be studied by a scientist working in the field of physical science? | A. How do rocks form? |
| _____ | 8. What is scientific inquiry? | B. What substances are in soil? |
| _____ | 9. Which question would most likely be studied by a scientist working in the field of life science? | C. How are birds and reptiles related? |
| _____ | 10. Which question would most likely be studied by a scientist working in the field of earth science? | D. How are force and motion related? |
| _____ | 11. What is scientific inquiry? | A. the questioning of scientific laws |
| _____ | 12. What is scientific inquiry? | B. an unchanging set of steps used by all scientists |
| _____ | 13. What is scientific inquiry? | C. a method that always results in new scientific theories |
| _____ | 14. What is scientific inquiry? | D. a process that uses skills and methods to answer questions |
| _____ | 15. What is scientific inquiry? | A. What is the nature of center of the earth? |
| _____ | 16. What is scientific inquiry? | B. Which atoms are in a water molecule? |
| _____ | 17. What is scientific inquiry? | C. How are plant cells similar to animal cells? |
| _____ | 18. What is scientific inquiry? | D. What is the density of the lithosphere? |
| _____ | 19. What is scientific inquiry? | A. How is the earth layered? |
| _____ | 20. What is scientific inquiry? | B. Do plants need water? |
| _____ | 21. What is scientific inquiry? | C. How does electricity travel through conductors? |
| _____ | 22. What is scientific inquiry? | D. Which land animal travels the fastest? |
Measurement and Scientific Tools

Directions: On the line before each clue, write the letter of the term that matches it correctly. Then answer the questions that follow.

1. a summary
   - A. explanation

2. (SI)
   - B. digital

3. occurs when a measurement is on target
   - C. significant digits

4. 0.370 has three of these.
   - D. International System of Units

5. an interpretation
   - E. precision

6. identified by 5, but not five
   - F. accuracy

7. how similar or close measurements are to each other
   - G. description

8. Which unit of the International System of Units is used to measure mass?


Key Concept What is the difference between accuracy and precision?

Directions: Label this diagram by writing the correct terms from the word bank on each line.

accurate	accurate and precise
not accurate or precise	precise but not accurate

1. ________________ 2. ________________ 3. ________________ 4. ________________
Measurement and Scientific Tools

Key Concept What are some tools used by life scientists?

Directions: On the line before each statement, write correct if the statement is correct or not correct if the statement is not correct. If the statement is not correct, change the underlined word(s) to make it correct.

_____ 1. A science journal is used to measure observations.

_____ 2. A triple-beam balance is used to measure the mass of objects.

_____ 3. A thermometer measures the temperature of substances.

_____ 4. Graduated cylinders are used to measure the volume of solids.

_____ 5. Microscopes enable you to see objects that are too large to be seen with the unaided eye.

_____ 6. Scientists use computers to compile, retrieve, and analyze data.

_____ 7. A magnifying lens is a hand-held lens that enlarges the image of an object.

_____ 8. A slide is a thick, circular piece of glass that is used to prepare objects or substances for observation under a compound microscope.

_____ 9. A cover slip is a small glass or plastic tube used to draw up liquids and transfer them to another place.

LESSON 3  Key Concept How do independent and dependent variables differ?

Directions: On the line before each definition, write the letter of the term that matches it correctly. Each term is used only once.

_____ 1. a type of scientific investigation that tests how one variable affects another variable

A. constants
B. control group
C. controlled experiment
D. dependent variable
E. experimental group
F. independent variable
G. variable

_____ 2. any factor in an experiment that can have more than one value

_____ 3. the factor measured or observed during an experiment

_____ 4. a factor in an experiment that is changed by the investigator

_____ 5. factors in an experiment that remain the same

_____ 6. a group in a controlled experiment that is used to study relationships among variables

_____ 7. a group that contains the same factors as the experimental group, but the independent variable does not change
**Clinical Trials and Scientific Methods**

A clinical trial is a kind of scientific experiment that usually tests the safety and effectiveness of a medication to treat human illness. Clinical trials help answer questions about vaccines, new drugs, or new ways of using existing drugs. Before clinical trials on people can begin, many tests done in laboratories and on animals must yield promising results.

**Protocol and Protection**

In most controlled experiments in science, the plan for performing an experiment is called the procedure. In a clinical trial involving people, it is called a protocol. The protocol includes a description of the type of people who can participate, the schedule, medications, and length of the study.

People who take part in a clinical trial know that the treatment they get might not be effective and that they might suffer adverse effects. People who participate can ask questions and drop out at any time.

The government has strict guidelines to safeguard human test subjects. Before clinical trials can begin, a drug must be proven low in risk and high in safety and effectiveness. An Institutional Review Board oversees the process to ensure human rights and ethical conduct of the trial.

**Phases**

Phase I is a trial on 20 to 80 people to evaluate safety, side effects, and a safe dosage range. If Phase I is successful, Phase II will test an expanded group up to 100 people. Phase III studies more than 200 people to further determine safety, effectiveness, and side effects, and also to compare the drug to existing therapies. Phase IV studies are done after the drug is marketed and collects information about how effects vary among populations.

**Placebo**

People in a clinical trial are given an experimental drug or another substance that is inactive and has no treatment value. The inactive substance is called a placebo. This is done as a way to assess a drug’s effectiveness. If an expected result occurs as often in the group receiving a placebo as it does in the group receiving the experimental drug, then a logical conclusion would be that the drug has little value.

People tend to predict outcomes and to anticipate events based on previous knowledge. To avoid complication, trial staff do not inform subjects which one they are receiving. This is called a blind study.

**Applying Critical-Thinking Skills**

*Directions: Answer each question or respond to each statement.*

1. **Differentiate** In a clinical trial, is the group that is taking the placebo or the group that is taking the trial drug considered the control? Explain.

2. **Infer** Why would a Phase I clinical trial be performed on so few people, when it is usually the case that more accurate results come from a larger sample size?