GED Science
Day 10

What's the difference?

Fact vs. Law vs. Theory

Scientific Explanations

Science is self-correcting and scientific knowledge is constantly being updated. With the introduction of new data, hypotheses and theories can be altered. Unlike opinions, which can change based on the emotions or beliefs of a person or group of people, any changes in scientific ideas must be substantiated by new evidence.

Scientific Explanations

There are many ways to approach a question, but the scientific approach to questioning requires testing through the gathering of evidence. There are some questions science cannot answer, because they are not testable. Questions such as "Why are we here?" or "What happens when we die?" are questions that philosophers and theologians attempt to answer, but these questions cannot be tested by scientists, and therefore are not appropriate questions for scientists to answer.

Scientific Explanations

Supernatural explanations, such as ghosts or magic, are considered unscientific because they rely on a lack of evidence. These explanations cannot be tested, because they are not directly observable. It is easier and more practical to test observable events, because once disproved, these explanations can be eliminated. To support a supernatural explanation, every other possible solution must be tested and eliminated. The impracticality of this task means that it can never be said with certainty that a supernatural explanation explains natural events. For example, attributing a flickering light to a ghost cannot be done with certainty unless every other possible explanation can be disproven, including bad wiring, an old light bulb, power surges in the electrical grid, and more.

Language of Scientific Ideas: Facts, Laws, and Theories

In addition to opinions and hypotheses, scientific ideas can also be classified as facts, laws, and theories

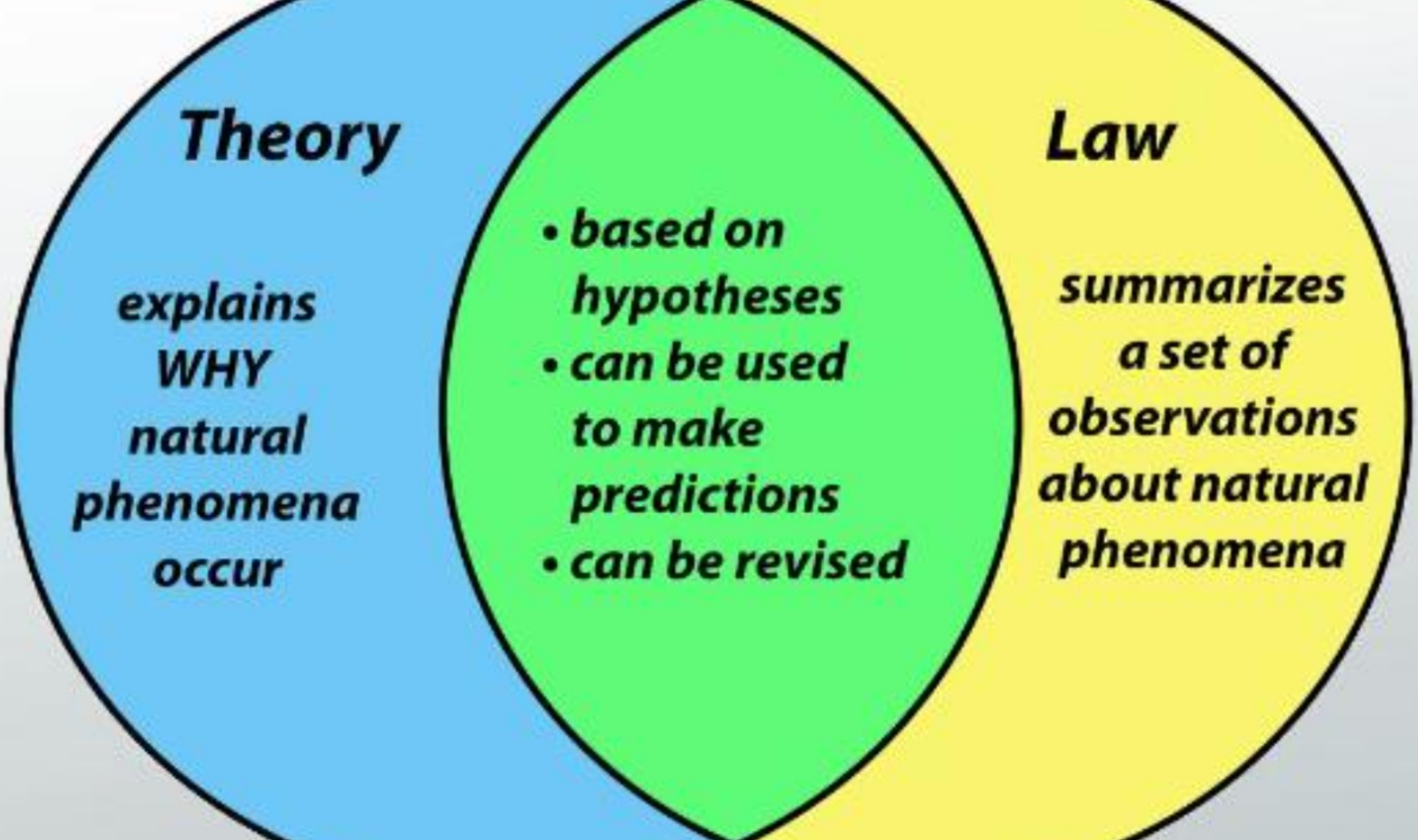
A **fact** is an observation that has been repeatedly confirmed. Scientists use the word fact to indicate that something has been tested and observed to the point that it no longer needs to be tested. For example, it is a fact that, when observed from above the North Pole, the earth rotates in a counter-clockwise direction. This observation has been confirmed repeatedly, both from earth and space. Scientists no longer need to study this phenomenon to understand it to be true. Facts can drive hypothesis formation, and facts can be used to support laws and theories.

However, even though facts are relatively stable, it is important to recognize that new evidence can still disprove ideas that are considered to be facts. For example, in 1795, a kilogram was defined by the weight of a liter of water. Now, a kilogram is defined to be equal to the weight of a standard metal cylinder stored in France. Other scientific definitions accepted as fact have changed over time. For example, the accepted definitions of planet and species, changed as scientists learned more about solar systems and the genetic makeup of organisms.

A **law** is a specific description of events that will occur under particular circumstances. A law will hold true under specified conditions and can be used to make predictions under those conditions. For example, through careful observation and experimentation, scientists noticed that matter is never lost or gained in chemical reactions. This, and other observations, is formalized in the Law of Conservation of Mass, which states that atoms are the basic particles of matter and that they are not created or destroyed, but instead they are rearranged in chemical reactions. Laws are sometimes expressed as equations using mathematics. Laws are not explanations of occurrences, but are descriptions or predictions of occurrences based on theoretical information. Theories explain why laws hold true.

A **theory** is a well-substantiated explanation of some aspect of the natural world, backed by evidence, including supported hypotheses. A theory has been evaluated by the scientific community and is strongly supported. One individual cannot come up with a scientific theory. Scientific theories are reserved for big ideas that often describe a large set of observations, and provide a cohesive explanation for those observations. In day-to-day conversation, people may describe ideas as being true or false, but in science, theories are not accepted as true or right.

Rather, in science, theories are accepted as the best-supported explanation of the world based on evidence. Sometimes testing reveals that a theory has exceptions, in which case the theory can be modified. One of the hallmarks of science is that ideas can change based on evidence. The theory of evolution by natural selection describes how species change over time in response to environmental conditions. The current theory of evolution has been modified as our understanding of genetics and the inheritance of DNA has advanced.


Theory
explains WHY natural phenomena occur
• based on hypotheses
• can be used to make predictions
• can be revised
Law
summarizes a set of observations about natural phenomena

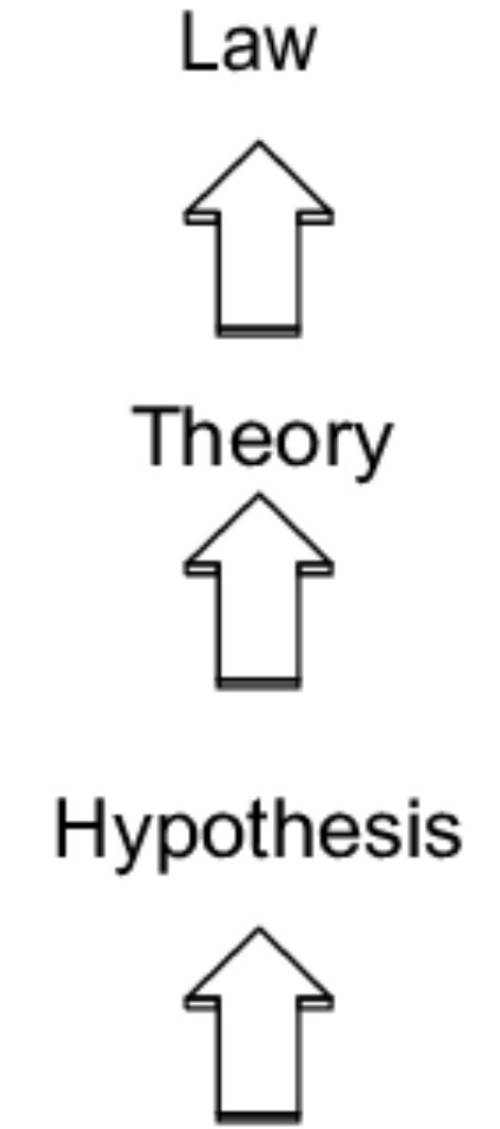

Law
Theory
Hypothesis
Facts and
Observations

Table 1.3. Definitions of fact, law, and theory, and questions to ask when classifying scientific language.

	Definition	Questions to Ask
Fact	An objective and confirmed observation about the natural world.	Is this an observation of the natural world rather than an explanation? If yes → FACT
Law	An analytical statement that allows a scientist to make a prediction about how the natural world will behave under a given set of circumstances.	Can this be used to predict how a system will behave under different conditions? AND/OR Is there a mathematical equation associated with this? If yes → LAW
Theory	A suggested explanation for a phenomenon in the natural world that is well supported by facts, tested hypotheses, and scientific laws.	Is this supported by scientific evidence? AND Does it offer an explanation of natural phenomena? If yes → THEORY

Is it Scientific?

Decide whether each statement and question is scientific or not (i.e. whether it is testable). Be ready to explain your answers afterwards.

Scientific?	Statement/Question
Y / N	Plants need water to grow.
Y / N	What is the meaning of life?
Y / N	Where do ghosts come from?
Y / N	Do fish need sunlight to survive?
Y / N	If you plant magic beans, they will grow faster than if you plant normal beans.

Fact, Law, or Theory?

Decide whether each of the below could be classified as a fact, a law, or a theory. Make sure you have reasons to defend your choices.

1) Fact / Law / Theory — The Earth revolves around the Sun.

2) Fact / Law / Theory — Those organisms that are better adapted to their environment tend to survive better than less-adapted organisms and thus more often pass on their genes to the next generation. This process is referred to as natural selection.

3) Fact / Law / Theory — The mechanical advantage of a system is defined as the ratio between the output force and the input force of the system. $\frac{F_{output}}{F_{input}} = MA$

4) Fact / Law / Theory — The Earth rotates on its axis.

5) Fact / Law / Theory — The earth's crust is not fixed, but is composed of a set of plates that move slowly due to the fluid motion of the mantle beneath, in a process known as plate tectonics.

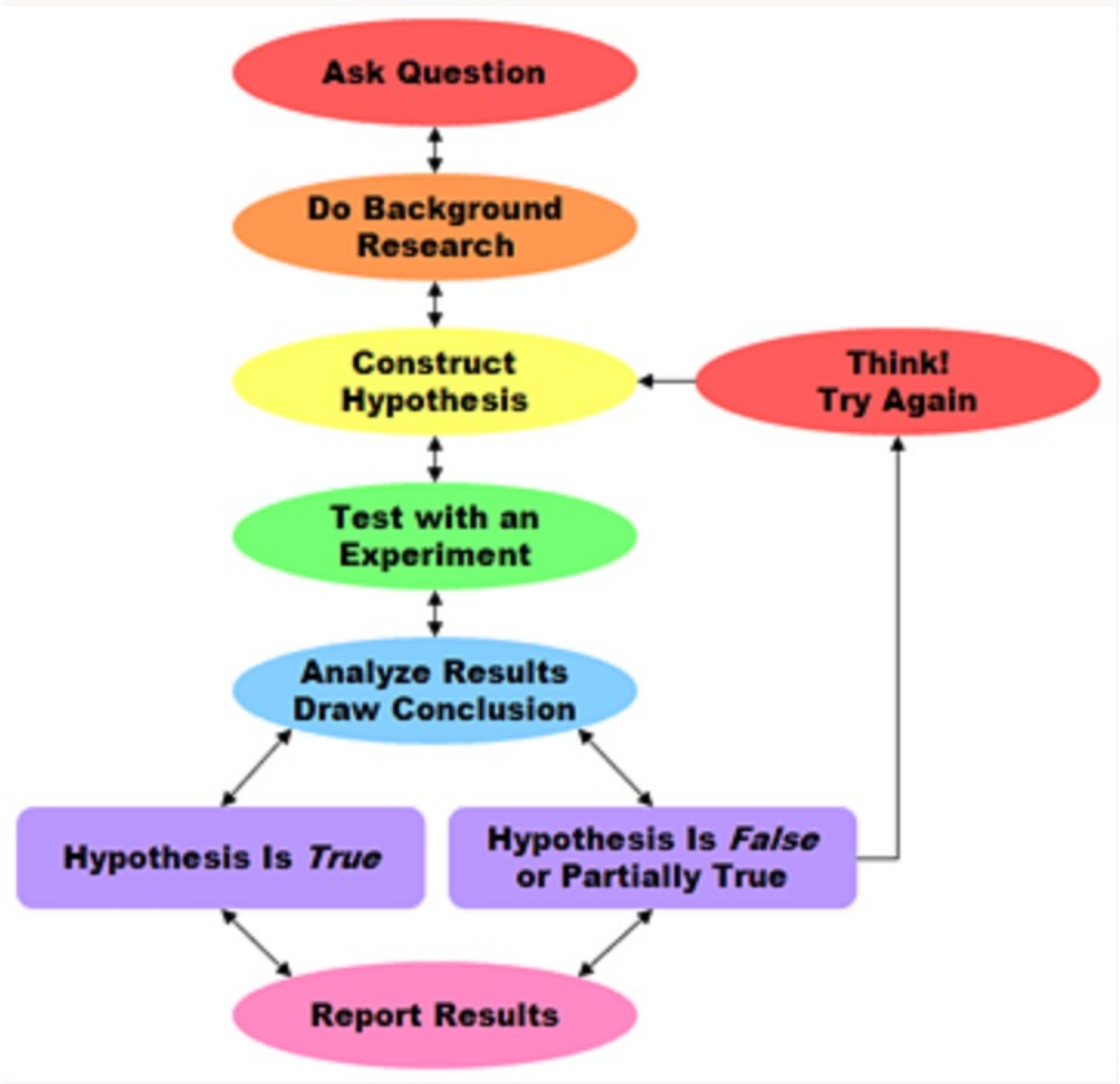
6) Fact / Law / Theory — All other factors the same, if you push on an object with more force, it will result in more movement.

7) Fact / Law / Theory — The relationship between un unbalanced force on an object and its resulting acceleration is proportional to its mass, and is given by the formula F=ma

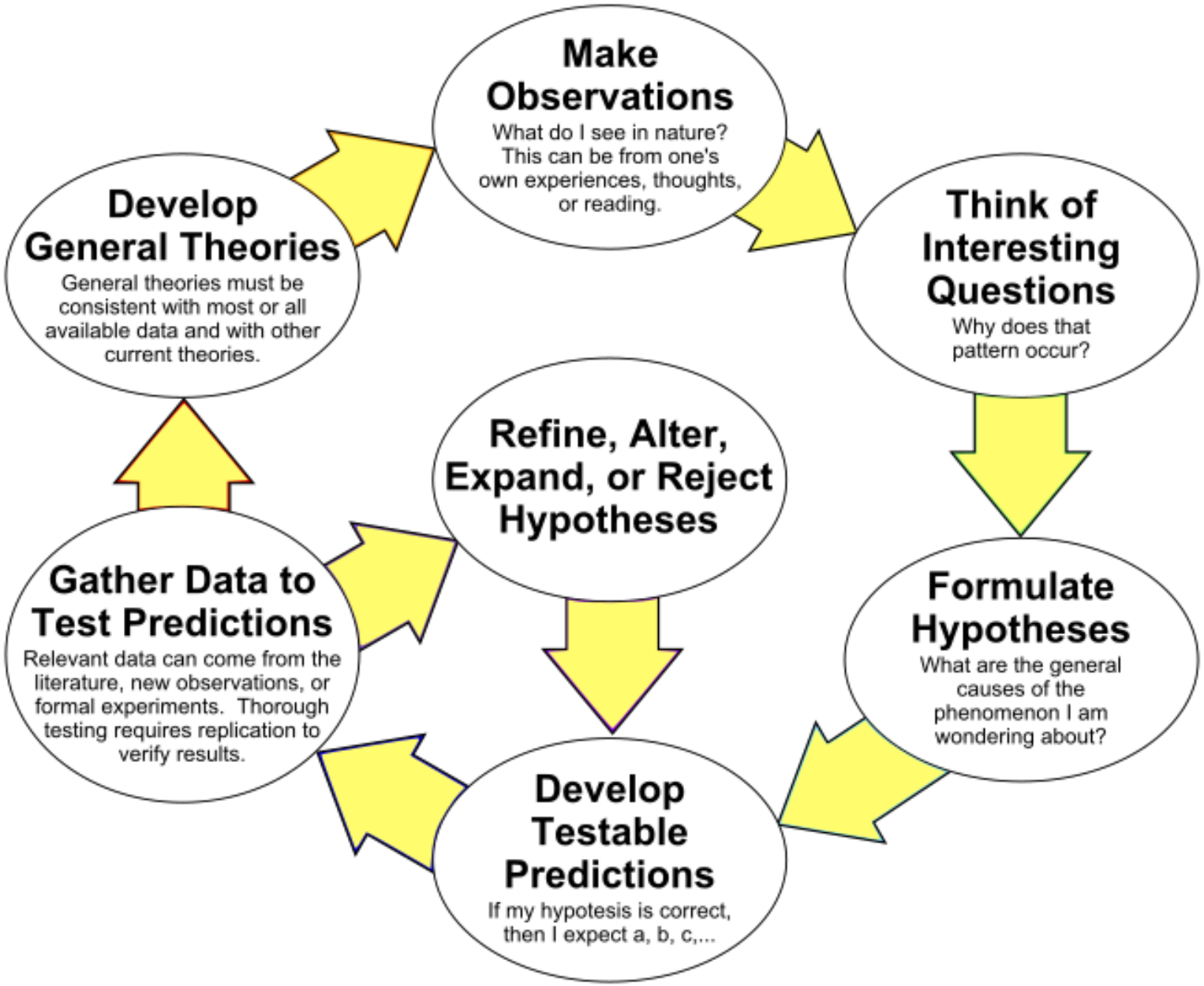
Creating an Experimental Design

The GED Science Test may ask you to describe how you would design an experiment to test a hypothesis – a possible explanation for an observation, a natural occurrence, or a scientific problem. To answer this type of item, you explain how the experiment will be conducted , what data will be collected, and how the data will be analyzed.

Scientific Method Flow Chart



The Scientific Method as an Ongoing Process



Scientific Method

For the GED test, you will focus on the last two stages of the scientific method:

- ***Design and carry out controlled experiments to test the hypothesis***
- ***Analyze the results and communicate the findings***

Step 1: Read and Analyze the Prompt

For this short answer response item, you will not have a passage to read, only a prompt. To unpack the prompt, look for the hypothesis you will be asked to test. Then ask yourself “What am I supposed to do?”

Prompt

- **A math specialist has designed a software tutorial program that she believes will help struggling students score better on a standardized state math test. She hypothesizes that if struggling students use her program three hours a week for six months, they will see their test scores increase by an average of 10 percentage points.**

- **Design a controlled experiment that the math specialist can use to test her hypothesis. Be sure to include how the data will be collected and how the results will be analyzed.**

- **Time: 10 minutes**

Step 2: Plan and Write

How the experiment will be conducted:

When you think about how to conduct the experiment, focus on what it is you are trying to test. Because you want to know whether three hours of ise of the software a week will raise struggling students' scores, you will need two groups of students to conduct the experiment: one that uses the program for three hours a week for six months, and another that does not use the program at all.

Step 2: Plan and Write

How the experiment will be conducted:

Students in both groups should have the same level of math knowledge. That way, you will know any differences you find are the result of the software and not the result of different levels of ability. Finally, you would also need to control the amount and type of classroom instruction the students receive. Otherwise, you would not know whether differences were the result of the software or the result of differences in teaching.

Step 2: Plan and Write

What data will be collected:

You will need to collect students' scores on a standardized math test before and after the six-month test period. Each group's scores on each test should be averaged, and each student's use of the software should be tracked over the six-month period to ensure that every student in Group 1 used the program three hours a week.

Step 2: Plan and Write

How the data will be analyzed:

Within each group, test scores from before and after the six-month period should be compared. You can look at changes in average scores to determine the software's effectiveness. Then, scores from Group 1 must be compared to the scores from Group 2 to see whether Group 1 made more progress than Group 2.

Read the prompt and then answer the questions:

Prompt:

A textile manufacturer wants to determine if a new fabric dye can be used for a line of outdoor furniture fabrics. They dye must be able to resist fading after constant exposure to sunlight. If the dyed fabric fades less than 10% after the equivalent of two years of daily exposure to damaging UV rays, then the dye has enough fade resistance to outdoor use.

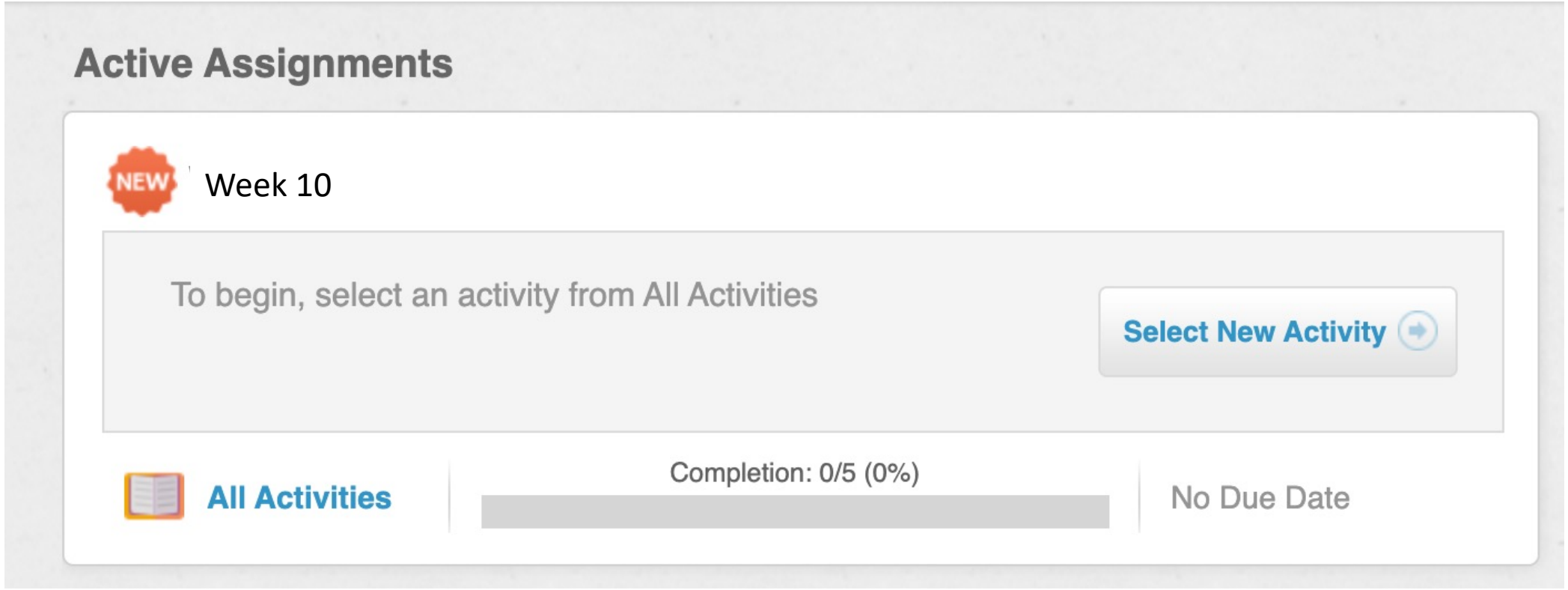
Design a controlled experiment that the manufacturer can use to test the hypothesis. Be sure to include how data will be collected and how the results will be analyzed.

How should the manufacturer conduct the experiment?

What data should the manufacturer collect?

How should the manufacturer analyze the data?

Homework!


Active Assignments
NEW
Week 10
To begin, select an activity from All Activities
Select New Activity
All Activities
Completion: 0/5 (0%)
No Due Date