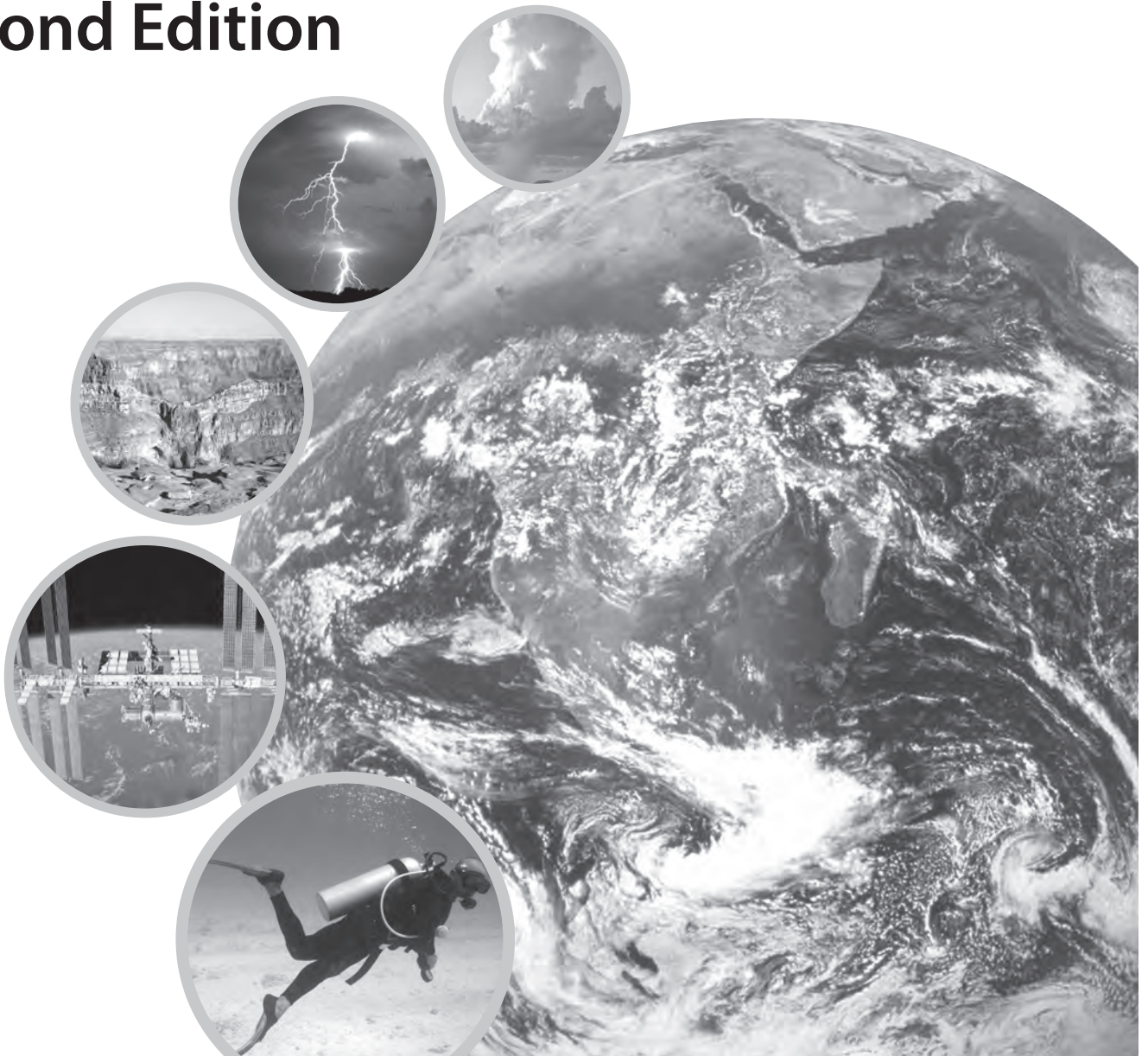


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# *Science: Earth & Space*

Second Edition

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**ANSWER KEY**

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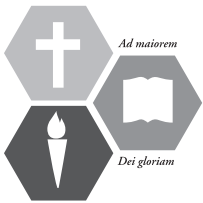
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# Preface

This answer key for *Science: Earth and Space, Second Edition* (copyright © 2018), was developed by the staff of Christian Liberty Press to help the instructor be as successful as possible in teaching this course. We have provided sample answers for the Section Review questions found at the end of each section and the Chapter Review sections at the end of each chapter. This key should be used by the instructor to review the student's daily work. Students do not necessarily have to use the same wording in their answers, but they should give the same information. Some questions have more answers given than required and are marked by *Answers will (or may) vary*; students only need to give the required number of responses as stated in the textbook.

May God grant you wisdom and diligence as you seek to teach your children the laws and realities of God's marvelous universe.

*The Staff of Christian Liberty Press*

# TEXT KEY

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## Chapter 1: Introduction to Science

### ◆ Section Review 1.1, Page 6

1. “Science is the study of the matter and movement of God’s physical creation” (p. 1).
2. Pedology is the study of soil (p. 2).
3. A scientific law is a scientific theory that has never been proven false (p. 2).
4. *Falsifiable* means that something can be proven false, that there is a situation that can occur to disprove the hypothesis (p. 2).
5. An experimental group is a group on which a test is performed, the group exposed to the variable being tested (p. 3). A control group is a group used as a standard for comparison, a group exposed to the same constants but not exposed to the variable being tested (p. 4).
6. “A prototype is a model of a design (or some part of a design) that is used for testing” (p. 6).

### ◆ Section Review 1.2, Page 10

1. An inference is a conclusion based on reasoning from evidence (p. 7).
2. An if/then statement is called a hypothetical proposition (p. 7)
3. In a hypothetical proposition, the condition (the “if” part) is called the antecedent. When this condition is known to be true, then the conclusion (the “then” part) is also true. This is called affirming the antecedent (p. 7). The conclusion is called the consequent, and if it is known to be false, the antecedent is inferred to be false. This is called denying the consequent (pp. 7–8).
4. Using the method of difference, two situations are the same except for one factor. If there is a difference in result between the two, then it can be inferred that the one different factor had a part in causing the difference. This is the basis for designing an experiment. The factor that is different is the independent variable, and the factors that are the same are the controlled variables. The effect is the dependent variable (p. 9).
5. Repeatability refers to the same scientist performing essentially the same experiment multiple times and getting the same results. Reproducibility refers to other scientists performing the same experiments, and even expanding the scope, and coming to the same conclusion (p. 9).
6. A post hoc fallacy assumes, without further evidence, that something caused what happened after it (p. 9).
7. A model is anything that provides a representation of something else. A verbal model is a description of something using words. A hypothesis is a verbal model, using words to describe an effect or process (pp. 9–10).

### **Thought Provoker**

In a properly constructed hypothetical proposition, if the condition (the antecedent) is met, then the conclusion (the consequent) must be true. The grammar of the statement dictates it (p. 7).

### ◆ Section Review 1.3, Page 17

1. Organic material (humus) and inorganic mineral material are the two kinds of material that make up soil (p. 11).



2. Humus enriches the soil with nutrients (p. 11).
3. Topsoil and subsoil are the top two layers of soil (p. 12).
4. Weathering is the process by which rocks are broken down into soil (p. 12).
5. The “combination of different sizes of mineral particles determines the texture of the soil.” The “type of rock and the method of weathering determine the particle size and composition of mineral materials” (p. 12).
6. Sand allows air and water into the soil (p. 12).
7. Loam is a balanced mixture of sand, silt, clay, and humus (p. 13).
8. Soil color can indicate the amount of organic matter and the types of minerals present in the soil (p. 14).
9. The pH scale expresses the acidity or basicity of a substance. The value of 7 is neutral. Values less than 7 are acidic, and values greater than 7 are basic (p. 15).

### ◆ Section Review 1.4, Page 22

1. Nitrogen, phosphorus, and potassium are the primary plant food elements (p. 17).
2. Phosphorus in fertilizer is usually in the form of phosphates (p. 17).
3. Nitrogen-fixing bacteria are bacteria that convert nitrogen into nitrogen compounds (p. 18).
4. Nitrifying bacteria convert ammonia into nitrates (p. 18).
5. Denitrifying bacteria put nitrogen back into the air (p. 18).
6. Phosphorus promotes plant growth through energy transfer. It is essential for cell division and promotes maturation and fruit formation (p. 19).
7. Potassium improves disease resistance, encourages root and fruit growth, and helps to regulate water balance in plants (p. 19).

#### Thought Provoker

Lightning “causes nitrogen and oxygen to form nitrates that are carried to the soil by rain.” Nitrates are essential for plant growth, and therefore benefit man in the form of fruits and vegetables for our food (pp. 17–18).

### ◆ Section Review 1.5, Page 26

1. *Impermeable* means “nonporous” (p. 23).
2. When the pore spaces in the soil are completely filled with water, the soil and porous rock are saturated (p. 23).

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**Note:** It is likely that question 3 was meant to read: “Give the term that describes any water located below the soil’s surface.”

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3. Groundwater is any collected water below the soil’s surface. The water table is the upper surface of groundwater (p. 23).
4. The size and number of pores, and the amount of recent rainfall, are the two factors that determine the depth of the water table (p. 23).
5. An aquifer is an amount of ground water collected in porous rock or a gravel-soil mixture. An aquifer is usually formed below or between layers of impermeable rock (p. 23).
6. Capillarity (or capillary action) is the upward movement of water through a tiny space in response to surface tension (p. 24).

### Thought Provoker

Plants need air to be available to their roots. “If no air is available to the roots, the plant will suffocate. The roots of plants use oxygen from the air found in the pore spaces of soil” (p. 22). If the pore spaces are full of water for too long, the plant will “drown.”

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## Chapter 1 Review, Pages 26–27

### ◆ Define

1. **science:** the study of the matter and movement of God’s physical creation (p. 1)
2. **matter:** the substance of the physical world; anything that occupies space or has substance (p. 1)
3. **pedology:** the study of soil (p. 2)
4. **scientific method:** an organized way for scientists to gather and pursue scientific knowledge; hypothesizing, observing, and experimenting are the three main components (p. 2)
5. **hypothesis:** a sensible explanation for an event of nature, formulated after gathering information and giving thought to the problem (p. 2)  
**data:** facts (p. 2)
6. **criterion:** one of the minimum characteristics that a design must have to function (p. 5)  
**constraint:** any characteristic required to solve the problem (p. 5)
7. **inference:** a conclusion based on reasoning from evidence (p. 7)
8. **proposition:** a statement of fact (p. 7)  
**hypothetical proposition:** an if/then statement; if the antecedent (condition) is true, then the consequent (the conclusion) is also true (p. 7)
9. **repeatability:** refers to the ability of the scientist to repeat an experiment multiple times and get the same result (p. 9)  
**reproducibility:** refers to the ability of others to repeat and expand on the experiment and come to the same conclusion (p. 9)
10. **post hoc fallacy:** the assumption, without further evidence, that something caused what happened after it (p. 9)
11. **organic material:** component of soil that is derived from living organisms (humus) (pp. 10–11)  
**mineral material:** component of soil that is derived from nonliving matter (minerals and rocks) (p. 11)
12. **atom:** the most basic unit of matter (p. 11)  
**molecule:** atoms linked together in a group (p. 11)
13. **mass:** the amount of matter (atoms and molecules) in an object (p. 11)  
**weight:** the pull of gravity on an object (p. 11)  
**density:** how tightly packed the atoms and molecules are in an object (p. 11)
14. **weathering:** processes that break rock down into soil (p. 12)
15. **bedrock:** layer of solid rock below the subsoil (p. 12)
16. **loam:** a balanced mixture of sand, silt, clay, and humus (p. 13)
17. **pH scale:** scale used to express the acidity or basicity of a substance (p. 15)



18. **phosphates:** a group of chemicals containing the element phosphorus bonded to oxygen and other elements (p. 17)  
**potash:** potassium oxide, a chemical of two potassium atoms bonded to an oxygen atom (p. 17)
19. **element:** substance composed of only one type of atom (p. 17)  
**compound:** substance containing two or more elements bonded together (p. 18)
20. **nitrogen-fixing bacteria:** bacteria that convert nitrogen into nitrogen compounds (p. 18)
21. **saturated:** completely filled with water (p. 23)  
**groundwater:** any collected water below the soil's surface (p. 23)
22. **aquifer:** groundwater collected in porous rock or gravel-soil mixture, usually formed below or between layers of impermeable rock (pp. 23–24)  
**artesian well:** a self-pumping well; a well drilled into an aquifer where the water is under pressure and will automatically rise to the surface (p. 24)
23. **capillarity:** upward movement of water through a tiny space in response to surface tension (p. 24)

### ◆ Identify

1. Hypothesizing, observing, and experimenting are the three main components of the scientific method (p. 2).
2. Inductive reasoning and deductive reasoning are the two main categories of reasoning (p. 7).
3. Recycling is the reusing of old materials (p. 12).
4. Topsoil and subsoil are the top two soil horizons (p. 12).
5. Munsell charts are used to describe soil colors (p. 14).
6. Nitrogen, phosphorus, and potassium are the three primary plant food elements (p. 17).
7. The water table is the upper surface of groundwater (p. 23).

### ◆ Explain

1. The independent variable in an experiment is the factor that is changed in the test subjects in order to test the hypothesis. The dependent variable is the factor that is observed to determine the results of the experiment (p. 3).
2. Only one independent variable should be used in an experiment in order to make the results clear. If more than one variable is used, the scientist will not know which variable produced the result that he observed (p. 3).
3. An experimental group is the group on which the test is performed, whereas the control group is a group in which the independent variable is absent; it is used for comparison (pp. 3–4).
4. A prototype is a model used to test the design. It may be completely functional or be a partial model used to test one aspect of the design. Improvements are made to the design after testing using the prototype (p. 6).
5. In a hypothetical proposition, the condition (the “if” part) is called the antecedent. When this condition is known to be true, then the conclusion (the “then” part) is also true. This is called affirming the antecedent (p. 7). The conclusion is called the consequent, and if it is known to be false, the antecedent is inferred to be false. This is called denying the consequent (pp. 7–8).
6. Using the method of difference, two situations are the same except for one factor. If there is a difference in result between the two, then it can be inferred that the one different factor had a part in causing the difference (p. 9).

7. “Inductive reasoning can never prove a hypothesis beyond all doubt. No matter how carefully observations and experiments are performed, it cannot be ensured that every possible factor is the same in every observation” (p. 9).
8. Humus is important because it holds water in the ground and it enriches the soil with nutrients (p. 11).
9. The “combination of different sizes of mineral particles determines the texture of the soil.” The “type of rock and the method of weathering determine the particle size and composition of mineral materials” (p. 12).
10. Sand is made up of large particles and is coarse. Silt is made up of smaller particles and feels smooth like flour. Clay is made up of smaller particles yet and is tightly packed, hard, and moldable (when wet) (p. 12).
11. The amount of organic matter and the types of minerals present affect soil color (p. 14).
12. Soil pH affects the growth of plants because different plants grow well in different pH conditions. Most plants grow best in soil that is neutral or slightly acidic (p. 15).
13. Phosphorus is essential for cell division and promotes maturation (p. 19).
14. Plants need air to be available to their roots. “If no air is available to the roots, the plant will suffocate. The roots of plants use oxygen from the air found in the pore spaces of soil” (p. 22).
15. As rain seeps down through loose topsoil, the water forms a film on the surface of each soil particle, keeping some water in the soil above the water table (p. 23). Also, upward movement of water in response to surface tension (capillarity) draws water into the soil above the water table (p. 24).

### ◆ Apply

1. A hypothesis must be falsifiable (have the possibility of being false) to be scientific. To test the hypothesis, there must be some situation that can occur that would disprove the hypothesis (p. 2).
2. *Answers will vary. See pages 2–4 for experimental procedures.*
3. For the hypothetical proposition, “If lemon juice has a pH below 7, it is acidic,” affirming the antecedent (confirming that lemon juice has a pH below 7) leads to the conclusion that lemon juice is acidic (p. 7).
4. Plants, animals, and humans all depend on the nitrogen cycle for life. Nitrogen is an important component in the atmosphere and is also essential in the soil for plant growth. Humans and animals eat the plants, and humans also eat animals that depend on the plants (p. 18).
5. Both nitrifying bacteria and denitrifying bacteria perform amazing conversions regarding nitrogen. Nitrifying bacteria convert ammonia into nitrates, and denitrifying bacteria convert nitrates in the soil to atmospheric nitrogen (p. 18).
6. If the pore spaces are full of water for too long, the plant will “drown,” since the roots need the air found in the pore spaces (p. 22).
7. An artesian well works only when the water is under enough pressure to push it up through the small opening of the well. If the aquifer were not below an impermeable rock layer, the water would have plenty of places to flow and would not be under pressure. It would simply spread out (p. 24).

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## Chapter 2: Foundations of Geology

### ◆ Section Review 2.1, Page 38

1. Geology is the study of the earth (p. 28).