CHAPTER 6

ACT SCIENCE REASONING TEST: STRATEGIES AND CONCEPT REVIEW

The ACT Science Reasoning Test measures the interpretation, analysis, evaluation, reasoning, and problem-solving skills that apply to the study of the natural sciences. The questions require you to recognize and understand the basic concepts related to the information contained within the passages, critically examine the hypotheses developed, and generalize from given information to draw conclusions or make predictions. The ACT Science Reasoning Test includes seven passages, each followed by four to seven multiple-choice questions, for a total of forty questions. You will have thirty-five minutes to complete the ACT Science Reasoning Test. The content areas found in the passages are Biology, Chemistry, Physics, and Earth Sciences. You do not need to have advanced knowledge of these content areas; you only need to be able to interpret the data as it is presented and understand the scientific method and experimental design. All of the information you need to answer the questions is in the passages. Usually, if you’ve completed two years of science coursework in high school, you will have all of the background knowledge necessary to understand the passages and answer the questions correctly.

You may have to do some math on the ACT Science Reasoning Test. You are not, however, allowed to use a calculator. Only basic arithmetic computation will be necessary to answer these questions. You can do math scratch work right on your test booklet.

The ACT Science Reasoning Test has passages in three basic formats:

1. **Data Representation** These passages are mostly charts and graphs. The questions ask you to read information from them or spot trends within the data presented.

2. **Research Summaries** These passages explain the set-up of an experiment or a series of experiments and the results that were obtained.

3. **Conflicting Viewpoints** These passages are like the Reading Test passages. There are usually two scientists or two students who disagree on a specific scientific point, and each presents an argument defending his or her position while possibly attacking the other, conflicting position.

### GENERAL STRATEGIES AND TECHNIQUES

Use the following strategies and techniques to answer the questions on the ACT Science Reasoning Test more easily.
The correct answer is D. The introductory paragraph and the table both suggest that radon levels can be different—homes with basement cracks might be more likely to have a radon problem than those homes without basement cracks, for example. Logic will tell you that you can eliminate answer choices A and B. Because answer choice C is not supported by details in the passage, it can also be eliminated.

Be "Trendy"

Many of the Science Reasoning questions reward test takers who can spot trends in the data presented. When charts or graphs are given, take a moment to figure out which variables are being charted and note any apparent relationships between them. A direct relationship is when one variable increases as the other increases. An inverse relationship is when one variable decreases as another increases. Sometimes drawing arrows next to the data helps to show a pattern of increase or decrease.

Consider the following example:

The molar heat of fusion (ΔH_{\text{fus}}) is the amount of heat necessary to melt (or freeze) 1.00 mole of a substance at a constant pressure.

The following table lists molar heats of fusion, boiling points, and melting points for several elements.

<table>
<thead>
<tr>
<th>Element</th>
<th>Melting point (°C)</th>
<th>Boiling point (°C)</th>
<th>ΔH_{\text{fus}} (kJ/mol)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>839.00</td>
<td>1,484.00</td>
<td>8.54</td>
</tr>
<tr>
<td>Silver</td>
<td>961.92</td>
<td>2,212.00</td>
<td>11.30</td>
</tr>
<tr>
<td>Iron</td>
<td>1,535.00</td>
<td>2,750.00</td>
<td>13.80</td>
</tr>
<tr>
<td>Nickel</td>
<td>1,453.00</td>
<td>2,732.00</td>
<td>17.46</td>
</tr>
</tbody>
</table>

Note: measured at a pressure of 1 atmosphere (atm).

1. According to the table, as the energy required to melt 1.00 mole of the given elements increases, the melting points:
   A. increase only.
   B. decrease only.
   C. increase then decrease.
   D. neither increase nor decrease.

The correct answer is C. The passage states that, "The molar heat of fusion (ΔH_{\text{fus}}) is the amount of heat necessary to melt (or freeze) 1.00 mole of a substance at a constant pressure." According to the table, as the molar heat of fusion increases, the melting point increases from calcium, to silver, to iron, then decreases for nickel. By noticing a trend in the data, the question becomes easier to answer correctly.

Don't Let Them Scare You with Complex Vocabulary

There will certainly be language on the Science Reasoning Test that is new to you. Don’t be worried by words that you have never seen before. The ACT usually defines terms that are absolutely essential to your understanding. You can answer questions about some terms without even knowing exactly what they mean as long as you focus on the overall idea of the passage. Never spend
investigation and acquisition of new knowledge based upon actual physical
evidence and careful observation. The Scientific Method is a means of building
a supportable, documented understanding of our world.

The Scientific Method includes four essential elements:

1. Observation
2. Hypothesis
3. Prediction
4. Experiment

During the observation phase, the experimenter directly observes and
measures the phenomenon that is being studied. Careful notes should be taken
and all pertinent data should be recorded so that the phenomenon (the thing
observed) can be accurately described.

The experimenter then generates a hypothesis to explain the phenomenon.
He or she speculates as to the reason for the phenomenon based on the
observations made and recorded.

Next, the experimenter makes predictions to test the hypothesis. These
predictions are tested with scientific experiments designed to either prove or
disprove the hypothesis. The Scientific Method requires that any hypothesis
either be ruled out or modified if the predictions are clearly and consistently
incompatible with experimental results.

If the experiments prove the hypothesis, it may come to be regarded as a theory or law of nature. However, it is possible that new information
and discoveries could contradict any hypothesis at any stage of
experimentation.

Experimental Design

When scientists design experiments to test their hypotheses, they have to be
careful to avoid “confounding of variables.” This means that they have to
isolate, as much as possible, one variable at a time so that they can reveal
the relationships between the variables, if any. An independent variable
(manipulated by the experimenter) is under the control of the scientist. As the
scientist changes the independent variable, it is hoped that the dependent
variable (observed by the experimenter) will change as a result, and that a
relationship can be established. A control is an element of the experiment
that is not subjected to the same changes in the independent variable as the
experimental elements are. For instance, if we want to find out how the
consumption of sugar impacts the fatigue level of ACT takers, we would need
at least a few ACT takers who do not consume any sugar so that we can
measure the “baseline” or “natural” fatigue level of ACT takers for comparison
to the group who consumes sugar. If there were no control group, we wouldn’t
be able to say for sure that sugar has any impact on the fatigue level of ACT
takers. If all of the test takers consumed sugar, and if all of them were sleepy,
we would face a confounding-of-variables situation because the sleepiness
could be caused by any other factor that the group had in common, like the
ACT itself.

Some of the ACT Science Reasoning Passages refer to “studies” rather than
experiments. An experiment is an artificial situation that is created by the
researcher. A study is characterized by careful, documented observation.
Nevertheless, studies can include some of the elements of experiments, such as
control groups.
3. What is the best way for Sally to organize, interpret, and present her data?

The results of Sally's experiment are recorded on the graphs below.

**Questions 4-7 refer to the following figures. Place an "X" next to the correct answer.**

**Figure 1**

**Figure 2**

4. Based on Figure 1, which fertilizer affected plant height the most?

   ___ Fertilizer A
   ___ Fertilizer B
   ___ Fertilizer C
   ___ All were equally effective.
3. At which site were the fewest butterflies collected on Friday? 

4. Which site shows a constant increase in the number of butterflies collected daily throughout the week? 

Questions 5–8 refer to the following graph. Place an “X” next to the correct answer.

5. During which of the following one-year spans were there fewer than 10 electrical impulse events in all?
   __ 1923–1924
   __ 1925–1926
   __ 1926–1927
   __ 1930–1931

6. Which of the following one-year spans showed the highest number of electrical impulse events overall?
   __ 1922–1923
   __ 1923–1924
   __ 1924–1925
   __ 1925–1926

7. How many electrical impulse events occurred from 1923 through 1925?
   __ 6
   __ 11
   __ 18
   __ 25

8. During which year were no electrical impulse events recorded?
   __ 1922
   __ 1925
   __ 1927
   __ 1928
ANSWERS AND EXPLANATIONS

EXERCISE 1

1. Sally must design an experiment that will allow her to evaluate the effectiveness of several different fertilizers. In order to do this, she needs a group of plants for each of the different fertilizers to be used, and an additional control group. The control group should be grown in the absence of any fertilizer: this way Sally can compare the results from the other groups to the control group to measure the effectiveness of the fertilizers. For example, if the control group produces 3 flowers per plant and the Fertilizer A plant produces 6 flowers per plant, Sally will know that Fertilizer A benefited the plant. She should measure the number of flowers per plant and the height of each plant in each group at a set of specific time intervals. More measurements will typically lead to more accurate results.

2. There are several independent variables that must be controlled to conduct an accurate experiment. For example, Sally must account for differences in individual plants, distribution of fertilizer, distribution of water, and exposure to sunlight. In order to control for plant type, the same species of plant should be used in each experiment. Having multiple plants per group and averaging data can control the differences in individual plants. Sally should use equal amounts of fertilizer, water, and light for each group. In addition, the plants need to receive the fertilizer, water, and light at the same time each day.

There are two dependent variables: the number of flowers and the height of the plant. These represent the data she is trying to collect.

3. Sally should first record her data in a table. Tables are ideal for organizing numerical data. In order to better interpret and present her findings to a wide audience, Sally would benefit from a set of graphs. Since the data is a representation of growth and flower number over time, line graphs would work best. With a line graph, Sally can see the progress of a particular fertilizer over time as well as compare its effectiveness to the other fertilizers and the control group.

4. To answer this question, you should look at Figure 1 and compare the plant heights in Week 1 to the plant heights in Week 8. You can see that the line representing the height of the plants that received Fertilizer B is very steep, which indicates the greatest amount of change. The plants that received Fertilizer B grew about 30 centimeters from Week 1 to Week 8.

5. According to Figure 1, the plants that received Fertilizer B had an average height of about 33 centimeters at 5 weeks, whereas the plants in the control group (those not receiving any fertilizer) had an average height of about 13 centimeters at 5 weeks. Therefore, the plants receiving Fertilizer B were, on average, about 20 centimeters taller than the plants receiving no fertilizer.

6. The data in both figures shows that plants receiving fertilizer grew taller on average and produced more flowers on average than did the plants in the control group. This supports the statement that the application of fertilizer yields taller plants with more flowers.

7. To answer this question, find on Figure 2 the spot at which the lines representing Fertilizers B and C intersect; this is the point at which the data is identical. Because the lines intersect at Week 4 and Week 5, those are the weeks during which the plants receiving Fertilizer B and C produced the same average number of flowers.
PRACTICE QUESTIONS

Following are simulated ACT Science Reasoning passages and questions, along with explanations for all of the questions. Carefully read the directions, apply the information from this chapter, and attempt all of the questions. Preceding each of the passages is a description of the passage type.

DIRECTIONS: There are three passages in this Practice section. Each passage is followed by several questions. After reading a passage, choose the best answer to each question. Circle the letter of the answer you choose.

Data Representation

Data Representation passages present scientific information in tables, charts, graphs, and figures similar to those you might find in a scientific journal or other scientific publication. The questions associated with Data Representation passages will ask you to interpret and analyze the data shown in the tables, charts, graphs, and figures. The following is a Data Representation passage and several questions. The answers and explanations are at the end of this chapter.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Dominant alleles</th>
<th>Recessive alleles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualitative traits</td>
<td>purple round</td>
<td>white narrow green</td>
</tr>
<tr>
<td>Flower color</td>
<td>purple</td>
<td>white</td>
</tr>
<tr>
<td>Leaf shape</td>
<td>purple</td>
<td>narrow green</td>
</tr>
<tr>
<td>Color of hypocotyls</td>
<td>purple</td>
<td>green</td>
</tr>
<tr>
<td>Quantitative traits</td>
<td>short</td>
<td>tall</td>
</tr>
<tr>
<td>Plant height</td>
<td>long</td>
<td>short</td>
</tr>
<tr>
<td>Pod length</td>
<td>short</td>
<td>short</td>
</tr>
</tbody>
</table>

Figure 1 (next page) is an illustration of how some of the genetic traits may be passed from 1 generation of soybean plants to the next. Each parent passes only 1 trait on to successive generations. The plants are numbered consecutively within each generation.

Passage I

Soybeans have been bred to exhibit a hereditary association of several characteristics: flower color, leaf shape, the color of the hypocotyls (the part of the seedling that is below the seed leaf), plant height, and pod length. Some of these characteristics, or traits, are considered qualitative, because the trait is influenced by only a few genes. Other traits are considered quantitative, because they show continuous variation, and are influenced by a number of genes. Alternative versions of a gene are called alleles. The dominant and recessive alleles for each soybean characteristic are displayed in Table 1. Dominant alleles are visible traits that mask all other traits, and they are more likely to be passed along from one generation to the next. Recessive alleles are hidden characteristics that are masked by dominant alleles. A soybean plant may carry a recessive gene, whose traits will show up only in later generations.
Research Summaries

Research Summary passages provide descriptions of one or more related experiments or studies. The passages usually include a discussion of the design, methods, and results of the experiments or studies. The corresponding questions will ask you to comprehend, evaluate, and interpret the procedures and results. The following is a Research Summary passage and several questions. The answers and explanations are at the end of this chapter.

Passage II

Water pressure influences the rate at which water flows. As water pressure increases, so does the rate of flow. Water pressure can be defined as the amount of force that the water exerts on the container it's in. The more water that is in the container, the greater the water pressure will be. Students conducted the following experiment.

Experiment

Students used push pins to punch holes in an empty, plastic 2-liter bottle. The students created 4 holes, each 1-inch apart, from top to bottom. The pins were left in each hole as it was created. The bottle was filled to the top with water and placed on a table. An 8-inch by 9-inch pan with a piece of blotting paper was placed lengthwise in front of the bottle. A ruler was placed in the pan to measure the spot at which the water stream touched the paper. The students removed the pin nearest the top of the bottle and marked the spot where the water stream touched the paper. The pin was then replaced, the bottle was filled to the top, and the next pin was removed. The spot where the water stream touched the paper was measured. Rate of flow was indicated by the length of the water stream. This was repeated a total of 4 times, once for each pin. The results are recorded in Table 1.

<table>
<thead>
<tr>
<th>Pin</th>
<th>Position of pin in the bottle</th>
<th>Length of water stream (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>First (top)</td>
<td>1.5</td>
</tr>
<tr>
<td>B</td>
<td>Second</td>
<td>2.0</td>
</tr>
<tr>
<td>C</td>
<td>Third</td>
<td>3.0</td>
</tr>
<tr>
<td>D</td>
<td>Fourth (bottom)</td>
<td>3.5</td>
</tr>
</tbody>
</table>

5. Based on Table 1, water pressure is greatest:
   A. at the top of the full container.
   B. at the bottom of the full container.
   C. when the water stream is 1.5 inches long.
   D. when the water stream is 3.0 inches long.

6. Which of the following is an assumption that the students made prior to beginning the experiment?
   F. Water pressure has no effect on the length of the water stream produced.
   G. The rate of flow cannot be accurately determined using push pins and plastic bottles.
   H. The rate of flow corresponds directly to the length of the water stream produced.
   J. Water pressure and rate of flow are the two most important characteristics of water.

7. Which of the following graphs best represents the relationship between water pressure and rate of flow, according to the passage?
   A. Increasing rate of flow
   B. Increasing water pressure

8. Based on the results of the experiment, removal of Pin C:
   F. created a 3.5-inch water stream.
   G. caused the bottle to empty more quickly than did removal of Pin D.
   H. increased the total water pressure in the bottle.
   J. created a 3-inch water stream.

9. Suppose that the students removed the pins in order, replaced each pin after measuring the water stream, but did not refill the bottle after removing and replacing each pin. According to the passage, the water stream lengths would most likely:
   A. be identical to the first experiment.
   B. increase for each pin removed.
   C. decrease continually after removal of the first pin.
   D. be equal for each pin removed.
**ANSWERS AND EXPLANATIONS**

1. The correct answer is C. Based on Figure 1, Plant 1 and Plant 2 in row F2 both have purple hypocotyls, so you cannot conclude that one is dominant over the other. Eliminate answer choices A, B, and D. Since row F2 signifies the second generation of plants, both Plant 1 and Plant 2 are members of the same generation, answer choice C.

2. The correct answer is H. The passage states that a “soybean plant may carry a recessive gene, whose traits will show up only in later generations.” The passage also indicates that green hypocotyls are a recessive allele. Both of these statements support answer choice H.

3. The correct answer is A. According to Table 1, both purple flowers and round leaves are dominant traits. Therefore, it is most likely that these will be passed on to later generations. The other answer choices are not supported by the passage.

4. The correct answer is J. According to the passage, a quantitative trait shows “continuous variation.” Therefore, it makes the most sense that plant height is considered a quantitative trait because plant height varies over the lifespan of the soybean plant. The other answer choices are not supported by the passage.

5. The correct answer is B. The passage states that as “water pressure increases, so does the rate of flow.” The passage also indicates that rate of flow corresponds to the length of the water stream. Since the rate of flow was greatest when Pin D was removed, you can conclude that the water pressure was greatest at the bottom of the full container.

6. The correct answer is H. In designing the experiment, the students must have assumed that they could accurately correspond the rate of flow to the length of the water stream. The other answer choices are not supported by information presented in the experiment.

7. The correct answer is A. The passage states that as “water pressure increases, so does the rate of flow.” This relationship is indicated by the graph in answer choice A.

8. The correct answer is J. Table 1 indicates that the length of the water stream produced when Pin C was removed is 3.0 inches. The other answer choices are not supported by the passage.

9. The correct answer is C. According to the passage, the “more water that is in the container, the greater the water pressure will be.” This suggests that, if the amount of water in the container is reduced, the water pressure will also be reduced. So, if the students do not replace the water in the container, it is likely that the lengths of the water streams will decrease continually after the first pin is removed.

10. The correct answer is F. Scientist 1 argues that a planet’s location, security of its orbit, potential for planetary disasters, and surface characteristics affect the probability of complex life existing there. This argument best supports answer choice F.

11. The correct answer is C. Scientist 1 argues that “if one takes into account planetary disasters, the possibility of complex life decreases.” The other answer choices are either discussed by both scientists or by Scientist 2 only.

12. The correct answer is G. Scientist 1 argues that it takes many precise factors together to allow complex life to form. In addition, Scientist 1 says, “if one takes into account planetary disasters, the possibility of complex life decreases.” The other answer choices are not supported by the passage.

13. The correct answer is C. Scientist 2 says that “it is not impossible that there is another set of characteristics and properties that together are also able to support complex life.” Scientist 2 goes on to say that “… complex life-forms outside of our solar system may use another gas for respiration.” These statements best support answer choice C.

14. The correct answer is F. According to the passage, both scientists agree that oxygen is necessary for the existence of complex life on earth. The other answer choices are supported by either one or the other scientist, but not both, or they are not supported at all by the passage.

15. The correct answer is B. Scientist 2 states that “complex or intelligent life may not appear simultaneously… One complex life-form might never discover or know about a life-form that existed before or after the extinction of the first life-form.” This statement best supports answer choice B.