Nature of Science Unit Notes

Lesson 1: Understanding Science

biology study of all living things; life science

critical thinking comparing what you already know with the information you are given to decide whether you agree with it

ethics rules of conduct or moral principles

hypothesis possible explanation about an observation that can be tested by scientific investigations

inference logical explanation of an observation that is drawn from prior knowledge or experience

observation using one or more of your senses to gather information and take note of what occurs

prediction statement about what will happen next in a sequence of events

science the investigation and exploration of natural events and of the new information that results from those investigations

scientific law describes a pattern or an event in nature that is always true

scientific theory explanation of observations or events based on knowledge gained from many observations and investigations

technology practical use of scientific knowledge, especially for industrial or commercial use

A. What is science?

1. The investigation and exploration of natural events and of the new information that results from those investigations is called science.
2. Scientists observe the natural world and form questions about what they see.
3. Scientists use reliable skills and methods in problem solving.

B. Branches of Science

1. Life science, or biology, is the study of all living things.
2. Earth science is the study of Earth, including its landforms, rocks, soil, and forces that shape Earth's surface.
3. Physical science is the study of chemistry and physics; physical scientists study the interactions of matter and energy.

C. Scientific Inquiry

1. As scientists study the natural world, they ask questions about what they observe.
2. Scientists practice scientific inquiry—a process that uses a variety of skills and tools to answer questions.
3. A scientist usually begins a scientific investigation by making a(n) observation, which involves gathering information.
4. A(n) inference is a logical explanation of an observation that is drawn from prior knowledge or evidence.
5. After making observations and inferences, scientists sometimes form a(n) hypothesis that can be tested by scientific investigation.

6. When a scientist forms a hypothesis, he or she usually makes a(n) prediction, or a statement about what will happen next in a(n) sequence of events.
7. Testing a(n) hypothesis often means testing predictions; if the prediction is confirmed, it supports the hypothesis, and if the prediction is not confirmed, the hypothesis might need revision.
8. Three ways to organize data are to create graphs, classify information, and make models and calculations.
9. Scientists must decide whether or not the data they have collected support their hypothesis.
10. Scientists might make more inferences when drawing conclusions.
11. Communicating results is important because scientists use new information in their research.

D. Results of Scientific Inquiry
1. Outcomes of scientific inquiry may include technology, new materials, and possible explanations for phenomena.
2. The practical use of scientific knowledge, especially for industrial or commercial use, is called technology.

E. Scientific Theory and Scientific Laws
1. An explanation of observations or events based on knowledge gained from many observations and investigations is called a(n) scientific theory.
2. A(n) scientific law describes a pattern or an event in nature that is always true.
3. It is important to be skeptical, or to question information, about scientific issues presented in the media.
4. Comparing what you already know with the information you are given in order to decide whether you agree with it is called critical thinking.
5. Science cannot answer questions about personal opinions, values, beliefs, or feelings.
6. Scientists follow safety procedures when they conduct investigations.
7. It is important to follow ethics when you work with living things or do research with people.

Lesson 2: Measurement and Scientific Tools

accuracy description of how close a measurement is to an accepted or true value

description spoken or written summary of observations

digital of, pertaining to, or using numbers (numerical digits)

explanation interpretation of observations

International System of Units (SI) internationally accepted system for measurement

precision description of how similar or close measurements are to each other

significant digits number of digits in a measurement that are known with a certain degree of reliability

A. Description and Explanation
1. A spoken or written summary of observations is called a(n) description.
   a. An observation that uses the senses is called a(n) qualitative observation.
   b. An observation that uses numbers is called a(n) quantitative observation.
2. An interpretation of observations is called a(n) explanation.

B. The International System of Units

1. The internationally accepted system for measurement is the International System of Units (SI).
2. The seven base units are the meter, kilogram, second, ampere, kelvin, mole, and candela.
3. A description of how close a measurement is to an accepted value is called accuracy.
4. A description of how similar or close measurements are to each other is called precision.

C. Measurement and Accuracy

1. Tools used to measure quantities can limit the accuracy of a measurement.
2. A thermometer with measurements divided into tenths is more accurate than a thermometer with measurements divided into whole numbers.

D. Significant Digits

1. When you take any measurement, some digits you know for certain and some digits you estimate.
2. Significant digits are the number of digits in a measurement that are known with a certain degree of reliability.
3. When you use significant digits, others can know how certain your measurements are.

E. Scientific Tools

1. A science journal is used to record descriptions, explanations, plans, and steps used in a scientific inquiry.
2. A(n) balance can be used to measure the mass of an object.
3. The temperature of substances is measured using a(n) thermometer.
4. The kelvin is the SI unit for temperature, but in the science classroom, temperature is measured in degrees Celsius.
5. Thermometers should not be used to stir anything.
6. Liquids are held, poured, heated, and measured in laboratory glassware.
7. A(n) microscope is used to observe small objects that cannot be observed with an unaided eye.
8. Computers are used to compile, retrieve, and analyze data for reports; to create reports and other documents; to send information to others; and to research information.
   a. Hardware is made of the physical components of computers, such as monitors and keyboards.
   b. Software is the term used for programs that run on computers.

F. Tools Used by Life Scientists

1. A handheld lens that magnifies, or enlarges, the image of the objects observed through it is called a(n) magnifying lens.
2. To prepare objects or substances for observation under a compound microscope, you would use a thin, rectangular piece of glass called a(n) slide.
3. Scalpels and scissors are dissecting tools that are used to examine tissues, organs, or prepared organisms.
4. A small glass or plastic tube similar to an eyedropper that is used to draw up liquids and transfer them to another place is called a(n) pipette.

Lesson 3: Case Study

constants factors in an experiment that remain the same

dependent variable factor that is measured or observed during an experiment

independent variable factor being tested in an experiment that is changed by the investigator to observe how it affects a dependent variable

variable any factor in an experiment that can have more than one value

A. Biodiesel from Microalgae
   1. Scientists have been exploring the use of protists to produce biodiesel.
   2. Biodiesel is a(n) fuel made mostly from living organisms.

B. Designing a Controlled Experiment
   1. A type of scientific investigation that tests how one variable affects another variable is called a(n) controlled experiment.
   2. In a controlled experiment, the control group contains the same factors as the experimental group, but the independent variable does not change.

C. Biodiesel
   1. Rudolph Diesel invented the diesel engine.
   2. Replacing food crops with fuel crops is not a good solution because there is a shortage of food in many parts of the world.

D. Aquatic Species Program
   1. The Aquatic Species Program (ASP) initially studied possible ways that microalgae could capture excess carbon dioxide in the air.
   2. ASP project leaders noticed that some microalgae strains produced large amounts of oil.

E. Which Microalgae?
   1. Microscopic organisms that live in marine or freshwater environments are called microalgae.
   2. During photosynthesis, microalgae produce oils that can be converted into biodiesel.

F. Oil Production in Microalgae
   1. Starving microalgae of nutrients, such as nitrogen, increases the amount of oil they produced.
   2. Starving the microalgae also caused their size to decrease, resulting in no overall increase in oil production.

G. Outdoor Testing v. Bioreactors
   1. Growing microalgae in open ponds can be challenging but might be less expensive than other methods.
   2. Some researchers are now growing algae under controlled conditions in closed glass containers called bioreactors.

H. Why So Many Hypotheses?
   1. Dr. Richard Sayre, a biofuel researcher, said that all the ASP research was based on forming hypotheses.
   2. According to Dr. Sayre, to get research support, a scientist has to develop a(n) question and propose some strategies.

I. Increasing Oil Yield
   1. Microalgae use light energy, water, and carbon dioxide to make sugar.

2. Scientists from a biofuel company wondered whether microalgae oil yields could be increased by distributing light to all microalgae.

J. Bringing Light to Microalgae
   1. Researchers and engineers used light rods to feed artificial light to microalgae in a(n) bioreactor.
   2. Paddlewheels continuously rotate microalgae to the surface so the organisms are exposed to more light.

K. Why Grow Microalgae?
   1. Power plants that burn fossil fuels release carbon dioxide into the atmosphere, which contributes to global warming.
   2. Microalgae use carbon dioxide during photosynthesis and produce sugar, which can then be converted to oil.

L. Are microalgae the future?
   1. The costs of growing microalgae are currently too high to compete with petroleum-based diesel.
   2. Microalgae-based biodiesel might one day become an affordable reality in the United States.