Living Environment Summer Assignment

Directions: Please read the information about Scientific Inquiry, and answer the corresponding questions.

Using a separate sheet of paper, record your answers. This assignment is due the first week of class in September. Good Luck!!

Nature of Science

What is Science?

Science is a method of generating knowledge through consensus. The scientific method is designed to address questions about the material world in a way that other people can understand, follow, and repeat. But some questions cannot be answered by scientific research because they are not scientifically testable. For example, questions that involve intrinsic value, ethics, or morality cannot be answered by science.

Law, Hypothesis, or Theory?

Scientific statements can sometimes be categorized as laws, hypotheses, or theories, based on the level of consensus surrounding the statement among the scientific community. Scientific **laws** are concise statements of fact. Laws are generally accepted by the scientific community to be true and universal.

A **hypothesis** is a possible explanation for an observable phenomenon. Hypotheses are based on previous observations and/or research. Individual scientists can suggest hypotheses which ultimately can be supported or refuted by experimental results. Hypotheses are often predictions about what will happen in an upcoming experiment. These predictions are based upon existing information.
A **theory** is a broad explanation of a set of related observations or events. Scientific theories often incorporate many related hypotheses and laws, and they provide a general mechanism for how all of the different factors work together. They must be able to explain past events as well as predict future occurrences or observations. Therefore, theories can never be proved because there always exists a possibility, even if it is slight, that a future event will not conform to the theory.

Although theories must be supported by a great deal of evidence before they are accepted, even accepted theories can be shown to be incomplete or incorrect by new evidence. New evidence often surfaces with the invention of new technology. At this point, theories can be overturned either by new theories that better explain natural phenomena or by new evidence that disproves the old theory. More often than not, however, the changes that take place in scientific theories are small modifications of prior knowledge rather than major shifts in the overall scientific view of how the world works.

Science Asks Questions

It is the nature of science to question everything that is testable. Scientists always try to do the following:

- question claims that are made by people who are not experts in a specific field or claims that are based on vague attributions such as "Leading doctors say..."
- identify flaws of reasoning in arguments that are based on poorly defined research (e.g. facts mixed with opinions, conclusions based on insufficient evidence).

- question the value of arguments based on small samples of data, biased samples, or experiments that did not have a control.
- recognize that there may be more than one way to interpret a given set of data.

Scientists often publish the results of their experiments in scientific journals, so they can collaborate with other scientists and eliminate bias. Thus, accurate record keeping, data sharing, and replication of results are essential for maintaining the scientist's credibility with others in society.

When similar investigations give different results, scientists must determine if the differences are minor or more significant and if further experimentation is required. If new scientific results contradict elements of a scientific theory, the theory is only amended after many different scientists agree that the theory requires modification. Major shifts in scientific views very rarely occur, but minor modifications of prior knowledge are continually made based on new research.

Scientific Knowledge

Scientific knowledge is gained through *observation* and *investigation*, but in order for new knowledge and methods to be accepted, the scientific investigations and explanations must meet certain criteria:

- They must be consistent with experimental and observational evidence about nature.
- They must be logical and respect the rules of evidence.
- They must be open to criticism.
- They must be clearly reported such that opportunities for further investigations are enhanced.

The Nature of Scientific Theories

Although scientific theories are based on extensive research, they are subject to change as new evidence becomes available, so theories are continually being tested, revised, and even occasionally discarded.

All current scientific theories, such as the *theory of evolution by natural selection*, *plate tectonic theory*, and the *big bang theory*, are open to criticism and can be challenged as new evidence surfaces. More often than not, however, the changes made to scientific theories are often small modifications of prior knowledge rather than major shifts in the overall scientific view of how the world works.

Some scientific ideas are incomplete and require more research or more advanced technology to reach completion. For example, the invention of the microscope led to a deeper understanding of the basic units of life and the eventual development of cell theory. This information proved vital to the later development of germ theory.

Multiple Choice Questions – Record your answers on the answer key.

1. Scientific investigations and explanations must be

A. All of these are correct answers.

B. consistent with experimental and observational evidence about nature.

C. clearly reported to enhance opportunities for further investigation.

D. logical and respect the rules of evidence.

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2. Hayden has placed a cricket in a terrarium. He is interested in learning about cricket behavior. Which of the following is a question about cricket behavior that Hayden can answer through a scientific investigation?

A. How will the cricket behave if another cricket is introduced into the terrarium?

B. Does a cricket prefer to live in the wild or in a terrarium?

C. Do crickets make better pets than lizards?

D. How will the cricket feel if the terrarium is left in a dark room for several days?

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3. Natural phenomena such as lightning strikes, tsunamis, tornadoes, and volcanic eruptions are difficult to study because the events surrounding them are often unique. Which of the following describes the best way for scientists to develop theories pertaining to natural phenomena?

A. discern patterns by observing a wide range of natural occurrences

B. It is impossible to develop scientific theories on natural phenomena.

C. consult fictional and nonfictional texts on natural phenomena

D. build scale models in a lab and perform experiments on the scale models

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4. Scientific inquiry involves

A. interpreting and processing data.

B. asking questions.

C. locating relevant and reliable information.

D. all of these

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5. When scientists begin a research project, they often begin by identifying a problem and making a hypothesis. If multiple scientists are able to support the same hypothesis with valid and independent experimental results, they can develop a scientific theory. Which of the following is true of scientific theories?

A. Scientific theories can be developed by an individual scientist.

B. Scientific theories are based on extensive research and can never be changed.

C. Scientific theories are continually being tested, revised, and even occasionally discarded.

D. Scientific theories often experience major shifts rather than minor modifications.

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6. Scientific explanations must always be based on _____.

A. creativity

B. evidence

C. opinions

D. mathematics

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7. Nicole has planted a vegetable garden in her back yard. She is experiencing several problems with the garden. Which of the following of Nicole's problems could be solved through a scientific investigation?

A. How can Nicole improve the garden soil's fertility?

B. Why doesn't Nicole's dog chase away the rabbits that infest the garden?

C. Which vegetable plants will look most attractive growing in the garden?

D. How can Nicole get her family to eat more fresh vegetables?

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8. Why is it important to continuously evaluate current scientific theories?

A. New experimental data will always confirm current theories, and it is good to have a lot of evidence.

B. It is not necessary to continuously evaluate current theories; they have been proven.

C. New experimental data can lead to a better understanding of theories or can even disprove them.

D. It is important to learn the historical circumstances in which they were formed.

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9. Humans have always wondered about the origin of life. In the past, people believed in spontaneous generation, or the theory that life could arise from non-living matter. This was partly because people did not understand why maggots seemed to emerge from rotting meat without any explanation.

Then, in 1668, an Italian scientist named Francisco Redi disproved the theory of spontaneous generation by performing an experiment in which he covered a piece of meat, preventing flies from laying eggs there. Consequently, no maggots emerged.

This experiment shows that

A. all scientific explanations are useless because nothing in the world is definite.

B. all scientific explanations are tentative and subject to change or improvement.

C. all scientific explanations do not have to be based on experimental or observational evidence.

D. all scientific explanations are definite and cannot be changed regardless of experimental results.

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10. Scientific knowledge becomes stronger and more durable as a result of

A. its inability to change over time.

B. publication in local newspapers.

C. the falsification of data.

D. frequent examinations during new investigations.

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11. Which of the following is most often used to guide scientific inquiries and evaluate proposed explanations made by other scientists?

A. the opinion of leading scientists

B. historical and current scientific knowledge

C. popular cultural trends and beliefs

D. political and societal influences

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12. In the 1800s, the southern region of the United States was still primarily agricultural. Two crops that were frequently planted were cotton and tobacco.

However, one scientist, George Washington Carver, promoted the growth of other crops, such as peanuts and sweet potatoes, because he wanted poor farmers to be able to grow a crop that could be used as a source of food as well as a source of income.

This is an example of how learning about the historical development of science and about the individuals who have contributed to scientific knowledge provides a better understanding of

A. data analysis and statistical trends.

B. global politics and economic policies.

C. scientific events that have not yet occurred.

D. the relationship between science and society.

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13. Which of the following is an example of a scientific theory?

A. conservation of mass

B. evolution

C. elements in the periodic table

D. the speed of light

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14. Which of the following is essential to making ethical decisions about the application of scientific knowledge?

A. values

B. wealth

C. laboratory safety

D. measurement skills

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15. Randy is studying the migratory behavior of northern right whales. He wants to develop a scientific description for the location of male northern right whales during the winter.

Randy hypothesizes that the males follow the females from their shared autumn habitat near the coast of Canada to the waters near the coast of Florida, where the females are known to give birth in the winter.

After following a group of female northern right whales through the winter and spotting zero male northern right whales accompanying them, Randy determines that his hypothesis is incorrect. To continue his study, what should Randy do next?

A. accept the theory that male northern right whales follow groups of female whales during the winter.

B. assume that his observations were inaccurate and male northern right whales must still follow groups of females during the winter

C. propose a new hypothesis explaining the whereabouts of the male northern right whales during the winter

D. accept the theory that male northern right whales migrate to waters near the coast of Iceland in the winter.

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16. Which of the following statements is true?

A. Scientific explanations are built by combining evidence that can be observed with what people already know about the world.

B. Scientific explanations only consider evidence that is observed within controlled, laboratory experiments.

C. If a single scientific experiment contradicts a well-established theory, the theory is automatically invalid.

D. Once an idea becomes a scientific theory, it is permanent and cannot be changed.

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17. Granny Mae claims that her pies make a nutritious breakfast because the pies contain fruit.

A good scientist should

I. question the reliability of the source of the claim.

II. instantly believe Granny Mae because grandmas always know what's best.

III. analyze experimental results to test the validity of this claim.

IV. ask multiple sources whether or not the claim is true.

A. I, III, and IV only C. II only

B. II and III only D. I and IV only

18. Scientists conduct investigations for a variety of reasons. Which of the following reasons best explains why a scientist would want to use Charles Darwin's ideas on natural selection to study which traits are most beneficial to genetically altered mice?

A. to discover new aspects of the natural world

B. to test the conclusions of prior investigations

C. to explain recently observed phenomena

D. to test the predictions of current theories

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19. In the 2nd century B.C., the universe was thought to revolve around the Earth. Ptolemy suggested this theory. However, in the 16th century, Copernicus developed a theory that put the Sun as the center, with the Earth rotating on its axis and revolving around the Sun. Galileo used one of the more advanced telescopes of his day to confirm Copernicus' theory and helped lead the way for it to be proved.

What does this case illustrate?

A. Current scientific theories can be altered with new experimental data.

B. Current scientific theories are as accurate as they will ever be.

C. None of the scientific theories in the 16th century were accurate.

D. Scientific theories only last about 1400 years before they must be changed.

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20. A scientific theory can be incorrect but still be considered a good scientific theory. How can this be?

A. A good scientific theory makes a testable prediction of what will happen, even if it is eventually proven wrong.

B. Scientific theories are accepted truth and no longer subject to testing for verification.

C. Good scientific theories are sometimes incorrect, but they can still be accepted as true.

D. Only correct scientific theories are considered to be good.

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