CONTENTS

Acknowledgments ix

How to Use This Curriculum xi

Unit 1: Foundations of Physics 1
- **LESSON 1:** A Physics Foundation 2
- **LESSON 2:** A Recipe for Success 6
- **LESSON 3:** Meaningful Measuring 14
- **LESSON 4:** Fancy Metrics 20

Unit 2: Parts and Pieces 25
- **LESSON 5:** Building Blocks 26
- **LESSON 6:** Particular Particles 30
- **LESSON 7:** A Construction of Molecules 36

Unit 3: States of Matter 41
- **LESSON 8:** Slow Solids and Lively Liquids 42
- **LESSON 9:** Gases and Plasma 46
- **LESSON 10:** Stating the Obvious 52

Unit 4: Forces and Work 57
- **LESSON 11:** Feel the Force 58
- **LESSON 12:** Gravity Is Great 62
- **LESSON 13:** No Worries about Work 66
- **LESSON 14:** To Your Advantage 70

Unit 5: Motion 77
- **LESSON 15:** Newton Knew the Laws 78
- **LESSON 16:** Getting Stuck on Friction 82
- **LESSON 17:** Moving On 86
- **LESSON 18:** Moving Around 90
- **LESSON 19:** Projectile Possibilities 94
- **LESSON 20:** Keep the Ball Rolling 98

Unit 6: Energy and the Electromagnetic Spectrum 103
- **LESSON 21:** Don't Run out of Energy 104
- **LESSON 22:** Catch the Wave 110
- **LESSON 23:** Time to Connect 116
- **LESSON 24:** A Bright Idea 122
- **LESSON 25:** X-Ray Vision 128

Unit 7: Heat and Sound 133
- **LESSON 26:** Warming Up 134
- **LESSON 27:** Did You Hear That? 140
- **LESSON 28:** The Sound of Music 144

Unit 8: Attractive Forces 149
- **LESSON 29:** Get a Charge 150
- **LESSON 30:** What's in That Wire? 154
- **LESSON 31:** Attracted to Magnetism 158
- **LESSON 32:** Don't Forget Your Compass 162

God's Loving Plan 166

Glossary 171

Image Credits 181

About the Author 189

LESSON 8

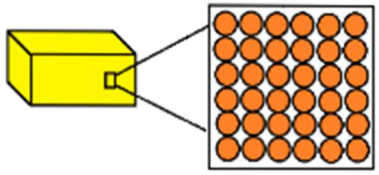
SLOW SOLIDS AND LIVELY LIQUIDS

Goal: To understand the differences between solids and liquids based upon their shape, molecular movement, and volume.

Did you know that molecules are in motion? They do not just rest quietly but are always moving around, even if we don't see their motion. Just how much a molecule moves depends on its energy. The more energy it has, the more it moves around. This idea of molecules moving around is very important in understanding the differences between solids and liquids. Do you know the differences? One difference is that the molecules in a liquid move faster than those in a solid.

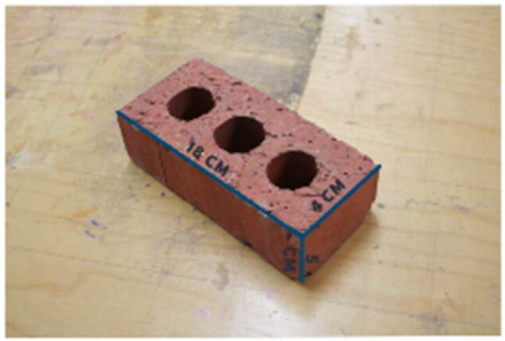
Water is a liquid at room temperature. When it gets cold enough, it becomes a solid (ice), and when it gets hot enough, it becomes a gas.

Any kind of matter that has a definite shape and definite volume is a **solid**. Definite shape means that the shape doesn't change. Consider a piece of gold. It has a definite shape. If it is a piece of jewelry, it may be shaped like a ring. When you place it on your finger, it keeps its shape. A chair, a leaf, and your foot are all solids. There are thousands of examples of solids God created. A solid's molecules move—but so slowly that it keeps its shape.



In a solid, all of the molecules vibrate, but they don't move about. That is what makes a solid keep its shape.

Another important characteristic of solids is that they have definite volume. **Volume** is the amount of space something occupies or how much space there is inside it. Let's think about a brick—the kind you might find in a building or a sidewalk. We can measure its length, width, and height to find its volume.



By multiplying these 3 dimensions, we can figure out the volume: 18 cm × 5 cm × 4 cm = 360 cm³.

VOCABULARY

solid
volume
liquid
state of matter

SCRIPTURE MEMORY

John 7:38: "The one who believes in Me, as the Scripture said, 'From his innermost being will flow rivers of living water.'"

The molecules of a **liquid** move much faster than a solid's molecules because liquids have more energy. They have a definite volume that flows freely. One way to identify a liquid is whether it can be poured. The volume of a liquid is definite and can be measured. If you put some water into a measuring cup, you can look at the marks on the side of the cup to see how many milliliters of a liquid you have.

Although a liquid has a definite volume, its shape changes based upon the container it's in. For example, when you pour a glass of water, the water doesn't fall out of the pitcher in a chunk; it takes the shape of your glass. If you pour water into a flower vase, the water takes the shape of the vase. Even though the shape changes, the amount of liquid obviously stays the same.

A state of matter is one of the forms in which matter can exist. Matter that is solid is said to be in a solid state. When it is liquid, it is in a liquid state. The difference between states of matter is the amount of energy the molecules have. We know that the molecules in a liquid move much faster than the molecules in a solid, and as we will see in the next lesson, the molecules in gases move even faster.

The volume of this water is approximately 40 ml. If you poured the water into a container with a different shape, the volume would still be the same.

CREATION CORNER

ICE AND WATER

Have you ever walked on a frozen puddle or pond? Normally when a liquid is frozen, the solid it creates is denser than the liquid was. One exception to this rule that shows the incredible forethought of our Creator is water. When water freezes, its solid (ice) is less dense than liquid water. You can imagine the effect of this on our world when you picture what happens when a pond freezes. If ice were denser than water, it would freeze and then sink to the bottom of the pond, killing pond life with it. Or, depending on the temperature, it would freeze from the bottom up, also killing organisms. An ocean freezing would be even more devastating than a pond, possibly causing worldwide flooding. However, because ice floats in water, it creates insulation, protecting marine life underneath. Ice in the Arctic also provides a place to live for animals like polar bears and seals. Because ice floats, these cold-weather creatures can easily travel across it for miles to find food. The next time you observe ice floating in your cold drink, consider the design our Creator put into why your ice cubes float.

MEET THE PHYSICIST

ROBERT BOYLE (1627–1691)

Robert Boyle was born in Ireland to a very wealthy family. When he was 12, he and his brother began a tour of Europe, including Italy, where Boyle learned of Galileo, whose studies interested him. As an adult, Boyle sold much of his family land, allowing him to focus on his love of science. His greatest contributions to science were his work with gases and the law named after him, Boyle's law. Without this law, scientists would not understand how weather changes due to pressure, how our lungs work, or why our ears pop when we climb a mountain. Boyle also studied the physical qualities of a gas all around us—air—and wrote many books about how matter changes physically into different states. He also wrote extensively about his worldview, explaining that God created the universe according to definite laws.