

# ACT SCIENCE REASONING TEST

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# ACT SCIENCE TEST



**Words of "Wiz-dom"**—I added the word “Reasoning” to this test’s title. That is because the emphasis is on the “**reasoning**” and not science information you’ve memorized in the past. There are very rarely questions about what you **know**. They almost always are questions about your scientific and analytical skills. Can you read charts and graphs that represent someone’s experimental data? If so, you’re well on your way. As long as you’ve taken a basic Earth or physical science course and a biology course, you’ve got the necessary background to deal with these questions.

Mostly, this is a test about common sense. You’ll need to read graphs and draw conclusions based on information that you are given. (Remember drawing inferences in the reading lessons? Good, you will be using the same strategy for the Science Reasoning Test.) The topic can come from any number of areas: biology, meteorology, geology, chemistry, physics or astronomy. Don’t worry about the content. Everything you need to know will be given to you with the exception of an occasional question on some tests. (You do know the earth is a planet, don’t you?) Your challenge will be to interpret data, draw conclusions, and show scientific understanding. For example, you might have to identify some new data that would contradict or support the conclusion drawn from the currently existing data.

# Understanding Data

When you are presented with information in the form of a chart or graph, you only need to do four things.

## 1. Read the Title to Get the Main Idea

The title reveals the main idea. (Does this sound like “Wiz-dom” from the Reading Test?) It is going to tell you what is represented by the data in the table, chart, or graph. In case there isn’t a title, you’ll be able to get the main idea from an introductory paragraph.

## 2. Check out the Labels to See What’s Been Measured

You’ve got to figure out what has been measured. You’ll see this information in the form of labels on the chart or graph. For example, if you have to read a graph, the horizontal and vertical axes will be labeled. A table will have titles at the heads of columns and/or to the left of rows. You will see standard items that scientists measure. For example, you may have to work with temperature, distance, pressure, experimental group names and/or numbers, size, etc.

## 3. Circle the Units to See How It Is Measured

Whatever has been represented by the graphic and labeled will be measured in **units**. You’ll see temperatures in degrees (Fahrenheit or Centigrade); distance in meters, feet, miles, etc.; pressure in pounds per square inch (or foot) -- or pressure in kilograms (or grams) per square centimeter (or meter); group names as colors, numbers, sex, species, etc.; size as units, dozens, hundreds, thousands; and so on. In brief, make sure you pay attention to how the scientist counted whatever data are represented.

## 4. Check the Trend to See Where It’s Going

Look for directions and patterns in the data. This issue is about relationships. How does one thing influence another or how do two things go together? It might be a table about time spent studying and ACT scores! Is there a point of diminishing returns? I believe, for example, that prep classes that meet for more than three hours are less efficient since students may experience mental fatigue and be less able to concentrate. The Wiz has created a fictitious study to test his hypothesis and presents the hypothetical data in the following table. Using the above steps, look at the table and check out my hypothesis. You can assume that I have all the appropriate controls, such as: sex, starting score, GPA, and teacher.

## Prep Class Schedule's Effect on ACT Scores

Group	Length of Class Period (Minutes)	Average ACT Score
Red	0	18.2
Green	60	20.3
Blue	90	20.7
Yellow	120	20.2
White	180	22.5
Orange	240	20.4

When you are looking for patterns and relationships, there are three major issues:

**Highs and Lows:** Situations may occur that reach a peak or valley.

**Ups and Downs:** Variables may be directly or inversely related. When one thing goes up, does the other? Then they are **directly** related. If they go in opposite directions, they are **inversely** related.

**Significant Points:** There are situations in which a “threshold” has to be met in order for something to occur. For example, water boils at 212 degrees Fahrenheit. The space shuttle has to reach 18,000 miles per hour to go into orbit. At 25,000 mph, rockets escape Earth’s gravity entirely. These are all examples of situations where a “threshold” has to be met in order for something to occur.

**Missing Data Questions:**

You will likely encounter questions that have you estimate missing data points. Then you “interpolate” or “extrapolate.” Interpolation means estimate a point **within** the given graph. For example, using the chart above what would you estimate to be the average ACT score if the time was 30 minutes? Extrapolation means to make an estimate beyond the existing data. For example, what would you estimate the average ACT score would be if the time were 360 minutes?

## How Scientists Work



**Words of "Wiz-dom"**—In a previous life, I was a biology teacher (the secret is out) so let me share a few thoughts about the scientific process that the test writers think you should know. Then we'll look at the three question types.

### Variables:

To begin, don't worry about the word "variable." It means a "characteristic" that changes. There are two kinds of variables in an experiment: independent and dependent. The scientist controls the **independent** variable to see what happens to the **dependent** one. For example, she might control the amount of water (independent) put on a lawn to see how fast it grows (dependent). If you have trouble keeping them straight on the test, ask yourself, "What depends on what?" In this case, how fast the grass grows depends on how much water is used. Did she control the rate of growth? No. She controlled the water to see what would happen to the grass. She **indirectly** controlled the grass. She **directly** controlled the water. The amount of water controlled the grass. Keep in mind the variable the scientist can personally and directly control is the **independent** variable.

You can think about the independent and dependent variables as having a cause and effect relationship. The independent variable causes some change in the dependent variable. The scientist's job is to determine what, if any, relationship exists. He measures the size of the independent and dependent variables so he can report the size of the cause and effect relationship. Think about thunder and lightning. Which is the cause and which is the effect? What are the characteristics of lightening that influence the loudness of the thunder? How could you measure them? Develop a chart for one of the situations below. Be sure it conforms to the requirements of a "good ACT chart." (Hint: Does it have a title, labels, and units?)

In the following real life situations, which are the independent (cause) and dependent (effect) variables?

How fast you drive AND number of speeding tickets.

Your grades AND how many hours you study.

How fast you run AND how far you are from where you started.

How wrinkled you get AND how long you sit in the tub.

How often you aggravate your parents AND how many times you get grounded.

The point is scientists study cause and effect relationships. When you see data on a graph, keep something in mind: the independent (controlled) variable will be represented on the horizontal axis and the dependent will be on the vertical axis. It is the dependent variable that goes up and down and is of interest to the scientist. In algebra class you call them *functions*! Isn't the **dependent** variable a function ( $y$  or the effect) of the **independent** variable ( $x$  or cause)?

### **Developing/ Applying/Checking Rules**

It seems as if scientists spend all their time doing one of three things:

- Developing new rules, principles, theorems, generalizations, etc.
- Applying one of the above.
- Checking to see if they and their colleagues are right.

The ACT uses this information. (Their test writers must have been in my biology class.) As you read the Science Reasoning passage, pay attention to whether:

- The scientist is presenting data to support a conclusion,
- Using a conclusion (rule, principle, theorem, etc.) to predict an outcome, or
- Using information to argue that she's right and he's wrong.

## Strategies

### Which Passage to Do First:



**Words of "Wiz-dom"**—The three types of passages (*Reading Data*, *Understanding Experiments*, and *Disputing Scientists*) do not show up in any special order on the test. Part of being in control is taking the test on your own terms and deciding which passages to do first. For example, most students feel the “Reading Data” passages are easiest and quickest to do. If that’s true for you, go ahead and do them first. There will be two or three of them and you’ll have almost half the passages finished in less than half the time. You could go on from there to “Understanding Experiments” (usually the second easiest for students) and finish with “Disputing Scientists.” Practicing will help you decide the best sequence to use on test day.



**Words of "Wiz-dom"**—Another strategy that may work for you is to do the passages based on the topic, not the passage type. For example, maybe you are very good in biology, okay in chemistry, but not so hot in physics, and you don’t know anything about geology. Flip through the Science Reasoning Test VERY quickly and see what the topics are. Do them in the order that you want based on your personal strengths. **DON’T** start with the ones that are hard for you. **When you skip around make sure you are bubbling your answer sheet correctly!** Continue to mark your answers in the test booklet as a safety measure.

### The General Approach

**Words of "Wiz-dom"**—One general approach to the Science Reasoning Test gives rise to all the specific strategies.

- 1. Read the passage (and charts, if present)**—You should read them in the same manner that you “read” passages on the Reading test. Don’t try to memorize anything. Remember MOPP. (Sounds like the ACT Reading Test to me!)
  - **Focus** on the Main Idea and how the passage is Organized. (Don’t worry about Purpose and Perspective. These are always objective scientists who are explaining scientific situations or phenomena. So, *M* and *O* are what you need to determine.)
  - **Read** the introductory paragraph since it’s going to tell you what the scientific issue (main idea) is. **Read** the first sentence or two of each paragraph or section of information. **Read** the title, labels and units for the chart.
  - **Skim** the remaining information. Don’t worry about specific numbers. Just pay attention to the trends. You’re going to have to come back to the graphics anyway.

After reading, you need to be able to answer these questions:

- The scientific topic (main idea) here is \_\_\_\_\_.
- The information given is about \_\_\_\_\_.
- How is the information (data) related to the topic?

**2. Read the question stem WITHOUT looking at any answers.**

- Restate the question in your own words (Pillar II). Don't get distracted by the answer choices unless a question asks "Which of the following...."
- Determine what information you need. If it is information that is provided in the passage, go look for it. Now's the time to pay attention to specific details in the charts.

You need to be able to answer these questions:

- What is the question?
- What do I need to know to answer this question?
- Where will I find the information needed to answer the question?

**3. Answer the question in your own words;** then look for a paraphrase of your answer. Pick the choice that most closely matches your answer.

# The Passage Types



**Words of "Wiz-dom"**—There will be six or seven passages on your test and each one will each have five to seven questions. Almost always each passage will be followed by the questions without you having to turn any pages in your test booklet. (Thank you ACT test writer.) While there are a variety of subjects covered by the passages, they can be classified as one of three passage types:

- Reading Data (2-3)
- Understanding Experiments (2-3)
- Disagreeing Scientists (1)

## Type I: Reading Data



**Words of “Wiz-dom”**—The reading data (or data representation) passages begin with a relatively short narrative introduction that describes a situation. The narrative is followed by data in charts and graphs. (It’s similar to a geometry word problem in the sense that it has a narrative and a diagram.) Then there will be five questions for each passage that have to do with interpreting the information from the charts.

### Applying the General Approach:

**1. Read the passage**—One thing that makes this an easier passage type is that there is very little reading. The introductory paragraph is usually all there is to “read.” After you do so, look at the charts and graphs. Make special note of the title (if there is one), labels of axes and/or columns and rows, and units. When there is more than one chart, figure out how the labels are different and circle the differences. When you look at the data, be sure you note trends. For example, if it is a table of numbers that are in ascending or descending order draw an arrow next to the column (or row) showing the direction. Be careful to note any changes in direction. Oftentimes, it is the direction that is more important than the specific numbers.

**2. Read the question**—Paraphrase it. Determine what information you need. The question will usually refer you directly or indirectly to a specific chart. It might say, “In Table 1,” or, “Based on the data about the density of different minerals.” In the first case, you know right where to look. In the second case, you have to figure out which table provides the information. However, since you took special note of such things when you were reading, you should be able to find it fairly quickly.

**3. Compare your answer to the answer choices**—As before, after you’ve answered the question, look for a restatement of your words among the answer choices. If it’s not there, then determine which of the answers most conforms to the *PICK* rules.



Keep in mind that these questions assume very little prior knowledge on your part. This **open book test** provides the answers to the questions in the text and data related to each passage. Finally, remember that the data presented and the correct answers will always make sense. That is, if you can’t figure out the data related to a question, pick the answer that makes the most sense. For example, if there is a chart describing time of the year and day length, the longest days are going to be in June in the northern hemisphere.

The questions will require you to:

- **Read data** in charts, tables, graphs and scatter plots,
- **Interpret data** in charts, tables, graphs and scatter plots, and
- **Analyze data** presented in charts, tables, graphs and scatter plots.

## Sample Passage

A population ecologist kept track of the number of deer that lived in a fenced hunting reserve in southeastern Montana from 1972 through 1978. The public protests over keeping deer “penned up for the pleasure of hunters” caused the legislature to ban such establishments. The year after the law was passed, a small group of poachers\* sneaked onto the property pursuing a “hunting bonanza.” The following is the ecologist’s record during those seven years.

\*illegal hunters

Year	No. of Hunters	No. of Deer Killed	Deer Population
1972	122	87	412
1973	131	84	421
1974	127	91	415
1975	12	54	475
1976	0	0	547
1977	0	0	112
1978	0	0	0

1. What was the first year during which hunting was banned?

- A. 1974
- B. 1975
- C. 1976
- D. 1977

2. With which conclusion would the ecologist most likely agree?

- F. All deer populations benefit from hunting.
- G. A confined deer population needs its size controlled.
- H. Deer hunting should be banned.
- J. Hunters killed Bambi’s mom.

3. Which of the following populations most closely approximates the maximum supportable size for this tract of land?

- A. 0
- B. 50
- C. 420
- D. 550

4.

Which two columns in the table most closely follow the same general trend?

- F. Number of hunters and deer killed
- G. Number of hunters and deer population
- H. Number of deer killed and deer population
- J. Year and deer population

5. What was the fewest number of deer killed during the time hunting occurred?

- A. 52
- B. 54
- C. 84
- D. 91

### Reading Data Answer Key

1	2	3	4	5
B	G	C	F	B

## Type II: Understanding Experiments



**Words of “Wiz-dom”**—The experiment (or research summary) format questions begin with a narrative introduction which is followed by a description of how some outcome (dependent variable) changes as something else (independent variable) is changed by the scientist. In short, the scientist changes one thing to see how something else changes. The results will be summarized (frequently in a chart) as “*Experiment/Study 1,*” “*Experiment/Study 2,*” etc.

There will be questions for each passage that usually will require:

- **understanding the results** of the experiments,
- **making predictions,**
- **recognizing situations** that would have changed or strengthened the results of the experiments,
- **identifying assumptions** made by the scientists, and
- **selecting additional data** that would either support or refute conclusions made by the experimenters.

There are **two things the test writer thinks you should know about conducting experiments:**

1. You need to control everything but the dependent variable.
2. The more times you repeat the experiment, the more reliable the results are.
  - If the studies involve time, the longer the experiment goes on, the better it is, and
  - The larger an experimental sample size is, the more credible the results.

### Applying the General Approach:

**1. Read the passage**—There’s a little more reading to do about this passage type but it’s similar to the strategies for Reading Data passages. As always, read the introductory passage. Then read the descriptions of each experiment or study carefully enough to know what the variables are. Focus on how the variables relate to the scientific issue that is the Main Idea. Usually the variables are shown in a graphic form. You need to do the same thing you did with Reading Data passages: focus on identifying trends.

**2. Read the question**—Paraphrase it. Determine what information you need. The question will usually refer you directly or indirectly to a specific chart. It might say, “In Experiment 2,” or, “Based on the results of Experiment 3.” In addition, there are questions that mention variables in combinations that require you to combine results from a couple of different experiments. If you noted the variables (labels) on the charts as you read, this is pretty straightforward.

Sometimes the questions ask about doing additional experiments that may or may not be useful. For example, “Which of the following would NOT provide useful information?” Try the PICK

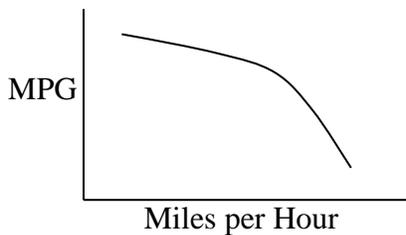
strategy from reading. If an experiment is not consistent with the variables that have been studied, it is probably not useful. The right answer is probably going to be the one that is most **consistent**. Also keep in mind that the information you need to answer the question is in the answer choices you are given. **So in questions involving modifying or conducting additional experiments, you need to read the answers before you come up with one on your own.**

**3. Compare your answer to the answer choices**—As before, after you've answered the question, look for a restatement of your words among the answer choices. If it's not there, check each answer by using the *PICK* strategy.

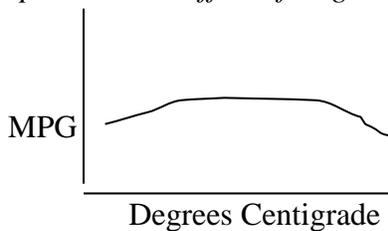
## Sample Passage

Researchers know that there are relationships between four variables: how fast a car is driven, the engine temperature, the type of oil used and how efficiently an automobile operates. In a series of experiments, the scientists are interested in studying how the first three each independently impacts the fuel efficiency or miles per gallon (MPG) a car gets. The results are below.

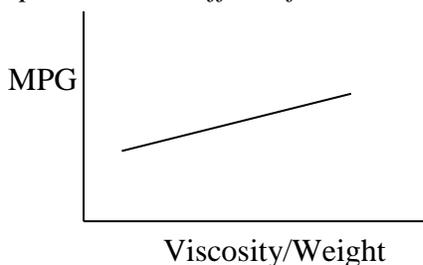
### *Experiment I: Effect of Increasing Speed*



### *Experiment II: Effect of Engine Temperature*



### *Experiment III: Effect of Oil Thickness*



1. Which of the following is an independent variable followed by a dependent variable?
  - A. Oil Thickness, Temperature
  - B. Fuel Efficiency, Temperature
  - C. Temperature, Speed
  - D. Speed, Fuel Efficiency
2. Which of the following was most important to control when conducting Experiment III?
  - F. Using different brands of oil
  - G. Make and model of the car
  - H. Driving at a steady speed
  - J. Changing the oil every 3000 miles
3. With which independent variable did the dependent variable have an inverse relationship?
  - A. Fuel Efficiency
  - B. Speed
  - C. Engine Temperature
  - D. Oil Thickness
4. Based on the results of the experiments, which of the following is a valid conclusion?
  - F. Goldilocks was right.
  - G. As oil weight decreases fuel efficiency improves.
  - H. Coasting downhill improves fuel efficiency.
  - J. At speeds over 90 MPH, fuel efficiency is 0.

### Understanding Experiments Answer Key

1	2	3	4
D	F	B	F

## Type III: Disagreeing Scientists



**Words of “Wiz-dom”**—Scientists don’t always agree. Of course, ACT test writers are happy about this since it gives them another question format! One passage on each ACT will involve disagreements among scientists (Conflicting Viewpoints). The introductory paragraph will tell you that there are different explanations for a certain scientific phenomenon or that different scientists have explained the phenomenon in different ways. Then each theorem, hypothesis or scientist’s point of view is explained separately. There are usually two viewpoints but you may see three or more.

There will be six to eight questions for this passage. They won’t be much different from some others you’ve already seen. They just have more questions related to the scientific process. You’ll need to draw logical conclusions, recognize how additional experiments and data would support one position or the other, and recognize points of disagreement.

### Applying the General Approach:

**I. Read the passage**—There are some special strategies to do with this passage type. As usual, read the introduction and then focus carefully on the first sentence of each perspective. It will almost always reveal the particular belief of that scientist or theory. These “belief statements” or “hypotheses” are followed by a narrative that supports that particular belief. Watch for:

- Evidence that directly supports the stated theory or belief,
- Statements that rebut other positions, and
- Responses to counter-arguments.

The supporting and rebuttal statements are most common. You should put a “+” in the margin next to support and a “-” in the margin next to contradictions to the other point of view so you can find them quickly when referring back to the passage.

Sometimes one position is easier to understand than the other. Don’t waste a lot of time trying to figure out the hard position. Get the easy points. If you’ve got other passages to do, go do them. If this is your last passage, only then is it worth trying to understand the difficult position.

### II. Read the question—Make sure you are referring to the correct scientist or theory.

Paraphrase the question. Determine what information you need. It may be in the narrative or a graphic. After reading the introduction and the first point of view, find all the questions that relate to that scientist. Then read the second point of view so you can do the related questions and finally do the comparison questions.

**III. Compare your answer to the answer choices**—You know what to do. Find a paraphrase of your answer.

Try your strategies on the following fanciful disagreeing scientists.

## Sample Passage

Some people have “attached” earlobes and some have “dangling” earlobes. Different explanations have been proposed as reasons why this is true. Two scientists present their views below.

### *Scientist 1*

Throughout history one can observe two distinct types of people. One group has the special advantage of pendulous earlobes from which ostentatious earrings can be hung. The other group essentially has no earlobe at all. The outer edge of their ears is attached directly and completely to the side of their necks just behind their jaw bone. It is hardly conducive to hanging dramatic, ornate jewelry.

Some scientists would like to explain this difference as some mystical biological phenomenon. It is no such thing. Clearly it is an acquired characteristic, changing as one grows up. As the ear matures it takes on a shape that reflects the intelligence of the individual. While it is commonly stated, “The eyes are the mirror of the soul,” it is also true that, “The lobes are the mirror of the mind.” Smarter individuals develop distinctive dangling lobes as they mature. Individuals with attached lobes are clearly of inferior mental capacity.

### *Scientist 2*

Hogwash! The difference between attached and dangling earlobes is certainly accounted for by home environment. My studies have concluded that earlobe shapes run in a family and so they must result from dietary habits. The shapes of the parents’ earlobes are reflected in their children’s ears. It is a matter of what foods are eaten. The more

meat that is ingested, the more pendulous the earlobes become. The more dietary fiber one consumes, the more attached is the earlobe. This is a simple case of fatty foods making deposits in the base of the ear. The adults in the house will exhibit the same traits as their children.

1. If the position of Scientist 1 is correct, which of the following would be true?
  - A. People with attached earlobes would have lower scores on intelligence tests.
  - B. People with dangling earlobes would wear large earrings.
  - C. Babies can have any shaped earlobe.
  - D. Wizards would have attached earlobes.
  
2. With which of the following statements would the two scientists most likely agree?
  - F. There are distinct advantages to dangling earlobes.
  - G. Earlobe shape is influenced by environmental factors.
  - H. All earlobes start out the same.
  - J. There are numerous possible explanations for the differences in shape.

(Continued on next page.)

3. Which of the following observations would most clearly contradict Scientist 2?

- A. One child in a household has different ears from everyone else.
- B. Grandparents have very different earlobes compared to their grandchildren.
- C. Long-term prisoners develop similar ears.
- D. A husband and wife plus their children have very different ears.

4. Which of the following findings from additional studies would resolve this dispute?

- F. 62% of Florida high school valedictorians have dangling earlobes.
- G. 55% of vegetarians have attached earlobes.
- H. No people who eat meat have attached earlobes.
- J. All high school students with attached earlobes have teachers for parents.

5. Which of the following findings from additional studies would contradict the assumptions made by both scientists?

- A. Newborn babies show a variety of earlobe sizes and shapes.
- B. People with attached earlobes wear great earrings.
- C. Vegetarians always have attached earlobes.
- D. People with dangling earlobes avoid taking the ACT.

**Disagreeing Scientists Answer Key**

1	2	3	4	5
C	H	D	H	A

## When You Get Stuck



**Words of "Wiz-dom"**—It's not a matter of "if" you get stuck. It's a matter of "when" and "how often." Count on encountering some questions that don't make much sense when you first see them. Sometimes you can't find a paraphrase of your answer when you look at your options. Here are some helpful strategies for WHEN you get stuck.

**Skip hard passages and come back.** The passages are not in order of difficulty so the next one might just be an easier or more interesting one. Quickly assess a passage and skip any difficult passage, and come back to it later if you've got time.

**Answer every question for each passage before you go on.** You can do the passages in any order but once you start work on a passage, answer all the questions without leaving any blanks before you go on to another passage. If you aren't sure about an answer, put a "?" next to it in your test booklet. Come back to it after you've finished the other questions about that passage.

**Guess among common elements of the answers.** Choose the answer that shares the most elements that appear in other answers for the same question. I know you hate to keep taking advantage of the test writer but this strategy works on the Science Reasoning Test just as well as it does on the Math Test. It certainly isn't foolproof, but it will improve your chances of being correct compared to random guessing.

**Use PICK.** Select the answer that is most consistent with the information given even though you don't understand all of it. There will be wrong/nonsense answers that you can eliminate. Rarely will you see a science question that doesn't have at least one nonsense answer.



**Words of ULTIMATE "Wiz-dom"**

**Practice. Practice.  
Practice.**