Name _____ Class _____

Day 1

How Scientists Work

How Do Scientists Explore the Natural World?

Science is a way of learning about the natural world. **Scientists explore the natural world using skills such as observing, classifying, making models, inferring, and predicting. They form and test their ideas through scientific investigation.**

Observing means using one or more senses to gather information. A **quantitative observation** deals with numbers, or amounts. A **qualitative observation** deals with descriptions that cannot be expressed in numbers. Once they have gathered data through observing, scientists must organize the data. One way they do this is classifying.

Classifying is grouping together items that are alike in some way. Scientists also make models to help them study things that cannot be observed directly. To explain or interpret things they have observed, scientists use **inferring.** Inferences are based on reasoning from prior knowledge and what was observed.

Predicting means making a statement or a claim about what will happen in the future based on past experience or evidence. While inferences are attempts to explain what has already happened, predictions are forecasts about what will happen. **Analyzing** involves evaluating observations and data to reach a conclusion about them. Scientists use all these skills in scientific investigations. A scientific investigation is the forming and testing of ideas about the natural world.

On the bottom of this paper, explain how the skills of science are part of a scientific investigation.

Day 2

How Scientists Work

Today, clean drinking water flows from faucets across the United States, but the discovery of water disinfection took hundreds of years and involved the work of many scientists. Read the passage below and then use a separate sheet of paper to answer the questions that follow.

Water Treatment and Disinfection

Before cities began treating water, thousands of people died every year from waterborne diseases such as cholera, typhoid fever, and dysentery. Today, american cities add small amounts of chlorine to relatively huge volumes of water in order to destroy the bacteria and viruses that cause disease. Chlorination also helps prevent recontamination as water flows from the treatment plant, through pipes, and into homes.

Anton van Leeuwenhoek was a Dutchman who learned to grind lenses and make microscopes. Using his invention, he was able to see microorganisms in water in 1676. As a result, cities began to experiment with water filtration. Filters were made from a variety of substances, including sand, wool, sponge, and charcoal.

In 1774, swedish pharmacist Carl Wilhelm scheele discovered chlorine when he put a few drops of hydrochloric acid on a sheet of manganese dioxide and a greenish-yellow gas arose. Later chemists were able to group chlorine as one of 100 naturally occurring elements. Other scientists studied models of chlorine's molecular structure. They concluded that chlorine's disinfectant quality comes from its ability to bond with and destroy the outer surfaces of bacteria and viruses.

In 1854, british scientist John Snow realized that cholera spread through contaminated water. He was able to trace outbreaks of cholera to specific water pumps. He was the first to predict the use of chlorine to disinfect water.

1. How did scientific observation play a role in the discovery of water chlorination?
2. What scientific skill was used when scientists grouped chlorine with the other natural elements?
3. How did making models contribute to the understanding of chlorine as a disinfectant?
4. What prediction of John Snow's proved correct?
5. How does the history of water chlorination suggest the advantages of scientists working together?

Day 3

The Characteristics of Scientific Knowledge

Read the passage. Then use a separate sheet of paper to answer the questions that follow.

Max Born

Born into a Jewish family in 1882 in Breslau, Poland, Max born was a gifted physicist and mathematician. He studied at the University of Breslau, Heidelberg University in Germany, and the University of Zurich in Switzerland. Born was instrumental in the development of quantum mechanics, a field of physics that attempts to discover and describe the behavior of energy and matter in atoms as well as in subatomic particles. From 1909 until 1933, born held professorships at several German universities. In addition to mathematics and quantum mechanics, he did extensive work in the fields of matrices, crystals, and optics.

Born served in the German Army in World War I. Nevertheless, after the Nazis came to power in Germany, Born was stripped of his professorship because of his Jewish heritage. He was forced to emigrate from Germany in 1933. After settling in the United Kingdom, Born lectured at Cambridge University before becoming a professor at the University of Edinburgh. In 1954, he was awarded the Nobel Prize in Physics. The quotation below is from Born's acceptance speech at the Nobel Banquet in Stockholm, Sweden.

> The human mind is conservative, and the scientist makes no exception from this rule. He will accept a new theory only if it stands the trial of many experimental tests.

1. According to Born, how are scientists ordinary?
2. Does Born perceive people as eager or reluctant to embrace change? Support your answer with evidence from the quotation.
3. Does Born believe that new scientific theories can ever gain acceptance and, if so, how?
4. What might happen if scientists accepted new theories as soon as new theories were proposed?

Day 4

Designing an Experiment

Density is the measure of how much mass is contained in a given volume. A common SI unit for density is g/cm^3, where the mass is measured in grams and the volume is measured in cm^3. As a physical property of matter, each substance has its own unique density. Read the passage below and then use a separate sheet of paper to answer the questions that follow.

The Effect of Density on Heat Retention in Liquids

For an exercise in scientific inquiry, Clark posed a question about density. He wondered if the density of liquid affected the liquid's ability to retain heat. Before determining a hypothesis, Clark researched density. He learned that the denser a liquid is the more molecules it contains. He knew that molecules absorb heat. So, he reasoned that denser liquids would absorb more heat. The molecules in the denser liquids would move faster, resulting in even more heat. His possible answer to his scientific question was that denser liquids would retain heat longer than less dense liquids.

Clark designed an experiment to test this hypothesis. He chose three liquids of different densities—water (1 g/cm^3), orange juice (1.25 g/cm^3), and maple syrup (1.32 g/cm^3). He had three test tubes, and he put water in one, orange juice in another, and maple syrup in the third. He used equal amounts of each liquid. He placed the test tube containing water in boiling water for two minutes, the test tube containing orange juice in boiling water for three minutes, and the test tube containing syrup in boiling water for four minutes. After removing the test tubes from the boiling water, he used a thermometer to measure their temperatures every minute for five minutes.

Clark ran three trials. Then he took averages of all the temperatures as the liquids cooled. After organizing and interpreting his data, Clark determined that his hypothesis was incorrect. The densest liquid, syrup, cooled down the quickest. Orange juice retained heat the longest. Clark then reasoned that the molecular makeup of the liquid itself, rather than its density, determined its ability to retain heat.

1. What was Clark's hypothesis?
2. How did Clark introduce bias into the experiment?
3. What did Clark conclude from his results?
4. What were Clark's independent and dependent variables?

Day 5

Scientific Literacy

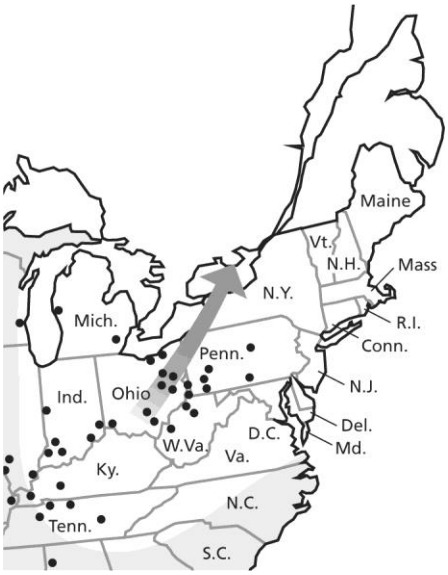
Read the passage and study the map below. Then use a separate sheet of paper to answer the questions that follow.

Acid Rain—A Public Issue

One important issue that requires the public to have scientific literacy is related to problems caused by acid precipitation—also called acid rain. Acid rain is rain and other kinds of precipitation that have become polluted by acids. Understanding the causes and effects of acid rain requires a basic knowledge of scientific principles.

The main cause of acid rain is the burning of coal to produce electricity at power plants. The burning of coal can produce a chemical called sulfur dioxide, which is released into the air by power plants through their smokestacks. High in the atmosphere, the sulfur dioxide combines with water to form sulfuric acid, a harmful chemical. The sulfuric acid falls to Earth as rain, snow, and other kinds of precipitation. This acid rain pollutes lakes, rivers, and other bodies of water. Water polluted with acid precipitation can destroy plants, animals, and microscopic life forms. In fact, almost nothing can live in some lakes where acid rain has long been a problem.

One great difficulty in addressing this problem of acid rain is that the area harmed by the pollution is generally not the area where the pollution is released into the air. The dots on the map on this page represent large smokestacks that release sulfur dioxide into the air. Notice that most of these are located in midwestern states. Normal winds in the united states—the arrow on the map—blow air from the midwest to the northeast toward the new england states. The acid rain then falls in upstate New york and New England. The result of these winds is that there is a difference between where the pollution is produced and where the pollution does harm. only if people in both areas understand science can solutions to the problem of acid rain can be found.



1. What is acid rain and what causes it?

2. To understand the causes and effects of acid rain, what does a citizen have to understand about science?

3. According to the map, what area of the country is mainly responsible for the production of acid rain, and what area mainly feels the effects?

4. Why is it especially important for people in midwestern states to have a good understanding of science if the problem of acid rain is to be solved?