Understanding the Scientific Method for the GED Science Test

By Murray Shukyn, Achim K. Krull

Part of GED Science Test For Dummies Cheat Sheet

The *scientific method* is a step-by-step approach to answering science questions and solving problems that you will need to know for the GED Science test. It ensures the credibility and reproducibility of experimental evidence. Here's a detailed version of the scientific method:

1. **Observe.**
   Many of the most important scientific discoveries start with an observation — information obtained primarily through the senses (seeing, hearing, touching, and so on).
2. **Research**.
   Another scientist may have answered the question or solved the problem already. Research provides insight into what's already been done to answer the question or solve the problem.
3. **Formulate a hypothesis**.
   A *hypothesis* is a proposed explanation for a condition or occurrence that can be tested and either proved or disproved *(falsified).* A hypothesis can usually be phrased as an if/then question; for example, "If I warm a cup of water, it will dissolve more sugar."
4. **Define variables and controls**.
   Establishing variables and controls is the first step toward designing an experiment:
   - **Variables:** Conditions that are changed to determine the effects of those changes. In the water/sugar example, heat is the variable being changed.
   - **Controls:** Conditions that remain unchanged, to prevent them from influencing the results. In the water/sugar example, using water from the same source and making sure the same amount of water is used for each test are controls.
5. **Create a procedure**.
   A *procedure* is a step-by-step process for conducting the experiment or study, including specifics about the data that will be collected and how it will be recorded.
6. **List and gather the required materials**.
   Before starting an experiment or study of any sort, the scientist needs to gather all the supplies needed, including, in some cases, participants for the experiment or study.
7. **Conduct the experiment or study**.
   It's show time! Scientists conduct the experiment or study and record the results.
8. **Analyze the data**.
   Analysis can be as simple as looking at the resulting data from an experiment or study, or it may involve plugging it into a spreadsheet, rearranging it, using it to create graphs, and so on.
9. **Draw conclusions or not**.
   The results may lead to certain conclusions, may be inconclusive, or may bring up other questions that need to be answered first. In some cases, the conclusions reveal a problem in the design of the experiment or study, or the way it was performed.

About the Book Author

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What You Need to Know about Scientific Theories and Supporting Evidence for the GED Science Test

By Murray Shukyn, Achim K. Krull

You will need to understand scientific theories for the GED Science test. The general public often dismisses scientific theories as irrelevant hunches that scientists have. In the world of science, however, a *theory* is an interpretation of the facts. Although the theory is subject to change, it's not a willy-nilly guess.

So when you see something like the "Big Bang theory" or the "theory of global warming," you can rest assured that scientists have invested a great deal of study, thought, and debate in coming up with that particular theory.

Think of hypotheses, theories, and laws as a hierarchy of truth:

- **Hypothesis:** An explanation of a limited number of observations based on experience, background knowledge, and logic.
- **Theory:** An explanation of a wide range of observations presented in a concise, coherent, systematic, predictive, and broadly applicable statement. A theory explains why a certain thing or condition is the way it is. A theory can't be considered to have been proven by the results of a single experiment.
- **Law:** An explanation of a wide range of observations that will most likely not be proven wrong. A law is less likely than a theory to be proven wrong. However, a law doesn't necessarily describe why something is the way it is. A law is more useful at predicting outcomes.

Remember	Any theory that has been proven repeatedly with consistent results may become a scientific law until disproven, in which case its status returns to that of a theory.

You may also hear the term *model,* which is a concept that has some validity and can be used to formulate predictions that are accurate only under certain limited conditions. Meteorologists often use different models to predict the weather.

Determining whether evidence supports or challenges a theory or conclusion

You can read about challenges to scientific theories in the news. Nearly every day, someone challenges the theory of global warming, questioning whether Earth really is heating up, whether the problem really is related to the amount of carbon in the atmosphere, and whether human activities really are the primary cause. And perhaps that theory itself will continue to evolve as technological advances reveal more about ecology and the effects of the potential life of living, breathing creatures on Earth.

However, many people dismiss theories more out of ignorance than anything else. Global warming skeptics, for example, point out that Earth has experienced numerous cycles of warming and cooling over its 4.5 billion years of existence, failing to recognize that the current warming trend doesn't follow the same pattern as those other cycles.

This doesn't mean that all global warming skeptics are ignorant. It just means that if you're going to question or challenge a theory or conclusion, you need solid evidence to dispute it.

TIP	On the test you may encounter questions that involve making a judgment call on whether evidence supports or challenges a theory or conclusion or what theory or conclusion can be drawn from a particular data set.

1. Which of the following pieces of evidence does *not* support the conclusion that H. pylori bacterium causes peptic ulcers in humans?
    - (A) Nine out of every 10 participants in a study who were infected with H. pylori bacterium developed peptic ulcers.
    - (B) Antibiotics that kill H. pylori bacterium have proven 90 percent effective in treating peptic ulcers.
    - (C) Eight out of every 10 animals infected with H. pylori bacterium developed peptic ulcers.
    - (D) Thirty to fifty percent of the population is infected with the H. pylori bacterium.

2. Which conclusion can be drawn from the following data?

Sugar Consumption (% of calories)	Increase in Systolic Blood Pressure (mm Hg)
10	0.0
20	2.0
30	6.2
40	10.4

    - (A) Increased sugar consumption raises blood pressure.
    - (B) People should stop consuming sugar.
    - (C) Blood pressure is not affected by sugar consumption.
    - (D) Results are inconclusive.

3. Medical researchers are beginning to believe that cholesterol-lowering medications used to treat patients with heart disease may cause dementia. Which of the following pieces of evidence would provide the best support for this conclusion?
    - (A) Several doctors reported that patients of theirs who had been prescribed cholesterol-lowering medication suddenly developed problems with thinking and memory.
    - (B) A double-blind, placebo-controlled study involving 200 participants demonstrated cognitive decline in patients taking a cholesterol-lowering medication.
    - (C) One patient reported cognitive difficulties while taking a cholesterol-lowering medication.
    - (D) In several trials, rats given high doses of cholesterol-lowering medications developed cognitive difficulties, as measured by their performance in navigating complex mazes.

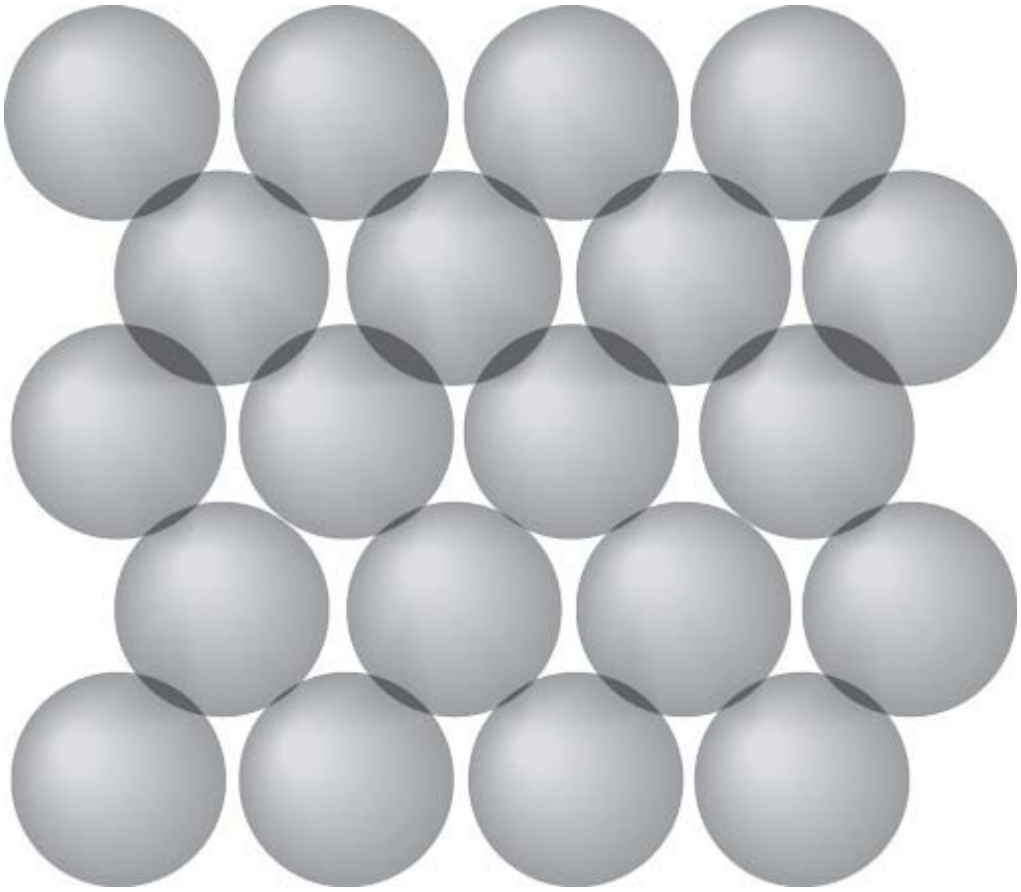
Check your answers:

1. The fact that a certain percentage of the population is infected with H. pylori bacterium, Choice (D), doesn't mean that it causes peptic ulcers.
2. The higher the percentage of calories from sugar, the higher the blood pressure, so Choice (A) is the correct answer.
3. A well-controlled study, Choice (B), provides better evidence than clinical evidence from doctors, Choice (A), or patients, Choice (C). Choice (D) represents good evidence, but the fact that high doses of medications cause a certain side effect in rats doesn't necessarily mean that a standard dose of the medication in humans will cause the same side effect.

Applying scientific models, theories, and laws

While evidence may support or challenge a scientific theory, you can go the other way and use scientific models and theories to explain natural phenomena and to predict the outcome of certain experiments or natural occurrences. On the test, questions may challenge your ability to apply scientific models and theories.

Matter has three phases: gas, liquid, and solid. In gases, molecules are separated with no regular arrangement. In liquids, molecules are close together with no regular arrangement. In solids, molecules are tightly packed in a regular pattern.



This illustration represents which of the following?

- (A) gas
- (B) liquid
- (C) solid
- (D) cannot be determined from the information provided

The illustration shows molecules packed closely in a pattern, representing a solid, Choice (C).

GED Science Test: Earth's Layers and Landforms

By Murray Shukyn, Achim K. Krull

Prepare yourself for the GED Science test by delving into the Earth's layers and landforms. Earth's layers and landforms are the earthy parts of Earth — everything that's not water, air, or a living thing. The planet Earth comprises the following three layers:

- **Core:** At the center of the Earth is a very hot, dense core thought to be made mainly of a metal alloy (mixture) of nickel and iron. The core contains most of Earth's mass and is its primary source of internal heat, emitting heat as radioactive materials within the core decompose into more stable elements. The core is subdivided into two layers:
  - **Inner core:** The inner core is solid because of the pressure exerted by the other layers and the force of gravity, which compacts the atoms so tight that they can't pass into a liquid state.
  - **Outer core:** The outer core is liquid because of the intense heat at the center of the Earth. The pressure in the outer core isn't sufficient to prevent the hot metal from turning to liquid.
- **Mantle:** The mantle that surrounds the core is estimated to be approximately 2,000 miles (3,000 kilometers) thick and is made of two layers of rock:
  - **Upper mantle:** The upper mantle is made of cooler, brittle rock that can break when subjected to stress. The breaking and shifting of this rock is responsible for earthquakes.
  - **Lower mantle:** Hot, soft rock composes the lower mantle. This rock flows when subjected to stress.

TIP	Activity in the mantle is responsible for creating mountains and producing earthquakes and volcanoes.

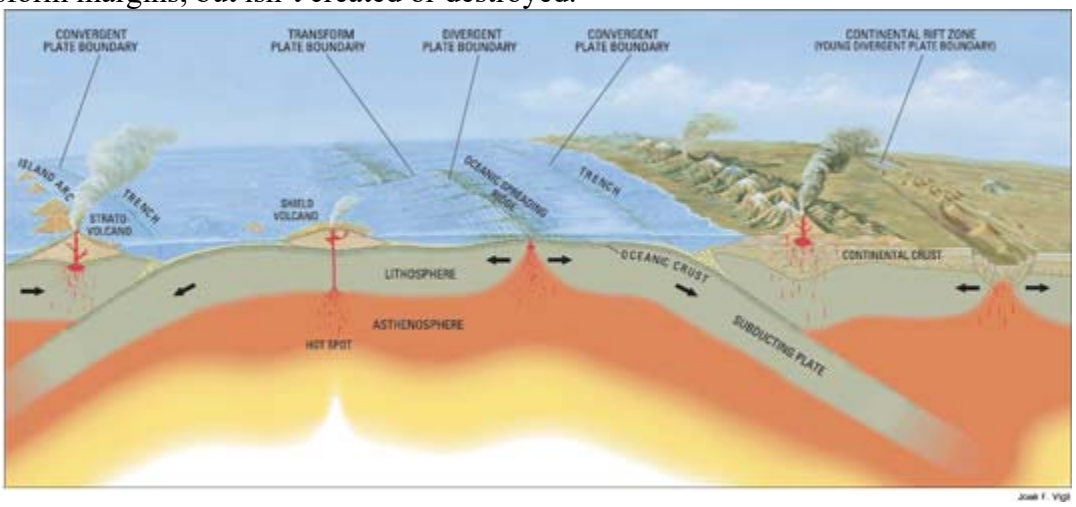
- **Crust:** The crust is the very thin layer that surrounds the Earth, and it differs depending on its location:
  - **Oceanic crust:** The crust below the oceans is relatively thin (3 to 4 miles) and is composed mainly of *basalt*.
  - **Continental crust:** The crust beneath the continents is approximately 20 to 30 miles thick and is composed primarily of *granite*.

The crust and the upper mantle form the *lithosphere,* a layer of brittle rock that floats atop the lower mantle. The lithosphere is broken up into several major and many minor *tectonic plates* that move, causing many of the geological events that can be observed on Earth's surface. *Plate tectonics* is the scientific theory that explains the movements of tectonic plates and the various geological events that occur as a result. Plate tectonics is responsible for the following:

- **Continental movement:** The various continents on Earth were thought to be one supercontinent commonly referred to as *Pangea.* As soft rock oozes up from the lower mantle, it pushes apart the plates on which the continents rest, causing them to "drift" apart over long periods of time.
- **Earthquakes:** Moving tectonic plates cause earthquakes as they drift apart, press against each other, or the edge of one plate slides below another.
- **Mountains:** As plates push into each other, the rock has nowhere to go but up, creating mountains.
- **Tsunamis:** When the edge of one tectonic plate slips beneath the edge of another at the bottom of the ocean, massive amounts of water are displaced, forming a wave that can be very destructive when it washes up on land.
- **Volcanoes:** Molten rock flows up between plates to create volcanoes. When the heat and pressure reach a certain point, the volcano erupts, sending rock and ash into the atmosphere and creating lava flows. The heat from a volcano may also melt snow and ice, creating mud flows.

Check out the three types of tectonic plate boundaries:

- **Convergent:** When two tectonic plates move toward or against each other, they form a convergent boundary characterized by mountain ranges, ocean trenches, volcanoes, and earthquakes. If the edge of one plate slips beneath the edge of another, the lower plate is referred to as a *subducting plate,* which is typically responsible for creating ocean trenches. When the edge of the subducting plate reaches a certain depth, it is absorbed back into the lower mantle.
- **Divergent:** When two tectonic plates move away from each other, a divergent boundary is formed characterized by frequent earthquakes, lava flows, and *geysers*. Under all this, a layer of molten rock flows slowly into the gap and hardens to form solid rock.
- **Transform:** Two plates sliding past each other form a transform plate boundary. At these boundaries, rocks are pulverized as the plates grind along, creating a linear fault valley or undersea canyon. As the plates alternately jam and jump against each other, earthquakes rattle through a wide boundary zone. In contrast to convergent and divergent boundaries, no magma is formed. Thus, crust is cracked and broken at transform margins, but isn't created or destroyed.



Tectonic plate boundaries.

1. What are the three layers of Earth's geosphere?
    - (A) inner core, middle core, outer core
    - (B) core, mantle, lithosphere
    - (C) core, mantle, crust
    - (D) core, mantle, tectonic plates
2. Plate tectonics help scientists explain which of the following?
    - (A) continental movement
    - (B) what causes volcanoes and tsunamis
    - (C) how mountains are formed
    - (D) all of the above
3. Which type of plate boundary is most likely responsible for the movement of continents away from each other?
    - (A) divergent
    - (B) convergent
    - (C) transform
    - (D) subducting
4. The crust is part of which of the following?
    - (A) the upper mantle
    - (B) the lower mantle
    - (C) the lithosphere
    - (D) the atmosphere

Now check your answers:

1. The three layers that compose Earth's geosphere are the core, mantle, and crust, Choice (C).
2. Plate tectonics help scientists explain continental movement along with the formation of mountains, volcanoes, and tsunamis, Choice (D), all of the above.
3. A divergent plate boundary, Choice (A), would be most responsible for causing continents to drift apart.
4. The crust is part of the lithosphere, Choice (C). The other part of the lithosphere is the upper mantle.

Textual Presentations on the GED Science Test

By Murray Shukyn, Achim K. Krull

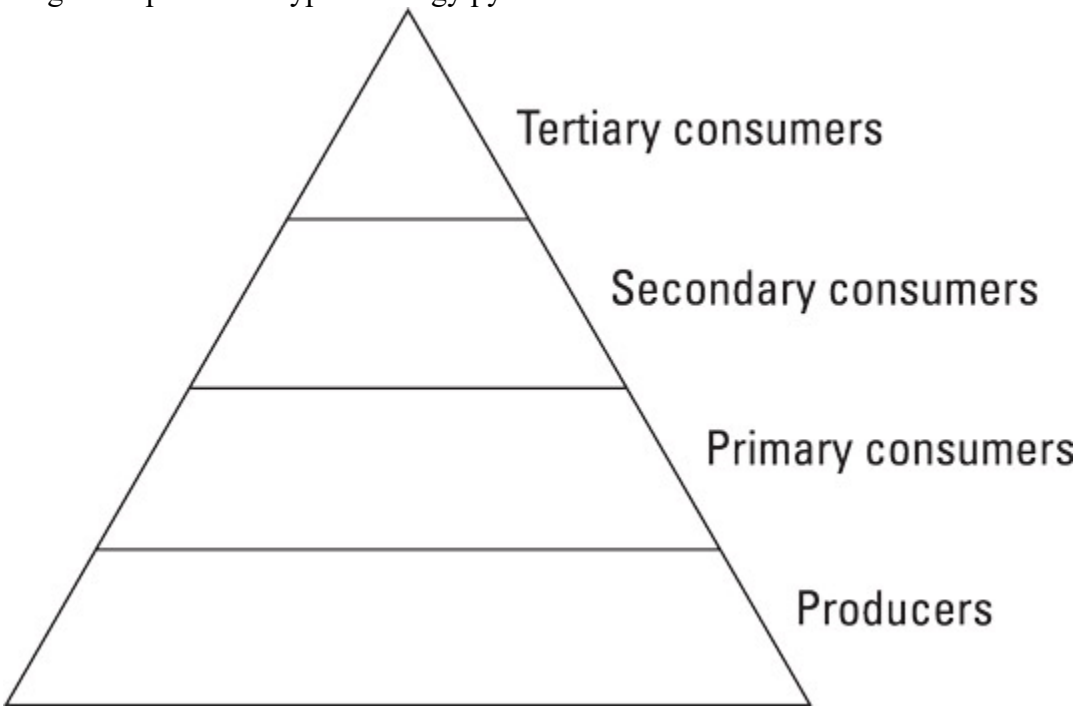
Much of the scientific information presented on the GED Science test comes in the form of reading passages — one or more paragraphs of text. The challenge with these passages is to be able to read and understand the passage and sift through it to find the specific information you need to answer the questions that follow the passage.

Here's a sample reading passage extracted from the booklet "Wetlands" published by the Environmental Protection Agency:

Some wetlands, such as salt marshes, are among the most productive natural ecosystems in the world. Only rain forests and coral reefs come close to matching their productivity. They produce huge amounts of plant leaves and stems that serve as the basis of the food web. When the plants die, they decompose in the water and form detritus.

Detritus and the algae that often grow on plants are the principal foods for shrimp, crabs, clams, and small fish, which, in turn, are food for larger commercial and recreational fish species such as bluefish and striped bass.

The following diagram represents a typical energy pyramid.



1. In the energy pyramid, detritus and algae that grow on plants are at which level in the food pyramid?
    - (A) tertiary consumers
    - (B) secondary consumers
    - (C) primary consumers
    - (D) producers

2. In the energy pyramid, producers convert
    - (A) nuclear energy into thermal energy
    - (B) radiant energy into chemical energy
    - (C) mechanical energy into electrical energy
    - (D) thermal energy into radiant energy

Check your answers:

1. Detritus and the algae that grow on plants are referred to as the primary foods for smaller animals that larger animals feed on, so the correct answer is Choice (D), producers.
2. Producers are plants that convert radiant energy from the sun into chemical energy in the form of plants, which are comprised of the chemicals carbon, hydrogen, and oxygen, which provide energy to the consumers in the food chain. Choice (B) is the correct answer.

How to Predict an Outcome Based on Data or Evidence on the GED Science Test

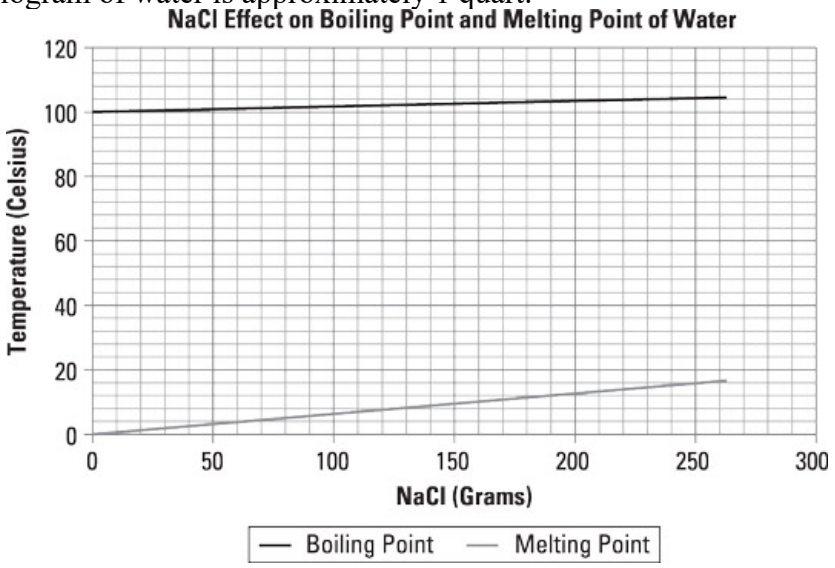
By Murray Shukyn, Achim K. Krull

Using evidence to predict outcomes is a necessary skill for the GED Science test. The greatest benefits of scientific studies can often be attributed to the fact that their conclusions enable people to predict outcomes. (You probably wish science could help you predict your outcome on the test!)

Remember	You witness science in action every day you check the weather forecast. By observing barometric pressure, humidity, temperature, the movement of high and low pressure systems, and other factors, meteorologists can make reasonable predictions about future weather conditions.

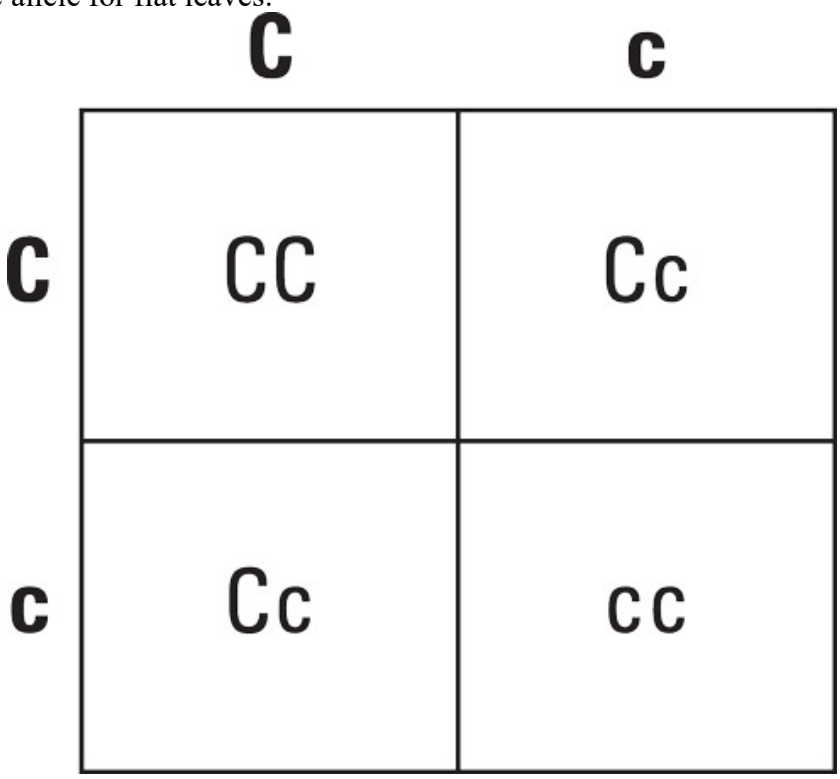
In a similar way, the Science test presents you with scientific information and asks you to predict outcomes based on that information. Here are a couple sample questions to help you practice answering such questions:

This graph shows the effect that adding salt to water has on water's melting and boiling points. One teaspoon of salt is 6 grams, and 1 kilogram of water is approximately 1 quart.



1. John adds 3 teaspoons of salt (NaCl) to a 6-quart pot of water to boil it at 105° Celsius instead of at the 100° Celsius he is accustomed to, because he read online that adding salt to water increases its boiling point. One teaspoon holds about 6 grams of salt. Did he add enough salt? Yes or No: _____

2. A certain plant species can have curly or flat leaves. The *allele* (gene form) for curly leaves is dominant, and the one for flat leaves is recessive. Two plants of the species are crossed, both with curly leaves. The Punnett square for the breeding looks like this, with "C" representing the allele for curly leaves and "c" representing the allele for flat leaves:



What percentage of the offspring is likely to have flat leaves?

- (A) 0%
- (B) 25%
- (C) 50%
- (D) 75%

Check your answers:

1. No. According to the chart, John would need to add more than 250 grams of salt to the water to raise its boiling point 5° Celsius. That's more than 41 teaspoons of salt! You may have to do a little math in your head to answer this question.
2. Only 25% of the offspring would be expected to have flat leaves. Because "C" represents the dominant gene, both "CC" and "Cc" offspring would have curly leaves. Only "cc" offspring would have flat leaves.

GED Science Test: Earth's Atmosphere

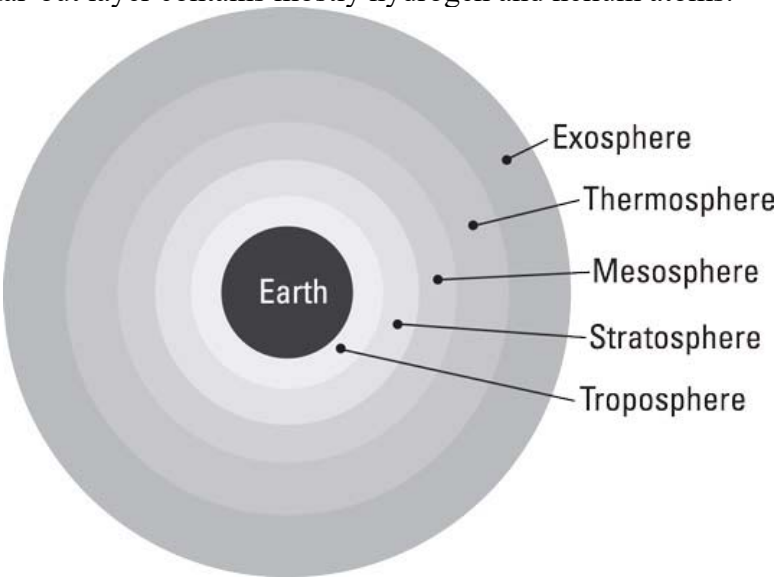
By Murray Shukyn, Achim K. Krull

Familiarize yourself with Earth's atmosphere to prepare for the GED Science test. Earth's atmosphere is composed of gases surrounding the planet and retained by Earth's gravity. Although the composition of gases in Earth's atmosphere is subject to change, the current mix is about 78 percent nitrogen, 21 percent oxygen, 0.9 percent argon, 0.03 percent carbon dioxide, 0.0 to 0.4 percent water vapor, and trace amounts of other gases.

TIP	In addition to providing the oxygen that humans and other animals breathe and the carbon dioxide that plants require for photosynthesis, the atmosphere protects plants and animals by screening out a considerable amount of ultraviolet radiation, retaining heat from the sun, reducing temperature extremes, and facilitating the transportation of water via clouds.

The following list names and describes all five of Earth's atmospheric layers from the ground up:

- **Troposphere:** This is where you live and breathe. The troposphere begins at the Earth's surface and extends up to the stratosphere. It contains roughly 80 percent of the mass of the entire atmosphere and is where most familiar weather patterns form.
- **Stratosphere:** The stratosphere is best known for the company it keeps. This is where the ozone layer hangs out. The ozone layer is comprised of *triatomic oxygen* (O_3), meaning each molecule consists of three oxygen atoms instead of the standard two in the normal *diatomic oxygen* (O_2) that you breathe. The ozone layer is great for blocking ultraviolet radiation from space, but this form of oxygen is toxic closer to the Earth's surface as it is harmful to breathe and can burn plants. In the stratosphere, temperature increases the higher you fly.
- **Mesosphere:** This extends up from the stratosphere, and the temperature decreases as altitude increases. Most meteors burn up in the mesosphere before they have a chance to crash into the Earth because the density of the atmosphere rises considerably closer to the Earth's surface.
- **Thermosphere:** This layer is toasty — up to 1200°C. It has a higher temperature at higher altitudes, but due to the lower pressure and the fact that molecules are so far apart, the "air" doesn't feel as hot as it would at lower altitudes.
- **Exosphere:** This far-out layer contains mostly hydrogen and helium atoms.



Earth's five atmospheric layers.

Remember	Weather events occur in the troposphere and are typically triggered by *fronts* — the leading edges of air masses that differ in temperature and pressure. To understand the weather, you need to understand the four types of fronts:

- **Cold front:** Cold fronts occur where colder, denser air pushes under warmer, thinner air. Cold fronts travel faster than warm fronts and usually form more violent storm conditions and higher amounts of precipitation.
- **Warm front:** Warm fronts occur where warmer air forms a wedge over the colder air and slowly advances, pushing the cold air out. Warm fronts sometimes have thunderstorms on their leading edge, but more often form fog.
- **Stationary front:** When fronts stop moving, they're said to be stationary, and you experience little if any change in the weather until another front pushes it out of the way.
- **Occluded front:** Occluded fronts form when cooler or warmer air is behind the front. When cooler air is behind the front, the cooler air moves under the cool air ahead of it, and the occluded front behaves very similar to a cold front. When warmer air is behind the front, the warmer air rises above the air that's in front of it, and the occluded front acts very much like a warm front. In both cases, the boundaries between the warmer and cooler air are well-defined.

Hurricanes, tornadoes, and other violent storms usually form when a cold air mass is above a warm water or land mass. This causes violently convective (air-moving) conditions that lead to violent storms. A front or a consistent wind generally triggers the spinning effects, but the true nature of how these storms are formed is still somewhat of a mystery.

You can tell a lot about the weather by examining cloud formations. The following list explains the differences among the three types of cloud formations.

- **Cirriform:** *Cirrus* clouds are generally detached and wispy. They fly high and are generally non-convective, meaning they form when air movement due to temperature differences at different altitudes is minimal. Because of this, cirrus clouds are a sign of less turbulent weather conditions.
- **Cumuliform:** *Cumulus* clouds are mostly detached and fluffy. They are a product of local convective lift and indicate a more turbulent condition in the atmosphere.
- **Stratiform:** *Stratus* clouds are for the most part continuous and may have somewhat rippled form. These clouds usually form on slow-moving fronts with high levels of convective lift and float a bit lower in the sky than their cumulus cousins. The convection is across a much larger area than the conditions that form cumulus clouds and indicates turbulent atmospheric conditions.

1. Which of the following presents the layers of Earth's atmosphere in the correct order from the ground up?
    - (A) stratosphere, troposphere, mesosphere, thermosphere, exosphere
    - (B) troposphere, stratosphere, mesosphere, thermosphere, exosphere
    - (C) troposphere, thermosphere, mesosphere, stratosphere, exosphere
    - (D) exosphere, troposphere, stratosphere, mesosphere, thermosphere
2. The ozone layer, which is located in the stratosphere, provides which of the following?
    - (A) the oxygen you breathe
    - (B) the nitrogen you breathe
    - (C) protection against ultraviolet radiation
    - (D) matter required for cloud formations
3. Which of the following conditions is most likely to cause a violent storm?
    - (A) A colder, heavier air mass pushes under a warmer, lighter air mass.
    - (B) A cold front meets a warm front.
    - (C) An occluded front meets a warm front.
    - (D) A mass of cold air moves in above a mass of warm, humid air.

4. Which atmospheric layer has the highest concentration of gases?
    - (A) troposphere
    - (B) stratosphere
    - (C) mesosphere
    - (D) thermosphere

Check your answers:

1. Choice (B).
2. Choice (C).
3. Choice (D).
4. Choice (A).